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**THE AFRICAN PRIMARY SCIENCE AND  
AFRICAN MATHEMATICS PROGRAMS:  
EVALUATION AND RECOMMENDATIONS**

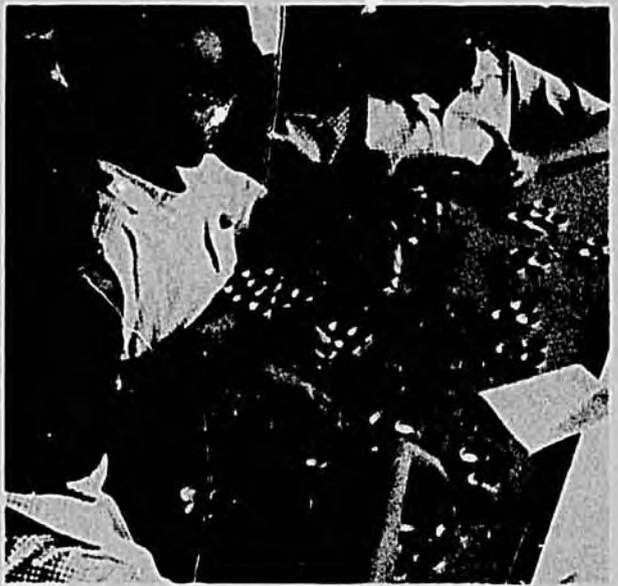
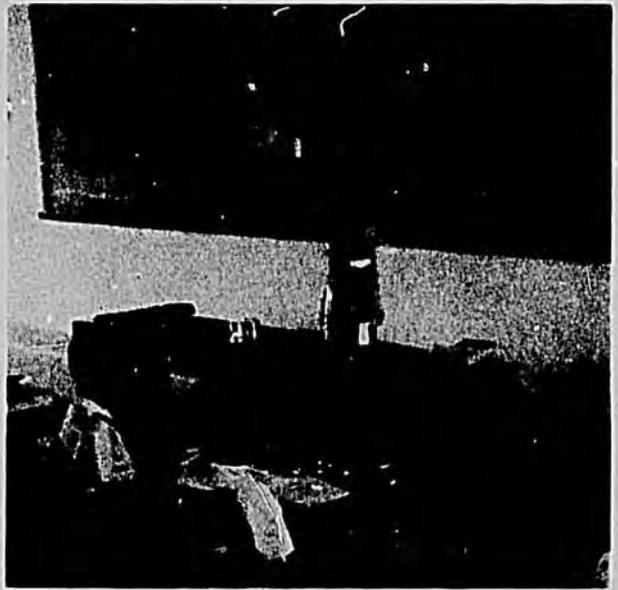
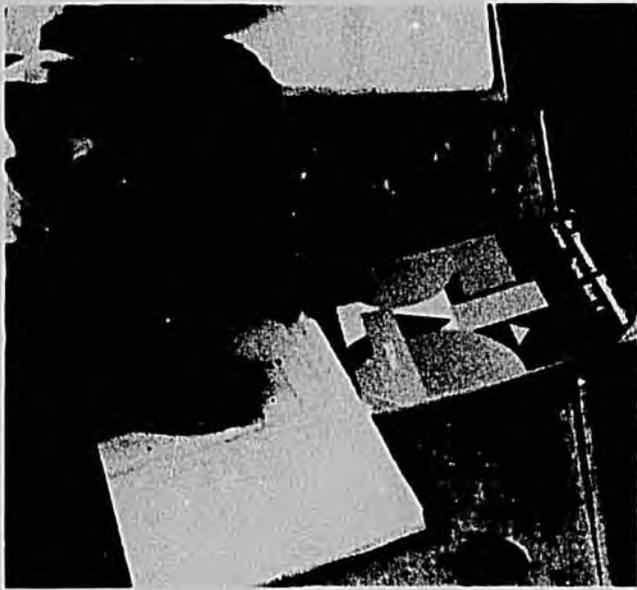
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Evaluation and Recommendations

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## Preface and Acknowledgements

The American Institutes for Research (AIR), and the Accra Office of the Test Development and Research Office of the West African Examinations Council, present this evaluation of the current utilization and impact of the African Mathematics Program (AMP) and the African Primary Science Program (APSP). These two Programs, developed by the Education Development Center (EDC), are currently in their implementation phases under Contracts AID/afr-711 and AID/afr-791. A summary of major recommendations and conclusions follows this preface. For the reader unfamiliar with AMP and APSP, the report then continues with a brief introduction to the African educational setting. This is followed by a presentation of the evaluation criteria, an abbreviated history of the projects which provided the research and developmental basis for the current implementation phase, a section on current utilization and impact of the implementation phase, and major conclusions with 56 program recommendations.

This study was funded through the Agency's Indefinite Quantity Contract AID/csd-3377, Work Order No. 2. Three full-time AIR staff members and two consultant African educators conducted evaluation field visits between 5 October and 11 November 1972. The five-person evaluation team included Dr. Victor J. Cleutat (Principal Investigator), Dr. David J. Klaus, (Project Director), Mrs. Jane G. Schubert (Project Associate), Dr. Christian O. Agbenyega (Consultant Coordinator for West Africa and Officer of the West African Examinations Council), and Dr. William C. E. Young (Consultant Coordinator for East Africa and Senior Lecturer, Faculty of Education, University of Nairobi). The in-depth cooperation of two African educators was helpful in assuring an assessment report of AMP and APSP which included the viewpoints of African educational experiences and philosophies.

This evaluation presents the utilization and impact of the AMP and APSP implementation at the time of the evaluation team's field visit, between 5 October and 11 November 1972, and developments subsequent to that time are not covered in the report. Much of the utilization and impact information

upon which the report is based was obtained through field interviews, the primary source of this information being the 47 interviewees listed in Appendix A. This annotated Appendix indicates each person's association with the programs, as well as their Ministry, University, or other affiliation within each country. Fiscal and scheduling constraints did not permit differential estimates of the accuracy or timeliness of the information obtained from each of these sources, operational constraints thus dictating the acceptance of interview information at face value as a portion of the data base for the report. These sources of information, however, were in many cases supplemented by information intrinsically more reliable, such as data from the contractor's reports to AID, records of meetings, and actual classroom observations which were conducted in each country visited.

Major recommendations and conclusions are summarized to provide the reader having limited time with a concise overview of the report. Those readers interested in further details should note that the section on recommendations and conclusions does not contain all data upon which the 56 recommendations are based. These recommendations in many cases are based on detailed data within the utilization and impact section.

Recommendations are directed at the major areas of the implementation programs as required in the evaluation contract: curriculum development, teacher preparation, in-country utilization, evaluation expertise, project administration, and institutional structure. The purpose of the evaluation was not to evaluate the research and development phases of the predecessor contracts, nor primarily the quality of the educational materials produced. Inclusion of a history of these projects is presented only to place the present implementation projects in proper historical context.

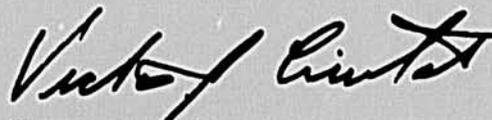
The AMP implementation contract includes Ethiopia, Ghana, Kenya, Liberia, and Sierra Leone; the APSP contract covers Ghana, Kenya, Sierra Leone, Tanzania, and Uganda. Three or four members of the evaluation team, in every case including one African consultant, visited each target country. (Visits to Tanzania and Uganda were scheduled but later cancelled during the field trip at the suggestion of AID. By reviewing secondary sources, and interviewing EDC personnel who had worked in these countries, the utilization and impact of APSP activities in Tanzania and Uganda were partially determined.)

The evaluation team acknowledges the competent and willing cooperation of EDC staff throughout the planning, conduct, and report preparation phases of this evaluation effort. Following an oral briefing on the field visits, presented to AID/Washington officials on 12 December 1972, a preliminary report was prepared representing an amplification of the tentative conclusions presented at that meeting. It was based upon further analysis of field observations, comments from the two African consultants on the tentative results, and additional discussions among the AIR project staff. This version of the report was reviewed by EDC staff and consultants and discussed with them at a meeting including AID/Washington officials on 14 March 1973. This meeting was attended by the following EDC staff members and consultants: Jack S. Goldstein, John Joanou, W. T. Martin, Gilbert Oakley, Jr., and Ralph H. Robins. Appreciation is acknowledged for their insightful review of the preliminary report, identification of certain factual errors which were not apparent from the field interviews, and presentation of supplementary information in areas where full data were not available during the field visits.

At this same meeting a number of project developments were reported, that had occurred subsequent to the evaluation team's field visit. These should be taken into account in any re-programming of these projects. It was noted that the present report should remain as the team's evaluation of the projects at the time of the field visit. Recommendations are thus based upon the status of the projects at that time.

In addition to the interviewees listed in Appendix A, the team also met with numerous classroom teachers, headmasters, and AID staff. It is impossible here to acknowledge adequately the indebtedness to all who provided guidance and information for this evaluation, sharing their knowledge, experience, and expertise with the team. Their assistance was invaluable in our pre-departure preparations, field interviews, and report writing. In addition to the five EDC staff and consultants mentioned above, the team especially appreciated the generous assistance of the following persons: Samuel H. Adu-Ampoma, Bryan A. Axtell, John E. Bowers, Robert W. Carlisle, Julius E. Coles, Roy Dubisch, Samuel D. During, Hubert M. Dyasi,

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Victor J. Cleutat  
Principal Investigator

February 1973

## Summary

### Introduction

The purpose of this evaluation project was to examine the current activities of the African Primary Science Program (APSP) and the African Mathematics Program (AMP) and, as a result of this assessment, identify ways in which the ongoing efforts of these two projects might be enhanced. Both programs were evaluated simultaneously because both are being conducted under contract with the Educational Development Center (EDC) and both include the participation of three of the same African countries.

Although AMP has been underway since 1961, and APSP since 1965, this evaluation focused only on the current implementation phase of each project. Implementation activities are limited to those from the larger group of earlier participating countries which demonstrated both a need for, and an interest in, continued assistance. Thus, while the background of each project has been included in the report to provide historical perspective, this evaluation and the conclusions and recommendations derived from it address only the most recent segment of what has been a very broad effort. No attempt was made to assess the full impact of these two projects on African education in general, or within countries not participating in the implementation projects.

Visits by the evaluation team were made during October and November 1972 to five of the seven countries participating in the implementation projects: Ethiopia, Ghana, Kenya, Liberia, and Sierra Leone. Circumstances prevented visits to Tanzania and Uganda, but some information was obtained on the projects in these countries as well. During the visits, interviews were conducted with 47 Ministry of Education officials, senior educators and contractor personnel; in addition, classroom observations were made in each of the countries and various other contacts were made with classroom teachers, school principals, and other individuals. Contractor reports and related documents provided additional data. The assessment of these two projects reflects their status at the time of the field visits, and accomplishments since then have not been incorporated into this report.

This evaluation concentrated on assessing progress toward implementation objectives in six areas for both mathematics and science: curriculum development, teacher preparation, in-country utilization, evaluation expertise, project administration, and institutional structure. Because of the patterns of institutionalization that have evolved, the mathematics project was considered separately for East and West Africa while the science project was viewed as a single effort. Emphasis was given to each of these three programs as a whole and not to easily anticipated variations in their status or impact within individual countries. Furthermore, no attempt was made to evaluate the technical quality of the contents of the curriculum materials or to assess the role of the curriculum projects in economic development or educational reform.

### Background

AMP and APSP both resulted from a conference at Massachusetts Institute of Technology's Endicott House held in 1961. The participating African and American educators concerned themselves with the need for modern and innovative curricula in Africa, particularly those which emphasized inquiry and activity techniques as opposed to classroom lectures. Actual demonstrations of a variety of these new approaches made a substantial impact on the African educators at the conference. There also was considerable interest in the non-traditional content represented by "modern" mathematics and new programs in elementary science.

Two subsequent conferences in Africa led to the creation of the African Mathematics Program. The goal of this program was the design and development of an experimental curriculum in mathematics for Africa. The preparation of the needed student texts, teacher guides, achievement examinations, and supporting materials was carried out through a series of seven summer workshops from 1962 to 1968. The first three of these were held at Entebbe, Uganda, and the remainder at Mombasa, Kenya. Ten African countries were represented at the workshops; roughly half of the participants were African and half were American experts.

Sixty-seven separate volumes were produced during these workshops. They comprised a curriculum in mathematics from Primary I through Secondary V

plus additional texts for advanced secondary pupils and teacher training candidates. As each volume was completed, it was sent to the U.S. for editing and for the reproduction of sufficient copies for tryouts in the participating countries. These, together with additional copies reproduced in Africa by some of the countries, made it possible for an estimated 2,000 classes to use the materials experimentally through 1969 when the series was completed.

Along with the development of curriculum materials in modern mathematics, emphasis was given to teacher training to acquaint teachers with the new content to be taught and the new methods to be used. Nearly 4,000 teachers, inspectors, and teacher training tutors attended workshops of one to three weeks each between 1963 and 1970. In addition, a special program of institutes supplemented by correspondence lessons was offered to senior mathematics tutors and other African educators from 1966 to 1968. This program, called the ABC Institutes, was sponsored by the Ford Foundation.

The current implementation phase of AMP, being conducted in five of the original ten countries, began in 1970. The goals of this phase were to provide instruction to mathematics tutors and supervisors, to produce new common mathematics textbooks based on the Entebbe and other texts, and to build a nucleus of local personnel capable in curriculum development and research in mathematics. This phase is being conducted on a regional basis, with Ethiopia and Kenya forming the East African Regional Mathematics Program (EARMP) and Ghana, Liberia, and Sierra Leone the West African Regional Mathematics Program (WARMP).

Both regions, through their largely African Management Committees, have begun regional institutions with African administrators. The EARMP headquarters is in Addis Ababa, Ethiopia, and the WARMP headquarters is in Accra, Ghana. Both regions have undertaken summer workshops to develop new regional materials in mathematics and both have initiated training programs for tutors and inspectors modeled after the earlier ABC Institutes. In EARMP, the two member countries already had begun their own preparation and utilization of modern mathematics texts before the implementation phase was initiated, and therefore have limited their joint curriculum development efforts primarily to new teacher training texts. The three WARMP countries,

none of which now has a complete modern mathematics curriculum, have begun preparing a full series of primary, secondary, and teacher training texts through the current series of summer workshops. In each region, trainee editors and trainee evaluators have been appointed to gradually assume the roles of editing and organizing draft materials and the conduct of evaluation studies.

The development phase of the African Primary Science Program began in 1965. The goals of this project were to promote national science centers in the participating countries, to create center staffs capable of creating curriculum materials and offering in-service training, and to provide and distribute curriculum materials appropriate for primary school science in Africa. Fourteen countries have participated in the project at one time or another. Unlike AMP, with its focus on a full range of student texts and accompanying teacher guides, the main thrust of APSP has been toward development of flexible units of instruction which depend primarily on locally available materials such as sand, jars, and tubing. The students use these materials to participate in learning activities that are described for the teacher in a pamphlet prepared for each unit. No student texts are required for most units, nor are fixed sequences of instruction required.

Summer workshops to develop prototype primary science materials were held in various African countries from 1965 to 1969. This effort ultimately produced 54 science units which may be used as an intact science curriculum, as a supplement to other science materials, or as models for local adaptations. During this period local science centers were established in seven of the participating countries as bases for further curriculum development efforts. Both pre-service and in-service teacher training was carried out to acquaint classroom teachers with the "discovery" method of instruction featured by this curriculum.

The implementation phase of APSP began in 1971. The five originally participating countries which joined this phase of the project were Ghana, Kenya, Sierra Leone, Tanzania, and Uganda. The goals of this phase have been the preparation of teacher training materials and aids to tutors in the use of these materials, training of curriculum development personnel at the local science centers, and support of an African based and directed organization

called Science Education Programme for Africa (SEPA). This organization represents an affiliation of most of the fourteen countries involved in APSP and has its headquarters in Accra, Ghana.

### Results

Both AMP and APSP have had considerable impact on educational efforts throughout Africa. These two projects are widely known and many thousands of students, teachers, and educators have used or have been involved with the new curriculum materials. Not surprisingly, there was considerable variation from country to country in the present or planned use of the curriculum materials created through these efforts. This variation may be due, in part, to differing needs within each country. Curriculum reform often has less priority than the more immediate task of providing as many students as possible with a classroom, a teacher, and a textbook. Preferences for competing approaches and the influence of other educational assistance programs can detract from the unanimity of support and endorsement frequently needed for success. Problems in printing, communications, and teacher preparation can override schedules and restrict options. Finally, an eagerness to achieve national identity can itself inhibit regional undertakings by giving priority to uniquely national solutions.

Despite these distractions, educators in all of the countries visited voiced a firm commitment toward the concepts of modern mathematics, the expansion of elementary science programs, and the pedagogic principles of the discovery approach. Even more important is the impact which these projects have had on knowledge within Africa about the process of curriculum reform and on the eagerness of African educators to explore and develop new curriculum models and materials to meet their own needs. In these accomplishments, the two programs have made lasting and far reaching contributions to the future growth and quality of African education. Thus, while the objectives of this evaluation were directed only at the current implementation phase of AMP and APSP, the cumulative gains from earlier efforts cannot be omitted from the evaluation results. The remainder of the results are divided into those appropriate to the East African Regional Mathematics Program, the West African Regional Mathematics Program, and the African Primary Science Program.

The implementation of a new, modern mathematics curriculum has been initiated independently by each of the participating countries in East Africa. In Ethiopia, where education in mathematics has received high priority within the government, the first two years of the original Entebbe primary texts have been translated into Amharic and are being introduced into the schools. Work is underway to translate and adopt additional texts from the series for use in grades three through six. Meanwhile, locally produced versions of the Entebbe materials have been adopted as the standard texts for middle and secondary grades where English is used for instruction. Although further revisions of the mathematics syllabus have been proposed and probably will be implemented, the approach and content is expected to continue along the lines of AMP.

In Kenya, a new program in primary mathematics was begun by the Ministry of Education in 1965. The materials being created for this curriculum reflect the Entebbe program but their developers consider them more as original texts than as adaptations. Student and teacher volumes for the first two years have been introduced into the schools and reports indicate they are being well received. A new curriculum recently was completed for secondary students in mathematics. It is largely British oriented, reflecting the expatriate dominance of the developmental team and of secondary school instruction in Kenya.

In both Ethiopia and Kenya, teacher training is regarded as a critical need. To meet this need, the EARMP countries have undertaken the development of new teacher training materials with contractor assistance on a regional basis as part of the current implementation effort. At the time of the evaluation team's visit, Volume I had been prepared, tried out, and revised. Volume II had been written and was undergoing field testing. Camera-ready copy of these texts and a supplemental volume now in preparation is expected to be given to the countries for reproduction and distribution in 1973. These materials were based on the four-volume Entebbe teacher training series but have been simplified to better meet the needs of typical teacher candidates.

A two-year training program for tutors at teacher training colleges and for school inspectors has been less successful. Participation in the

correspondence part of the program, which bridges the institutions held each summer, has been low in both countries. Turnover among tutors in Ethiopia and the relatively poor mathematics background of school inspectors in Kenya have further detracted from the program's potential. As a consequence, it will be several years before the pre-service and in-service training of teachers in the proper use of the new mathematics curriculum materials being introduced will be generally evident.

Further strengthening of the current EARMP effort was felt to be possible in certain areas. The curriculum development efforts that have been undertaken by each country could profit from more direct assistance and the assignment of staff as full-time counterparts to contractor personnel working on the teacher training texts. Evaluation efforts have thus far tended to be informal and, although an evaluator is being trained for each country, additional emphasis on evaluation as an important ingredient in curriculum development would be helpful. Finally, the creation of a regional institution to carry on program activities after the completion of the contract has proceeded more slowly than planned, perhaps because its intended functions do not seem to be essential to either ongoing or planned efforts.

In the West African region, an attempt is being made to prepare new versions of the entire primary and secondary series on a regional basis as well as new teacher training texts. All three countries have indicated their intention to consider this new program when it is available although there are obstacles in each country which may hinder their ultimate adoption of these materials.

In Ghana, a new series of primary texts in modern mathematics recently has been adopted by the Ministry of Education and these materials currently are being furnished for the first four of the seven years of primary school. This privately authored series was influenced by, but not based upon, the Entebbe curriculum. All of the secondary schools that teach modern mathematics are now using a British-oriented series which was recently prepared in Ghana by British expatriates. The present availability of these two groups of texts, their explicit suitability for Ghanaian children, and the anticipated cost of introducing another new curriculum were identified as reasons why adoption of the WARMP material may be problematical.

Neither Liberia nor Sierra Leone currently use modern mathematics texts in their primary or secondary schools. In both countries, however, curriculum planning committees are now in the process of devising modern syllabuses to use in selecting new mathematics curricula to meet their country's needs. Both countries had experimented with the Entebbe texts, but this series has been out-of-print and unavailable since shortly after the texts were completed. Although both Liberia and Sierra Leone could adopt the new series being prepared through WARMP, officials and educators in each country stressed that some further local adaptations of the materials probably would be necessary before these materials could be used. The delay in offering these materials for inspection also could hamper selection of the WARMP series; at the time of the visit, more than two years after work had begun on these texts, no copies of any of the volumes had yet been made available for field trials.

Teacher training is at least as great a concern in West Africa as it is in the East. The absence of suitable teacher training texts was noted in each of the three countries, and all three have eagerly awaited the first units of the regional teacher training materials which were begun in 1971. Meanwhile, Ghana has initiated its own in-service program for mathematics teachers and has already prepared some of its own pre-service teacher training materials. Liberia is about to initiate substantial in-service and refresher programs for teachers and will require materials for these efforts which are academically less demanding than the original Entebbe teacher training texts. Sierra Leone now has only a modest program of teacher training in mathematics. Its needs also are for simple texts which will help teachers become more comfortable with the concepts and approaches of modern mathematics.

A two-year training program for tutors and school inspectors has been initiated in the WARMP countries as the beginning of a long-range solution to enhancing classroom teaching in mathematics. Unfortunately, attendance at the institute which began the program was poor, and participation in the follow-up correspondence lessons has been below expectations in Liberia and Sierra Leone. Many of the participants have not yet received the text materials that are necessary to complete the correspondence lessons. Thus,

the need for teacher upgrading which was evident to the evaluation team during classroom visits will not be remedied at least for several years.

There is presently too little curriculum development capability in the three West African countries to permit them to undertake any substantial revisions or expansions of mathematics curriculum materials. The brief and widely-spaced writing workshops and the lack of African participation in the editing, assembly, and printing of WARMP materials have not helped to promote this capability. Apparent weaknesses in the present program also were noted in the areas of curriculum evaluation and local project administration. Further efforts are needed to demonstrate the appropriateness and the potential contribution of the new mathematics curriculum for the three countries, and stronger on-site leadership will be needed to increase the productivity of workshop and tutor training efforts.

The implementation phase of APSP is proceeding steadily and the materials have achieved acceptance as an integral component of African elementary science education. In Ghana, a strong science unit has helped introduce the APSP curriculum, which is now at least partially in use in about one fourth of the primary schools even though the materials have not yet been adopted formally by the Ministry of Education. Kenya, which participated heavily in the field trials of the service units, has made a limited number of units available for use in the lower primary grades and is currently considering steps to make use of the program for upper primary students. Several APSP units are being used on an experimental basis in Sierra Leone, and this use is expected to increase as more teachers are trained. Tanzania was reported to be making heavy use of the materials in its own Swahili version. It also was reported that Uganda is planning to widely employ APSP materials as soon as appropriate changes have been made in the primary school syllabus.

In general, the African educators who were interviewed evidenced a strong commitment to the pedagogic methods of the discovery approach used for APSP lessons. Teacher training in the use of these methods in the classroom has been an important limiting factor, however. Several of the participating countries have begun significant efforts to overcome this problem, such as the establishment of district field supervisors to visit and help teachers in Ghana, the distribution of kits of materials needed for the units

in Tanzania, and the arrangement to have Peace Corps Volunteers provide in-service teacher training in Sierra Leone. A variety of training institutes also are being offered by SEPA, the Pan-African organization being supported by the APSP project.

Most of the APSP countries have a curriculum development unit in science, but these units were not reported as yet having sufficient curriculum development capability to undertake major revisions of the 54 science units already available, or to prepare additional units tailored to the needs of individual countries. On-site contractor staff did contribute to curriculum development skills during almost the entire length of the APSP, but further training in these skills for African educators would be useful.

Some specific difficulties were identified which have tended to interfere with the more widespread adoption and use of the science materials within the participating countries. One of these has been the need for syllabus revisions in several of the countries to expand the role and aims of science teaching at the elementary level. Another has been the problem of the availability of materials. Although only a simple teacher's guide is necessary for most of the lessons, there were a number of reports suggesting that greater use would be made of the units if these guides were more readily available and more promptly distributed. Still another difficulty has been the need for greater emphasis on evaluation to demonstrate the value of the program to African elementary education. This may be remedied, however, by the efforts of the recently established SEPA Training and Evaluation Center at Ibadan, Nigeria.

The Pan-African organization being assisted by the project, the Science Education Programme for Africa, is rapidly materializing as a viable institution expected to be capable of continuing the implementation of APSP concepts after the present project has ended. This organization already has the support of seven African nations and the cooperation of five additional ones. It has an entirely African Secretariat Staff and Representative Council and meaningful amounts of locally supplied funds. SEPA has been fortunate in its strong and aggressive leadership and in the quality of its efforts to date. There is every indication that it will be able to obtain its planned complete autonomy in the near future.

## Recommendations

As a result of these findings, 56 recommendations have been prepared suggesting possible redirections and additions to the present implementation projects. So as to provide maximum flexibility in project planning, many of these recommendations overlap in the sense of representing alternative courses of action.

For the East African Regional Mathematics Program, it was recommended that the originally planned curricula development efforts be continued and completed as scheduled. More training was suggested to strengthen the curriculum development capabilities of the national curriculum centers in Ethiopia and Kenya, and possible improvements were identified to enhance current teacher, tutor, and supervisor training efforts. Greater emphasis was suggested in the area of curriculum evaluation. No changes were proposed in the supervisor field personnel now contributing to the project. Finally, the need to continue a regional institution was questioned in terms of its probable viability and functions.

For the West African Regional Mathematics Program, it was recommended that support for the materials development effort be reconsidered. This large undertaking is considerably behind schedule and there are realistic doubts whether the participating countries will be able to complete and then implement these materials on a regional basis as was originally intended. In place of this activity, it was recommended that more emphasis be given to meeting short-term needs for suitable curriculum materials in mathematics and to strengthening local curriculum development capabilities. The expansion of in-service teacher training was suggested along with improvements in the present tutor training program and in evaluation activities. Stronger leadership by contractor personnel and a re-examination of the future of the WARMP institution also was proposed.

For the African Primary Science Program, it was recommended that current efforts to implement the science curriculum materials be continued, and that supplementary assistance be given to individual countries to help them in their efforts to make these materials more readily available in their schools. Suggestions were made for enlarging teacher training and evaluation efforts and for expanding national curriculum development capabilities.

No changes were proposed in the staffing of this project. It was felt that program efforts to create a viable and useful African institution in science education have just about achieved success and that steps therefore should be taken to initiate more direct support for SEPA to further its growth toward independence.

# I. INTRODUCTION

## A. The African Educational Setting

Curriculum reform has been a major focus of attention in educational systems throughout the world. A number of factors contributing to this reform include the changing nature of society, the notion of equal educational opportunity, and the increased awareness of the need for relevance in education.

The current emphasis on curriculum reform in the United States can be traced to the early 1960's when educators quickly responded to the post-Sputnik emphasis on technological progress. The new curricula in mathematics and science which swept elementary and high schools received broad national support in an attempt to avert Russian technological dominance. An additional rationale for introducing new curricula was a reaction against the traditional practice of spending the majority of classroom time memorizing facts and figures, unaccompanied by understanding of the material being taught and devoid of any broad intellectual development. The pendulum of reform has now reversed in at least one academic area, as support for the new mathematics declines. The reverse is characterized by a return to instruction in basic reading and computation skills. An example of this reversal was the discontinuation during the Summer of 1972 of one of the most prominent activities in the new mathematics, that of the School Mathematics Study Group (SMSG) at Stanford University.

A group of 15 African educators, who convened with Boston and Cambridge scholars at the Endicott House Conference in 1961, generally agreed that curriculum reform was needed in African schools. Teaching demonstrations conducted at Endicott utilized innovative instructional techniques developed in the United States. In addition, discussion centered around changing curriculum objectives to provide relevant instruction both to university-bound students and to those terminating formal education at the conclusion

of secondary school. The Africans present at the Conference supported these new educational approaches that were displayed at Endicott.

Even though African curriculum reform received verbal support at Endicott, other more pragmatic considerations prevented these philosophical reforms from being implemented rapidly. Sharp differences between the African and American educational systems prevented the immediate introduction of curriculum reform in Africa. The European-modeled African examinations framework, for example, hinders a rapid alteration of instructional procedures and academic content. A paper prepared by an educational officer of the West African Examinations Council (WAEC), concerning the role of examinations in African education, for example, states that "the curriculum of schools has become very highly content oriented, and the examinations that help to maintain such standards are equally rigid in content [p. 2]."<sup>1</sup> West African secondary school students who meet specified standards of achievement receive certificates. The syllabus which determines content and standards against which achievement is measured receives priority, from educators who have created the syllabus, over non-syllabus classroom activities. This priority results in part from the regional and international reputation attached to the certificates of educational achievement. As a result of this priority, the need to improve curricula by changing content or instructional procedures receives verbal acknowledgement from educators and other appropriate decision-makers but little action, in individual classrooms or schools, which leads to real educational change. Unless a curriculum change is reflected in the syllabus, there will be no change in classroom instruction.

Concern among African educators about making classroom activity more relevant is often unaccompanied by action leading to syllabus change. This situation is not limited to African nations. There are educational issues in many countries which provide much discussion but which are followed by limited classroom change. New concepts and ideas for curriculum reform abound in the United States, fostered by a myriad of privately- and federally-sponsored projects. Many of these undergo field trials within classroom

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<sup>1</sup>Agbenyega, C. O. The influence of examinations on curriculum change in West Africa. Accra, Ghana: Test Development and Research Office, West African Examinations Council, 1972. (Unpublished manuscript)

settings but seldom become fully implemented into a curriculum. The United States educational system does, however, provide a more amenable setting for such experimentation and reform because of abundant teaching and support staffs, spacious facilities, a variety of equipment, and the absence of a centrally determined curriculum.

In a paper prepared by a Senior Lecturer on the Faculty of Education at a major East African University, support is given to the built-in conservative restrictions against drastic educational experimentation in African countries: "the reservoir of trained personnel and training facilities is limited, these problems [choice of educational methods, lack of flexibility for innovation] . . . have far-reaching consequences [p. 2]."<sup>2</sup>

Implicit in these statements is the fact that the African educational system is not well suited for introducing curriculum reform without careful assurance that the changes are incorporated into the endorsed syllabus. Curriculum reform usually further involves an alteration of teacher training, production of new instructional materials, and a number of other aspects which are integrated parts of the implementation process.

Evaluation of curriculum reform involves an awareness of the educational setting where such reform is attempted, and of the conditions necessary for implementation. The African setting and the American setting are not comparable; this frame of reference must be understood in examining the African Mathematics Program (AMP) and the African Primary Science Program (APSP).

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<sup>2</sup>Young, W. C. E. African philosophy of education and foreign aid - a subjective view. Nairobi, Kenya: University of Nairobi, 1972. (Unpublished manuscript)

## B. Evaluation Approach and Criteria

### 1. Background

Based on meetings with EDC staff, discussions with educators knowledgeable about the African educational setting, and representatives of AID, an evaluation plan was designed to achieve the contractual scope of work.

Two meetings were held between the evaluation team and the EDC directors of the AMP and APSP, one in April and one in September of 1972. These meetings assisted the team in gathering information about the development and implementation of AMP and APSP, their background, and their modes of operation. Numerous project components were reviewed: EDC reports to AID, basic contracts between AID and EDC, curriculum materials, evaluation studies, planning conference reports, and workshop reports.

To design the appropriate instruments for the data collection, a proposed outline of the type of information to be gathered was distributed to approximately 32 African and American professional educators who were either associated with AMP or APSP or were involved with some aspect of education in Africa. Responses to the outline provided the evaluation team with suggestions regarding the approach to the evaluation, and these were incorporated into the final design of the interviews.

Two interview forms were prepared, a Status Questionnaire and an Impact Questionnaire, in addition to a Classroom Observation Form. The forms were designed to obtain information from individuals at various levels of the educational systems in the countries to be visited. The Status Questionnaire was intended for the Ministry of Education officials in each country; the Impact Questionnaire was designed for university officials, teacher trainers, teachers, and EDC field staff members. The Classroom Observation Form was to record teaching methods and student behaviors.

A final pre-departure meeting was held with AID staff in Washington in September 1972. The evaluation team briefed the staff regarding schedules, interviews, and approach; in addition, the AID staff reviewed the data collection forms.

## 2. Data Collection

African educators were used wherever possible to assist in the data collection and planning efforts. In addition to those consulted regarding the proposed evaluation plan, the evaluation team included two African educators: Dr. Christian O. Agbenyega of the Accra Office of the Test Development and Research Office (TEDRO/Accra) of the West African Examinations Council (WAEC) joined the team for the West African visits, and Dr. William C. E. Young, Senior Lecturer, Faculty of Education, University of Nairobi, joined the team for the evaluation in East African countries.

In designing the data collection forms, the usefulness of AMP and APSP was determined by evaluating the status and impact of these projects, and the development of their regional implementing institutions. Specific attention was directed to evaluation in the areas of curriculum development, teacher training programs, production and distribution of teaching materials, development of evaluation expertise, and usefulness of the new regional institutions.

To measure the status and impact of AMP and APSP, questionnaires were used as a basis for interviews with personnel at various levels within the educational systems in each of the countries visited. These personnel included Ministry of Education officials, university staff, tutors in teacher training institutes, and classroom teachers.

From the Ministry officials the team gathered information regarding formal support of these Programs plus an official estimate of their utilization; university personnel associated with the development or implementation of the Programs were interviewed to determine their opinion of the scholastic content of the materials; tutors in teacher training institutions were questioned regarding the extent of use of AMP and APSP materials in the instruction of content and pedagogical methods in pre-service training; and classroom teachers were interviewed to determine availability of the materials at the classroom level, the actual adoption of the materials, the type of training they received to use these materials, and student response. In addition, personnel associated with the governing bodies of the regional implementing institutions were interviewed to determine the current developmental status of the institutions and the expectation of their continuation following the termination of the present contracts.

In addition to conducting interviews, classroom observations allowed the evaluation team to assess actual classroom behaviors and use of teaching methods and materials. The Questionnaires and Observation Forms were used to guide the collection of information rather than for recording data. Visits were tailored to each situation, the individual's knowledge about the Program, and the particular areas of his interest and concern.

### 3. Criteria

The two evaluated projects represent extensive efforts, both chronologically and geographically. Therefore, selected components of the projects were examined, although other components would have provided a more comprehensive evaluation. For example, no visit was planned or made to Nigeria where the support period for AMP had ended, and no effort was made to determine why different countries followed different pattern of development for their primary science programs. Expectations about the kinds of information and the resulting current useful recommendations guided the selection of evaluation components. The purpose of such recommendations would be either to enhance the present projects or to assist planning similar future projects.

The following components of the two projects received primary emphasis:

- a. overall project goals, including realism, attainability, explicitness, and suitability within a multi-national African setting;
- b. functional utility of the projects, considering usefulness of instructional products, effect of project activities on regional and national educational decisions and capabilities, and impact of the projects on classroom teaching;
- c. project approach for promoting curriculum reform, as shown by strategies used to generate interest, prepare materials, and insure effective implementation;
- d. project administration, including appropriate staff selection, anticipated difficulties, coordination of efforts, precision of field scheduling and reporting, and flexibility demonstrated in dealing with changing requirements and circumstances;

- e. project accomplishments such as viability of newly created institutions, relevance of participant training, and quality of evaluation procedures; and
- f. degree of Africanization as reflected in the involvement of key personnel, responsibility given to Africans, and the extent to which African needs and desires shaped the two projects.

The following components of the two projects received secondary attention:

- g. technical strength of the educational content and pedagogic approaches;
- h. desirability of curriculum reform as an element of developmental assistance;
- i. appropriateness of past levels of funding and the degree to which programs were monitored;
- j. rationale for decisions by participating countries concerning the extent of their program involvement or the ordering of their own educational priorities; and
- k. relationship between the programs and any evident or expected economic, social, or political changes within participating countries.

Finally, it is important to clarify what the evaluation team meant by "curriculum" and the steps it regards essential to comprehensive curriculum development. A curriculum is a productive sequence of student experiences in an educational setting designed to accomplish certain overall goals. As such, a curriculum is the planned process whereby students learn, and not the textbooks, lesson plans, or other materials which are produced during a curriculum development effort. In order to produce a usable and relevant curriculum, the following steps must be accomplished:

- a. identification of expected curriculum results in the cognitive, affective, and reasoning domains;
- b. establishment of a syllabus identifying the scope and sequence of the subject matter to be taught;

- c. selection of instructional content and pedagogic methods to be incorporated into the curriculum;
- d. preparation of student, teacher, and appropriate support materials;
- e. development of teacher capability, organizational structure, and logistic components;
- f. implementation of the new program within existing classrooms, schools, and systems; and
- g. evaluation of both the functioning and the product of the curriculum.

## II. HISTORY AND DEVELOPMENT

### A. General

#### 1. Inception of the Projects

During the International Conference on Science in the Advancement of New States held at Rehovoth, Israel, during July 1960, a series of conversations was held between the Reverend Solomon Caulker of Fourah Bay College, Sierra Leone, and Professor Jerrold R. Zacharias of the Massachusetts Institute of Technology (MIT). These conversations led to a mutual agreement to explore the potential application of modern curriculum development techniques to the educational needs of Africa. Although Reverend Caulker died soon after the Conference, Professor Zacharias, who had been largely responsible for the innovative Physical Science Study Committee (PSSC) curriculum in the United States, continued to pursue the curriculum development idea in the following months. Largely through his efforts, a steering committee of scientists and educators was formed to plan a conference of leading educators from Africa, the United States, and elsewhere. The purpose of this conference was to discuss the application of modern curriculum development techniques to African educational needs.

The Conference, held at MIT's Endicott House from 19 June to 29 July 1961, was attended by 79 individuals. These 79 individuals were composed of 15 African participants, 37 non-African participants, 12 non-African speakers, and 15 non-African visitors. Grants of \$110,500 from the Ford Foundation and of \$122,500 from the International Cooperation Administration supported the program. The working conference, or "Summer Study," consisted of several groups. Six of these groups, assisted by Educational Services Incorporated (ESI), later renamed Education Development Center (EDC), prepared reports based on their discussions and plans. The following paragraphs contain brief summaries of these reports.

## 2. Mathematics Group

The mathematics group was particularly impressed by a teaching demonstration presented by Professor David Page of the University of Illinois Arithmetic Project. He taught a lesson to 20 local fifth-graders using an inquiry and activity technique which generated high levels of interest, creativity, and achievement among the students. As a result, the mathematics group focused its attention not only on opportunities to improve the content of mathematics instruction in African schools, but also on the need for changes in the goals and techniques of the curriculum to give greater stress to encouraging imagination and inventiveness among the pupils. A conference of African mathematics educators met at Accra, Ghana, in November 1961, in a joint effort to prepare a new mathematics curriculum for primary grades. This new curriculum was to be modeled after the PSSC program, the secondary mathematics materials prepared by the SMSG, and the work of Professors Suppes of Stanford, Page of Illinois, Davis of Syracuse, and others. A parallel meeting to consider similar curriculum changes in mathematics education at the secondary level was scheduled for Ibadan, Nigeria, for Fall 1961.

## 3. Teacher Training Group

This group noted the need for training about two million African teachers, if the goal of achieving 100 percent primary school enrollment by 1970, as established at the UNESCO Conference held at Addis Ababa in May 1961, was to be achieved on schedule. Specific suggestions to meet this goal included a heavy emphasis on compulsory in-service teacher education and the extensive use of media such as television for teacher training. A broad plan was devised for the development of in-service teacher training materials, featuring the integration of teacher training materials with the new classroom curriculum materials. This group did not, however, prepare any specific plans for further implementing the general plan arrived at in the group sessions.

## 4. Language Group

The language group stressed the need to concentrate on teaching the primary language of instruction to be used by the pupils, usually

either English or French. The group noted that the least effective teachers often taught at the primary level during the establishment of pupils' language patterns. They proposed supplementing teachers' efforts with audio teaching aids to parallel textbooks already in use, and which would provide an appropriate model of spoken English or French which the students could imitate. The value of incorporating supplemental language instruction into other school subjects, such as science, was also noted, in addition to the need for early reading materials which were particularly relevant to African culture and experience. Tentative implementation plans included scheduling an additional planning meeting and the preparation of sample tape recordings of model spoken English.

#### 5. Humanities and Social Studies Group

Lack of teaching materials with an African orientation was noted by the humanities and social studies group. They felt that this would result in the African student lacking sensitivity to his own cultural and social heritage and having limited background for appreciation of differences among cultures. The recommendations of the group included: a) creation of materials which focused on Africa; b) various changes in the educational goals in humanities and the social sciences; and c) revision of curricular structures to broaden and integrate the teaching of these subjects. A committee responsible for more closely examining these problems was proposed, and tentatively scheduled to meet at Kampala, Uganda, late in 1961.

#### 6. Research-Oriented Group

This group considered the need for, and then planned, an African-based international institute for educational research. The tentative title given the proposed institute was Educational Resources, Africa (ERA). It was envisioned as a private, non-governmental center where modern educational methods, curricula, and materials could be studied, developed, and made available to tropical African countries. The specific purposes of ERA would include conducting educational research, creating instructional materials, organizing new curricula, preparing test instruments, conducting teaching aid workshops, implementing teacher training, demonstrating experimental materials in schools, and disseminating useful findings. At

the time of the Conference, an organizational meeting for ERA was proposed for November 1961 at Dakar, Senegal, for educators from Africa, the United States, and other countries.

### 7. Science Group

The science group agreed there were significant shortcomings in the scope, direction, and goals of science curricula in Africa. Suggestions were proposed for implementing changes, including: a) structuring science education in a helical pattern to serve both those who were interested in science as a career and those who were not; b) using familiar objects as fundamental classroom material; c) emphasizing the discovery approach characteristic of the PSSC course in physics; and d) self-involvement of the student in science instruction. Two specific plans evolved for promoting efforts in this direction. First, on a short-term basis, the group proposed to seek financing to prepare a series of biology films under the direction of Professors Weston and Walcott of Harvard University plus contributing to the support of an ongoing effort in the development of an elementary science curriculum under the direction of Professor Walcott. Second, the group suggested that major curriculum centers be established in Africa and the United States to work with the proposed ERA organization in developing a basic African science curriculum and science reading materials in vernacular languages, and investigating science education problems.

The directions proposed by two of these working groups, Mathematics and Science, served as nuclei of the two African curriculum development projects, the AMP and the APSP, described in the remainder of this report. The plans of a third group, the Humanities and Social Studies Group, also resulted in a project, which began in 1968. Although no specific projects resulted from the other remaining groups' efforts, many of the ideas generated and problems identified by them were incorporated into the plans and activities of AMP and APSP.

## B. African Mathematics Program

### 1. Initiation

The proposed conference on mathematics education for Africa was held at Accra, Ghana, during December 1961. In preparation for this meeting, Professor Davis of Syracuse University visited Kampala, Uganda, to gather information. A sample of modern mathematics material from the Stanford University Arithmetic Project (SUAP) was introduced experimentally in 11 Ghanaian primary school classes, and a sample of materials from the Madison Project (Syracuse University) was tried in Uganda. The Accra Conference was attended by African, American, and British scholars. Once again, demonstrations of several new American modern mathematics curricula were conference highlights, with participants learning about the Madison Project, the SUAP, the University of Illinois Arithmetic Project, and the work of the SMSG. At the conclusion of the 5-day meeting, the conference recommended holding an 8-week summer workshop at Entebbe, Uganda, during the summer of 1962. As a preliminary step, there would be a continuation of the trials at Ghana and Uganda, plus the development of additional working groups at Nigeria and Sierra Leone to study existing materials. A follow-on conference was held at Ibadan, Nigeria in March 1962, to consider progress made by the working groups and to formalize summer workshop plans.

The workshop program was proposed to AID by Educational Services Incorporated (ESI) which had assumed administrative responsibility for the program. The purpose of the workshop was described in the proposal as, "the experimental design of curricula in mathematics for possible use in African schools and the preparation of experimental curricular material." Three workshop phases were envisioned: a) establishing guidelines for mathematics curricula, designed for African use, which covered the Primary One through Sixth Form; b) initiating the preparation of materials within these guidelines both for experimental use in schools and for teacher training; and c) conducting teacher training for participants who, as teachers, would be responsible for first introducing the new materials in classrooms. The proposed budget of \$205,735 included the participation of 30 Africans and 16 Americans, plus staff support from ESI.

## 2. Materials Workshops

The actual workshop was sponsored by AID (AID/afe-24) and was attended by 56 participants. In addition to those from the United States, there were 25 representatives from 11 African countries. Six committees were formed to work on various activities during the workshop period. The First Year Primary Group focused on new curriculum materials which would substitute discovery methods for rote learning and introduce concepts such as sets and number lines to the pupils. Drafts of illustrated student materials and detailed teacher guides were prepared for 16 of the anticipated 30 units. The First Year Secondary Group emphasized attaining new objectives while preserving traditional ones so as to not interfere with School Certificate Examinations. Draft materials were prepared for a 9-chapter text and corresponding teacher guides. The Testing Group began the construction of objective tests to be substituted for the essay tests used in the General Certificate of Education (GCE) Examination in West Africa, and for their evaluation by Educational Testing Service (ETS) and the West African Examinations Council. A similar program was planned for East Africa. The Non-Textual Materials Group concentrated on design and production of models of measuring devices, games, and other aids to enhance mathematics teaching and which could be prepared locally. The Teacher Training Group outlined the contents of a teacher training text to introduce new mathematics methods and content to student teachers. The group also visited local schools and other facilities to gather implementation information for use by the other groups. The Curriculum Group outlined complete curricula for revised instruction in mathematics at both the primary and secondary level. It also reviewed available American texts to evaluate their suitability for African education.

This first, or 1962, Entebbe Workshop set the pattern for additional workshops that were held over the next several years. All employed the strategy that the first step was to prepare revised curriculum materials. When these materials were completed, the second, and much needed, step could be undertaken in the form of a massive program of teacher education. This very sizable effort was not expected to be accomplished at the 1962 workshop, and the need for at least one further workshop, in 1963, was recognized even before the first had begun. It also was expected that some work on materials development, particularly the completion, reproduction, and tryout

of the classroom units that had been planned at Entebbe, would continue in the participating African countries throughout the winter with some American assistance.

Efforts did continue during the winter. Experimental use of the SUAP in Ghana continued into a second year with 700 additional students. A parallel experiment also based on the SUAP materials was initiated in Liberia, and plans were made for Liberian tryouts of the new Entebbe materials. Similar plans were made or projects undertaken in Kenya, Nigeria, Northern Rhodesia, Sierra Leone, Tanganyika, and Zanzibar, all involving teacher training activities as well as the use of new classroom materials. Meanwhile, ESI took responsibility for both editing and reproducing the draft Entebbe materials for these tryouts. These reproduction costs, together with certain other expenses of ESI connected with the first workshop, were made possible by Ford Foundation grants.

The second Entebbe Workshop was held in the Summer of 1963, again under AID sponsorship (AID/res-21). All nations represented at the 1962 workshop again attended. The participants this time were divided into four groups. The Second Year Primary and Second Year Secondary Groups continued the development of classroom and teacher training manuals which was initiated the year before. Although feedback data were available from all participating countries on the experimental use of the first year primary and first year secondary materials from the preceding months, it was decided to emphasize the development of subsequent units so the new materials could be produced in time for use during the coming school year. Both groups, however, completed all planned units of the new texts and also revised the 1962 material during the eight-week period. The Testing Group completed the preparation of test items for materials covered by the new Secondary I curricula, and the Teacher Training Group expanded existing materials into a manual for use in an experimental teacher training program to begin during the 1963-1964 school year. An added feature of this workshop was the participation of a group of linguists who had observed trial classes using materials prepared in English. Their participation was supported by the Ford Foundation and their goal was to determine whether there was a need for materials in vernacular languages or for changes in the original materials to make them more suitable for Pan-African use.

Additional AID project funds were made available to ESI (AID/res-21) to finance a third Entebbe Workshop in the Summer of 1964 and for a series of teacher training institutes during the 1963-64 and 1964-65 school years. These institutes met the urgent need for a small cadre of teachers properly prepared to conduct experimental applications of the new materials. Nine of these courses were offered during December, January, and February of the 1963-64 school year, each lasting between six and fifteen days. One course was held in Ethiopia, Kenya, Tanganyika, and Uganda; two in Ghana and two in Nigeria; and one in Sierra Leone for teachers and tutors from both Sierra Leone and Liberia. There were roughly twenty to forty participants at each institute. The institutes consisted of lectures by visiting United States educators on the content of modern mathematics, demonstrations of the new Entebbe materials, and discussions of the value, goals, and application of the new mathematics in African schools.

The third Entebbe Workshop, in 1964, included participants from the same countries. In this case, however, the session was reduced from eight to six weeks. The Primary Writing Group focused on the pupil texts and teacher guides for Primary Three, and the Secondary Group on materials for Secondary Three. Also, it was recognized by the time of this workshop that the plan of seven years of primary instruction and five years of secondary instruction was not suitable for East Africa, and a small group began combining the first two secondary texts so the series could be offered in four years. The Testing and Teacher Training Groups continued their efforts from the preceding years.

Beginning with the fourth, or 1965, Workshop, sessions were held at Mombasa, Kenya, instead of Entebbe. The final four workshops proceeded much as before, except that the number of participants gradually diminished, as did the number of African countries represented. The initial three workshops included representatives from eleven nations: Ethiopia, Ghana, Kenya, Liberia, Nigeria, Northern Rhodesia, Nyasaland, Sierra Leone, Tanganyika, Uganda, and Zanzibar. By 1965, only eight countries were represented: Ghana, Kenya, Malawi (formerly Nyasaland), Nigeria, Sierra Leone, Tanzania (formerly Tanganyika and Zanzibar), Uganda, and Zambia (formerly Northern Rhodesia); seven countries participated in 1966, six in 1967, and seven again

in 1968. Attendance figures for the seven workshops are shown in Table 1. It should be noted that many individuals attended several of the workshops so that the number of different persons who participated is considerably less than 359.<sup>3</sup> This overall total approaches fifty man-years of effort. A supplementary workshop of two American and four African participants met in 1969 to review test results and prepare some examination materials needed to complete the test series.

TABLE 1  
Attendance at Mathematics Workshops from 1962 to 1968

Year	Africans	Non-Africans				Total
		U.S.	Expatriates	Others	Combined	
1962	25	19	11	1	31	56
1963	38	18	16	1	35	73
1964	24	22	8	3	33	57
1965	23	24	2	2	28	51
1966	18	23	4	2	29	47
1967	15	20	1	0	21	36
1968	<u>16</u>	<u>21</u>	<u>0</u>	<u>2</u>	<u>23</u>	<u>39</u>
Total	159	147	42	11	200	359

### 3. Workshop Products

The products of these seven workshops were a series of student texts, teacher guides, and supplementary materials covering a complete mathematics curriculum for primary, secondary, and teacher training levels. More specifically, the following materials were prepared and published:

<sup>3</sup>EDC reports indicate a total of 372 participants, including 186 different individuals (102 Africans, 75 Americans, 7 British, and 2 others); this figure, however, does not differentiate Africans from Expatriates, nor is it consistent with published lists of participants identified by name.

a. Primary School (6 years)

Primary One: Pupil Book and Teachers' Guide  
Primary Two: Pupil Book and Teachers' Guide  
Primary Three: Pupil Book and Teachers' Guide  
Primary Four: Pupil Book and Teachers' Guide  
Primary Five: Pupil Book and Teachers' Guide  
Primary Six: Pupil Book and Teachers' Guide  
Entebbe Primary Series Guide  
Handbook for Primary Teachers

b. Secondary School (5-year program)

Secondary One: Student Text and Teachers' Guide  
Secondary Two: Student Text and Teachers' Guide  
Secondary Three: Student Text and Teachers' Guide  
Secondary Four: Student Text and Teachers' Guide  
Secondary Five: Student Text and Teachers' Guide

c. Secondary School (4-year program)<sup>4</sup>

Secondary One: Student Text and Teachers' Guide  
Secondary Two: Student Text and Teachers' Guide  
Secondary Three: Student Text and Teachers' Guide  
Secondary Four: Student Text and Teachers' Guide

d. Additional Secondary School (British system)

O-Level: Student Text and Teachers' Guide  
A-Level: Student Text and Teachers' Guide

e. Teacher Training

Basic Concepts of Mathematics, Volume I: Teacher Training Text  
Basic Concepts of Mathematics, Volume II: Teacher Training Text  
Basic Concepts of Mathematics, Volume III: Teacher Training Text  
Basic Concepts of Mathematics, Volume IV: Teacher Training Text  
Sourcebook for Teacher Training Colleges

A few sample sections from the Entebbe materials are reproduced on the following ten pages. These sections, selected by EDC as representative of the content and approach of the materials, are from the Pupil Book and Teachers' Guide for Primary Four.

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<sup>4</sup>The 4-year secondary program, as noted earlier, was essentially a recombination of materials from the 5-year program to make them suitable for use in East Africa.

Pupil  
Book

**ENTEBBE MATHEMATICS SERIES**

Primary Four  
Preliminary Edition

Prepared at the 1965  
Mombasa Mathematics Workshop

Published for the  
AFRICAN EDUCATION PROGRAM  
of  
EDUCATIONAL SERVICES INCORPORATED  
Newton, Massachusetts  
by  
SCIENCE RESEARCH ASSOCIATES, INC.  
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Chicago, Illinois

## STORY PROBLEMS

The total number of people in Zambia is about 3,600,000. The numbers of people in Zambia's four largest towns are:

Lusaka	118,000	Ndola	88,600
Kitwe	114,500	Livingston	33,900

1. About how many of the people of Zambia do *not* live in one of the four largest towns?
  2. *Estimate:* The total number of people in all of Zambia is about \_\_\_\_\_ times the number who live in the four largest towns.
- 

The railroad in Kenya goes from Mombasa to the highlands and on to Lake Victoria. Mombasa is at sea level. At one place in the highlands the railroad is 8322 feet above sea level. Lake Victoria is 3726 feet above sea level.

3. A train moves from the highland to Lake Victoria. How many feet lower is it now?
  4. Is this more than one mile? (One mile is 5280 feet.)
  5. Is a train on this railroad ever a mile above sea level?
- 

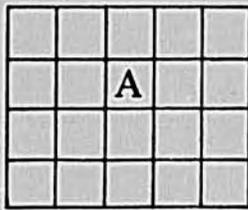
Tesfu lives in Addis Ababa in Ethiopia. It has about 443,700 people. Until last year he lived in Dire Dawa, a town of about 40,000 people.

6. How many more people live in Addis Ababa than in Dire Dawa?
  7. *Estimate:* The number of people in Addis Ababa is about \_\_\_\_\_ times the number of people in Dire Dawa.
- 

George took an airplane from Entebbe in Uganda to Lusaka in Zambia (1106 miles). Then he flew from Lusaka to Blantyre in Malawi (538 miles). His sister, Mwera, took an airplane from Nairobi in Kenya, to Lusaka (1154 miles), then another from Lusaka to Blantyre (538 miles).

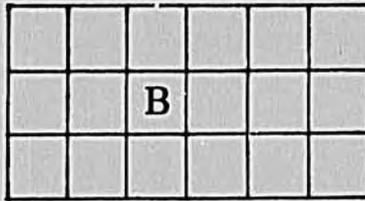
8. How far did George travel?
9. How far did Mwera travel?
10. Who travelled farther?
11. How much farther?

AREA OF REGIONS



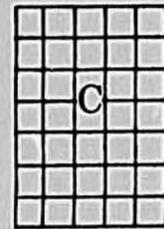
unit

1. The area of A is \_\_\_\_\_ units.



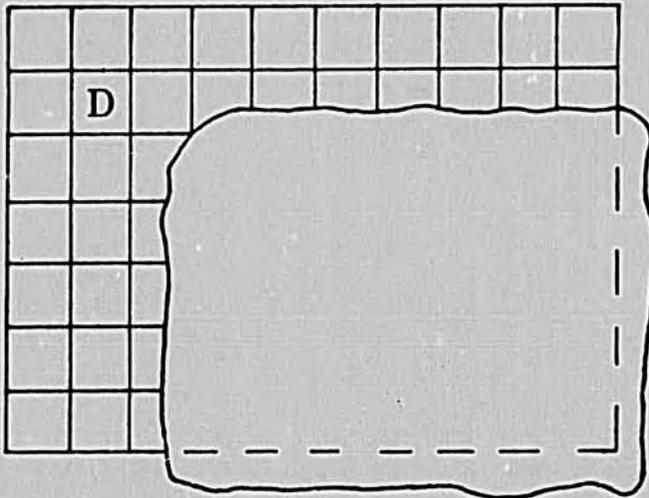
unit

2. The area of B is \_\_\_\_\_ units.



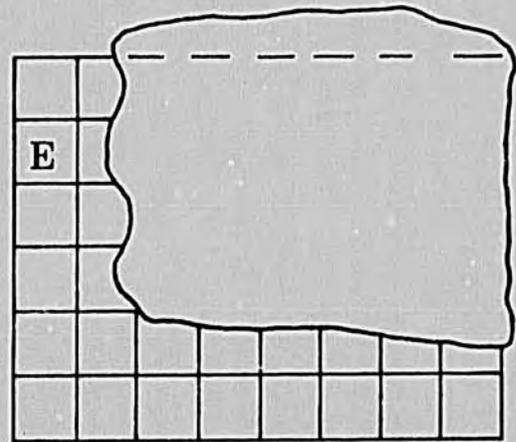
unit

3. The area of C is \_\_\_\_\_ units.



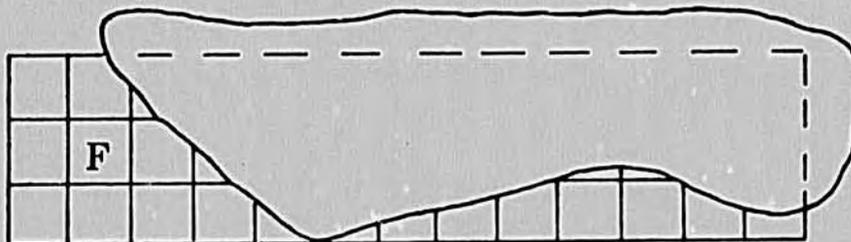
unit

4. The area of D is \_\_\_\_\_ units.



unit

5. The area of E is \_\_\_\_\_ units.



unit

6. The area is \_\_\_\_\_ units.

**ENTEBBE MATHEMATICS SERIES**

Primary Four  
Preliminary Edition

Prepared at the 1965  
Mombasa Mathematics Workshop

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## STAGE 3: Word Problems and Applications of Addition and Subtraction

*Vocabulary:* No new vocabulary

*Materials:* Pupil pages 116-119

### *Teaching Procedure*

The activities in this stage give practice in solving story problems and applying mathematics to problems of money, weight and measure. You may introduce these activities in the way that is best for your class. For example, if the children have difficulty in reading, read a problem with the entire class, let the children solve it independently, then read the next problem, and so on. If some children have no reading difficulties those children may work alone while you help others.

You make the solution of some problems an activity the class does together with your guidance. The solution of other problems the children may try without so much help.

Notice that in many of the problems several questions are asked. Some require addition or subtraction or both and the answer is a sum or difference. Others ask which of two numbers is greater. Some ask for an estimate and not an exact number. Point these things out to the children before asking them to do the exercises.

Encourage children to make mathematical sentences for the story problems. This is important information for children who have difficulty relating the numbers of the problem in the way the story suggests. The mathematical sentence is a way of stating the essential facts.

#### *ACTIVITY 1: Story Problems in Geography*

Pupil page 116

Go over and revise the steps in solving a story problem as you discuss the first problem on pupil page 116 with the children. The steps are:

1. Decide what the problem is about and keep in mind the question asked in the problem.

The problem is about the number of people in Zambia, how many of them live in one of the four largest towns and how many do not. The question asked is, "How many people do not live in one of the four towns?"

2. Write a mathematical sentence for the problem. There are two ways of writing the sentence. Either may be used:

$$3,600,000 - (118,000 + 114,500 + 88,600 + 33,900) = n$$

or

$$(118,000 + 114,500 + 88,600 + 33,900) + n = 3,600,000$$

3. Find a number that makes the mathematical sentence true. The number shown in brackets in the sentence (the total population of the four towns) is found first. The children can write the numerals in vertical form to find the sum, 355,000. Then subtract this number from 3,600,000 to find n. n is 3,245,000.
4. Use the number to answer the question in the problem.

The number of people who do not live in one of the four largest towns is 3,245,000.

Let a child read the incomplete statement in Exercise 2, about estimation. Revise briefly the idea of estimation. (An exact number is not required. Facts are used to make a good guess.)

Put these facts on the blackboard:

People in Zambia	3,600,000
People in four largest towns	355,000
People not in four largest towns	3,245,000

Guide the children to say that to answer the question they need only the first two facts. Let a child write a mathematical sentence for Problem 2.

$$3,600,000 = n \times 355,000$$

Let the children make an estimate of n. By inspection they may say that the best estimate is 10. The product is about 10 times the known factor.

Use a similar procedure with the other problems or let the children work independently and then discuss their answers.

Notice that the method of estimation in Exercise 7 is very much like that of Exercise 2. It also asks for an estimate of the missing factor. (The best estimate is about 10.)

Exercises 3 and 5 use ideas of altitude. You may wish to precede the exercises with a brief discussion of altitude, the meaning of "sea level" and "feet above sea level", and so on. In Exercise 4 a distance expressed in feet is compared to 1 mile.

*ACTIVITY 2: Using Addition and Subtraction*

Pupil page 117

The exercises on page 117 may require more than one operation. You may wish to do some or perhaps all of the exercises with the whole class. Or, you may let the children work in small groups, with perhaps some working independently. Go over at least one problem with the whole class, and talk about all of the problems when they are completed. Point out that several problems ask more than one question.

Show the children that in some problems it may be best to get all measurements expressed in one unit before writing a mathematical sentence. For example, in Exercise 1 if 50 pounds is changed to 1000 shillings ( $50 \times 20$ ); the sentence is:

$$1000 - (220 + 220 + 200 + 200) = n$$

Also, emphasize that in other problems it is better to relate some of the measurements before changing to the same unit. For example, in Exercise 5 it is better not to change 10 tons and 12 tons to pounds. The problem asks that the measurements be compared. 12 tons is 2 tons more than 10 tons. Then 2 tons is changed to 4480 pounds ( $2240 \times 2$ ) and the sentence is:

$$2600 \_ \_ \_ 4480$$

To make it true write:

$$2600 < 4480$$

Therefore, 10 tons and 2600 pounds is less weight than 12 tons.

Guide the children to see that they should think about the problem carefully in order to decide how to plan their work. The best place to start will not be the same for all problems or for all children.

sides of the cutouts. They will find that the sides are one inch long. Say, "The cutouts show square inches. We will use a square inch as a unit to measure regions. Which region shown on page 182 is the largest?" Some pupils will guess, some will suggest that they can tell by measuring the regions. Let each group lay the square-inch units or inch tiles on the regions and tell the measures of the regions. In their exercise books they will write, for example:

The size of rectangular region A is 10 square inches;

The size of rectangular region B is 6 square inches.

Let someone tell which region is largest. (Region A, because its measure is greater than the measures of the other regions.)

On pupil page 183, there are regions shown which are not rectangular. Ask the children to use their square-inch tiles to decide how many tiles can be fitted entirely inside the figures.

(6 in G; 3 in H; 1 in J; 4 in K; 5 in L; 2 in M)

Ask how many tiles are needed to cover each region completely?

(8 cover G; 6 cover H; 4 cover J; 6 cover K; 11 cover L; 6 cover M)

Let the pupils write in their exercise books the results, for example:

Region G is larger than 6 square inches and smaller than 8 square inches;

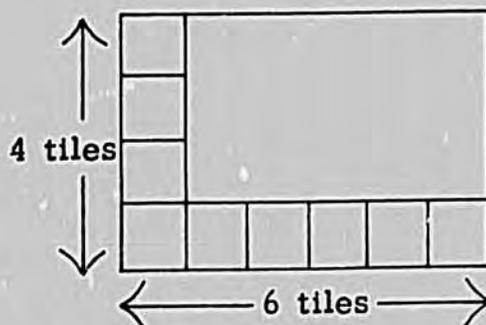
Region H is larger than 3 square inches and smaller than 6 square inches.

*ACTIVITY 2: Square-Inch Units and Square-Centimetre Units*

Pupil pages 184-185

Revise the idea of measuring a rectangular region with square-inch units. Show a rectangular cutout 4 inches by 6 inches and let a pupil measure this region with square-inch tiles. As he lays the tiles on the rectangular cutout, ask the class questions such as:

- How many rows of square-inch tiles does he need? (4)
- How many square-inch tiles in each row? (6)
- How can you find the number of square-inch tiles he used?  
(Accept any answer such as: Count by sixes, 6, 12, 18, 24; Add,  $6 + 6 + 6 + 6$ ; Multiply,  $4 \times 6$ )
- Does he need to put all the tiles on the region to find how many tiles he needs? (Guide the children to decide that he needs only the tiles along the edges to show how many rows and how many in each row.)



- Does he need to lay tiles on the region to find how many tiles he needs? Can he find the number another way? (Guide the children to decide that he could measure the two sides of the rectangle in inches in order to find how many rows of square inches and how many square inches in each row.)

Explain that we use the word area for the measurement of a region. Say, "The area of this rectangle (hold up the cutout that was measured) is 24 square inches".

Note: The word area is used for the measurement of a plane region. It is correct to say, for example, that the area of the rectangular region is 24 square inches. It is not quite correct to say "the area of the rectangle", since area is a measurement of a region. But this is such a common expression that we will use it without misunderstanding. Thus, "area of the rectangle" will mean "area of the rectangular region".

Ask, "What small units did we use to measure line segments?" (Inches and centimetres) Explain that people often use a smaller square unit than a

square inch. They sometimes use a square centimetre. Show the class a square-centimetre tile and let a pupil measure its sides with a centimetre ruler. He will say, "Its sides are each 1 centimetre long". Guide the class to say, "It is a square centimetre".

Hold up a rectangular cutout (3 cm. by 7 cm.) and ask the class how to find the area of this region in square centimetres. Let the class watch as you give a pupil some square-centimetre tiles and he lays these tiles on the region. When he does this, again ask questions similar to those asked about the 4 in. by 6 in. cutout.

Guide the class to decide, "We can find the area by finding the number of rows of tiles needed (3) and the number of tiles needed in each row (7). The area of this rectangle is 21 square centimetres".

On pupil page 184 let the pupils use their rulers to make sure what size units are shown in the figures (square centimetre). Then ask the children to answer the questions. Explain that they should imagine that square-centimetre tiles are laid on the regions (as shown by the crossed lines). In Exercises 4 to 6 the children imagine extra tiles that are needed to cover the regions. (Region C has an area greater than 24 sq. cm. and less than 30 sq. cm. Region D has an area greater than 25 sq. cm. and less than 36 sq. cm.) The number of square centimetres is found either by counting tiles or by multiplying the number of rows by the number of tiles in each row.

On pupil page 185 are more exercises in finding areas of rectangular regions. In Exercises 4, 5, and 6 the children will find that multiplication is the easiest way to find the area, because parts of the regions are covered. Enough of each region is shown to give the number of rows and the number of units in each row.

Answers for pupil page 185:

- |                    |                    |                    |
|--------------------|--------------------|--------------------|
| 1. 20 square units | 2. 18 square units | 3. 35 square units |
| 4. 70 square units | 5. 48 square units | 6. 39 square units |

Although the intention was to revise each set of materials based on test and tryout results, only the Primary One and Volumes I and II of the Teacher Training materials were revised. This probably was due in part to the sheer quantity of materials; the entire series involved some 67 volumes averaging about 200 pages each. As it was later determined, this amount of content may have been more than necessary. The Entebbe Primary Series Guide, which structures the sequence of individual lessons at various grade levels for 4 different patterns of school systems, notes that, "Experience has shown that the material in the six books of the Entebbe Mathematics Series - Primary has more learning activities than can be used in six years." Even when adjusted to an 8-year program, occasional units still are to be deleted from what was initially planned as a 6-year program.

Still another problem was the publication of materials. Various volumes were published by Science Research Associates, Inc. and Silver-Burdett, under contract with EDC, at a total estimated cost of slightly more than \$500,000. A few volumes were published directly by EDC at the end of the program, and Science Research Associates, Ltd. (England) agreed to publish a few of the volumes commercially (Primary One, Primary Two, Secondary One, and Basic Concepts, Volumes I and II). There usually was a considerable time lag between the preparation and printing of a volume; the Guide for the Primary Books, for example, was prepared at the Mombasa Workshop in the Summer of 1968 but was not printed until June 1970. All materials were edited extensively at EDC's United States offices between their writing and printing. The use of American editors was felt necessary for the entire Entebbe series and has continued for the regional programs.

Slightly over 500,000 individual volumes were printed with the direct support of project funds through 1970. Of these, 429,619 copies were reported as distributed to the 10 participating African countries. It should be noted, however, that a number of these were likely to have been inspection sets of between 50 and 67 volumes each, that an average of two volumes were needed per pupil per year, and that a significant number of these volumes were copies of Teachers' Guides. In addition, more than one million copies of translations or adaptations of the Entebbe texts were reproduced locally, principally in Ethiopia, Kenya, and Tanzania. An estimate of the actual number of students who used the materials can be derived from the following

data reported by EDC at the end of 1969, covering information regarded as complete through November 1967. A total of 1,667 classes was quite conservatively estimated to have grown to 2,000 by 1969. (The Final Report to AID states "At the latest date of full detailed information, 1967, these materials were being tried out in 3,400 classes [African Mathematics Program (EDC) Final Report to AID, April 2, 1971, p.5])."

TABLE 2  
Estimated Use of Entebbe Texts at the End of 1969

Country	Number of Primary Classes	Number of Secondary Classes	Number of Teacher Training Classes
Ethiopia	25	300	4
Ghana	116	37	20
Kenya	211	--	2
Liberia	35	18	3
Malawi	36*	6*	10
Nigeria	130*	200*	105
Sierra Leone	16	6	6
Tanzania	115	60	10
Uganda	28	--	60*
Zambia	65	3	40*
Total	777	630	260

\*Approximate

The estimated present use of AMP materials in each country participating in the implementation phase of the project is given later in this report. It should be noted at this point, however, that the original Entebbe materials are now out of print and unavailable from either EDC or any commercial publisher.

#### 4. Training Programs

Three main types of training programs have been offered. The first uses an extensive series of in-country, in-service workshops for teachers, tutors, inspectors, and others. EDC reports indicate the following institutes were held:

TABLE 3

## Teacher Training Institutes Held from 1963 to 1970

Year	Number of Institutes	Approximate Number of Attendees
1963-1964	9	360
1964-1965	6	263
1965-1966	9	375
1966-1967	10	544
1967-1968	13	751
1968-1969	11	683
1969-1970	<u>9</u>	<u>839</u>
Total	67	3,815

These institutes, which usually ranged from one to three weeks each, were offered in the countries served by the project. Instructional duties generally were shared by Africans familiar with the project and visiting American educators. The typical program included lecturers on the content of modern mathematics, discussion periods to inspect and review AMP curricula materials and, often, demonstrations on the use of the inquiry method for classroom presentation of these materials.

A second type of training program was a series of ABC Institutes held between 1966-1968. This program, sponsored by the Ford Foundation as an adjunct to the AID project, was designed primarily for senior mathematics tutors in the ten participating countries. The purpose was to produce a small cadre of qualified educators in each country who could then assist in developing adaptations of the Entebbe materials to meet local conditions and in continuing the in-country training of teachers, inspectors, and other tutors. Attendance at the three summer sessions, one month in 1966, one month in 1967, and two weeks in 1968, is shown below by "type" of participant (A, B, C, or D). The original plan was to have the same group of individuals participate in all three sessions. However, the eight Eastern Nigerians were unable to attend after 1966 due to the Nigerian civil war; Ghana changed its delegation between 1966 and 1967, and Zambia did not participate in 1966. Also, twelve of the participants in 1968 were Zambians who had

just completed a year of participant training in the United States but had not attended any of the previous sessions. Altogether, about twenty-five individuals attended all three sessions, and about ninety individuals attended at least one session.

TABLE 4  
Attendance at ABC Institutes from 1966 to 1968

Type of Participant	Year		
	1966	1967	1968
A (mathematics tutors)	33	36	32
B (Ministry of Education officials)	7	12	12
C (university mathematicians)	9	6	7
D (secondary school teachers)	-	<u>17</u>	-
Total	49	71	51

An integral part of the ABC Institute training program was the correspondence instruction offered between the 1966 and 1967, and the 1967 and 1968 sessions, for A, B, and D participants. The correspondence course materials were prepared and graded by the C participants. About 60 percent of the 1966 A and B attendees participated in the 1966-67 correspondence program, and about 40 percent of the 1967 A, B, and D attendees participated in the 1967-68 correspondence program. In conjunction with the ABC Institutes, three films and a number of video tapes were prepared for use in teacher training. In addition, a syllabus was prepared for use in both university and teacher training institute programs for teachers.

The third type of training program was instituted in 1970-71 as part of the regional implementation phase of the AMP project. The structure of this program paralleled the ABC Institute in that formal training courses were scheduled with intervening correspondence instruction. The intention of this program was to train mathematics tutors and inspectors in five of the participating countries: Ethiopia, Ghana, Kenya, Liberia, and Sierra Leone. However, the representatives sent to the opening training courses

were not always consistent with this objective. In West Africa, Sierra Leone supplied mostly primary school teachers, more than half of the Liberians were in jobs other than teaching, and 11 of the 74 participants from Ghana stopped teaching mathematics soon after the course. In East Africa, 12 of the 67 participants from Ethiopia were lecturers in mathematics and were regarded as over-qualified for the instruction; in Kenya, 24 of the 41 participants were primary inspectors who did not specialize in mathematics and for whom the training program was too comprehensive. The correspondence materials used for the program were based on those developed for the ABC Institute's correspondence lessons. Attendance at the first series of formal courses, two each in East and West Africa, is shown below with data reported in July 1971 on the number of attendees who were then participating in the correspondence program. Since then, the rate of participation in the correspondence program has been further reduced.

TABLE 5  
 Institutes for Mathematics  
 Tutors and Inspectors for 1970 and 1971

Institute/Location	Course Attendees	Correspondence Participants
<b>Njala Institute</b>		
Sierra Leone	30	16
Liberia	15	4
Ghana	<u>17</u>	<u>15</u>
	62	35
<b>Cape Coast Institute</b>		
Ghana	57	46
<b>Addis Ababa Institute</b>		
Ethiopia	67	30
<b>Nairobi Institute</b>		
Kenya	<u>41</u>	<u>24</u>
<b>Total, All Groups</b>	<b>227</b>	<b>135*</b>

\*This represents 59% of all attendees

## 5. Other Implementation Phase Activities

Three other kinds of participation are part of the present implementation phase of the AMP project. First, several in-country, in-service teacher training institutes were offered with technical assistance from the West African Regional Mathematics Program (WARMP) and the East African Regional Mathematics Program (EARMP), the two regional mathematics institutions. Second, a one-semester course was held at the University of Ibadan, Nigeria, during the Fall of 1972 for four trainee evaluators from the five participating countries. Third, a series of workshops is being held in each region to prepare regional mathematics curricula.

In the East, four Africans and three Americans are preparing a teacher training text in modern mathematics, Fundamental Concepts of Mathematics. Volume I was completed in 1971 and Volume II in 1972. A third volume, guiding classroom mathematics teaching, is currently in preparation. This volume will complete the planned series. Because Ethiopia and Kenya are preparing and reproducing their own texts for school use, regional editions of student materials or teacher guides are not planned. A volume of Subsidiary Mathematics for A-Level students not specializing in mathematics, however, is being considered as a possible addition to the series. In the West, the 1971 workshop consisted of twenty-five Africans and four Americans. This group is preparing new regional versions of the Entebbe primary, secondary, and teacher training materials. As of October 1972, revisions were drafted for the Primary I and Primary II Pupil Books and Teachers' Guides, and for the Secondary I Teachers' Guides. These are now being reproduced by EDC for the classroom trials needed for revision into final form. A draft of the first of four projected volumes for teacher training also has been prepared. Some work also has been done on Primary III, Primary IV, and Secondary II, but these were not fully drafted at the time of the evaluation team's visit in October 1972.

Work on the revised curriculum materials for the WARMP countries has proceeded very slowly and is far behind schedule. The plan was to have available by 1972, for review by the Ministries of Education of the three participating governments, camera-ready copy of the revised versions of Primary I, Primary II, and Secondary I materials. Due to a number of delays, the program is at least a year behind schedule. Administrative arrangements

initially were late for the workshop at Fourah Bay College, Freetown, Sierra Leone, primarily due to the long delay in the selection of that location. Materials assembled in Ghana were shipped to Sierra Leone for the workshop. These arrived in time, but some needed books were omitted from the shipment. No advance arrangements had been made for typewriters in Sierra Leone, and several had to be purchased hurriedly; typing volume was underestimated and an insufficient number of typists had been arranged for; insufficient lettering materials had been acquired; and there were problems with housing and meals. Neither Ghana nor Sierra Leone had yet appointed trainee editors to work with their American counterparts. Although each of the three participating countries was asked to nominate nine individuals to attend, eight indicated they would not attend and only three replacements were found, leaving twenty-two expected. Of these, four arrived after the sessions had begun.

As a result of the above difficulties, and although copies of the text were needed only for two trial classes in each of the three countries, the planned trials still had not been conducted prior to the 1972 workshop and, for that matter, neither were the materials ready for trials during the 1972-73 school year. In contrast, the EARMP group had developed the 412-page Volume I of their new teacher training text into camera-ready copy in time for trials in the participating countries two weeks after their first workshop ended.

Additional problems were encountered by WARMP. No Trainee Editor is available to work with the EDC Mathematics Editor on a regular basis. This means almost two years have elapsed without any systematic training in this skill for Africans in the three western countries and, because of an absence of editorial assistance, editing is proceeding very slowly. Some relief has been received recently from an American volunteer designated to serve as an assistant to the Mathematics Editor, but this is not contributing to the development of Africans' editorial skills. Another difficulty has been a lack of agreement on drafts being prepared for teacher training. Texts for this purpose are very much needed but none are likely to be completed until some fundamental differences are resolved between EDC and certain of the writing committee members.

## 6. Materials Evaluation Activities

Evaluation of materials produced at both the Entebbe and regional workshops has been regarded as a project component since its inception. During the project, on the other hand, evaluation has been relegated into a secondary role because of continued time pressures, frequent unavailability of materials, lack of skilled evaluators, and the apparent absence of realistic plans for evaluation programs. The result has been a series of studies of questionable validity and significance, which have provided minimum guidance for systematic revision of the materials to better meet classroom needs. It was evident to the evaluation team in 1972, as it was to the Committee on International Cooperation in Mathematics Education<sup>5</sup> in 1968, that very little emphasis has been given to the revision process throughout the project. The only consistent use of field information seemed to be teacher comments. Yet, the project field staff expressed doubt concerning the utility of information from this source: "One cannot rely on teachers' reports on the use of materials and there appeared to have been occasions when the local supervisors did not recognize weaknesses in the materials or were unwilling, through diffidence or fear of upsetting susceptibilities, to report on the weaknesses (African Mathematics Program [EDC] Final Report to AID, April 2, 1971, p. 32)."

## 7. Personnel

Throughout its entire history, AMP was guided by Steering Committees composed of leading mathematics educators. Many committee members have remained constant for long periods of the project, giving continuity to the group. The Committee also has reflected interested African membership over the period of the project as shown in the following table.

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<sup>5</sup>Report to the Committee on International Cooperation in Mathematics Education in the African Mathematics Program, September 16, 1969. (This evaluation was sponsored by the National Science Foundation through the Conference Board of the Mathematical Sciences.)

TABLE 6

Steering Committee and Management Committee  
Membership for Selected Years

Years	Membership			Total
	United States	Expatriate	African	
1961 - 1962	16	0	0	16
1964 - 1965	17	1	7	25
1970 - 1971	24	1	8	33
1972*				
VARMP	2	0	6	8
EARMP	2	1	6	9
Combined	4	1	12	17

\*These figures refer to the January 1972 Management Committee meetings. Two EDC representatives are usually present; African participants range from 6 to 8 for VARMP and from 3 to 7 for EARMP.

It was originally the responsibility of the Steering Committee to make plans and monitor progress; beginning with the regional implementation phase, it is the responsibility of the two regional Steering Committees, now referred to as Management Committees, to appoint each regional Program Administrator and to eventually assume full responsibility for planning and policy making for each of the two regional Programs. The EDC Project Director is not responsible to the committee but does report to it on progress at Committee meetings. During the current implementation phase of the project, the two regional Management Committees meet twice yearly.

Three different individuals have served as AMP Project Director since the inception of the project:

From 1962 to 1964, the Project Director was Professor William Ted Martin. He received his Ph.D. in mathematics from the University of Illinois in 1934. Professor Martin was Head of the Mathematics Department at the Massachusetts Institute of Technology for 23 years and has regularly attended their meetings. During the length of the project he has visited Africa at least yearly to attend workshops and visit the Ministries of participating countries. Professor Martin served only part-time during his term as Project Director.

From 1964 to 1971, the Project Director was Mr. Hugh P. Bradley, a British citizen who had previously participated in the project as a representative from Kenya where he had been Inspector of Schools. For the 16 years before that, Mr. Bradley held various educational posts in Africa. He received his M.A. from the University of Glasgow in 1937, in mathematics and physics. Mr. Bradley was unusually qualified for the position in that he was a joint author of the revised Highway Arithmetic and Mathematics series which was the standard primary text series in mathematics in East Africa and elsewhere in the early 1960's. He also was a founding member and an officer of the Kenya Mathematical Society. As full-time Project Director, Mr. Bradley visited Africa as often as three or four times per year.

From 1971 to the present, the Project Director has been Mr. John Joanou, who initially joined the project in 1967 as a Project Associate. Mr. Joanou attended St. John's College, Maryland, from 1954-56. His previous work experience was largely in the field of communications and public relations. Mr. Joanou has averaged three trips a year to Africa while serving as Project Director.

Another group of key AMP personnel has consisted of consultants who participated in the materials writing workshops and the various training institutes. Between 50 and 60 educators have served in this capacity since its inception. In the earlier phases of the project, most of this group was composed of faculty members from United States universities. Gradually, however, more Africans have assumed these roles, and there is now a sizable cadre of African mathematicians and educators who have served the project as technical experts.

A third group of personnel has been the EDC field staff who were added to the project after 1971, following the inception of the implementation phase. These include: Mr. Roger R. Hartman (Mathematics Editor, WARMP); Mr. John W. Alexander, Jr. (Mathematics Educator, WARMP); Mr. John T. Norris (Mathematics Educator, WARMP); Professor Roy Dubisch (Mathematics Editor/Educator, EARMP); and Mr. John C. Fitzgerald (Mathematics Educator, EARMP). Messrs. Alexander, Norris, and Fitzgerald arrived on site in October 1970; Mr. Hartman and Professor Dubisch arrived in July 1971.

## 8. Financial Support

The financial history of the AMP project is summarized in the following Table (7). These are based on budgeted amounts rather than actual expenditures, for AID support, and do not include local cash and in-kind contributions by participating countries. Of the total amount of \$4,583,610 summarized in the table, AID has provided or allocated \$4,204,610 (91.7 percent) and Ford Foundation has provided \$379,000 (8.3 percent).

TABLE 7  
AMP Financial Summary

Period	Contract	Amount
12 Jun 1961 to 31 Mar 1962	ICA c-1962	\$ 122,500
10 Dec 1961 to 28 Feb 1962	AID c-2350	62,000
10 Dec 1961 to 28 Feb 1962	Ford Foundation	7,000
31 May 1962 to 12 Nov 1962	AID/afr-24	204,512
3 May 1963 to 31 Oct 1967	AID/res-21	1,823,012
1 Jan 1966 to 30 Sep 1970	Ford Foundation	372,000
1 Jun 1967 to 31 Dec 1969	AID/csd-1567	1,034,286
26 Jun 1970 to 7 Aug 1973	AID/afr-711	<u>958,300</u>
<b>Total</b>		<b>\$4,583,610</b>

## 9. Implementation Phase Goals

According to EDC, (Progress Report to the Agency for International Development on the Regional Mathematics Programs, February 1, 1971 to October 5, 1971, p. 1) the purpose of the regional implementation project is:

- "a) To improve the mathematical background of the maths tutors and/or supervisors and the quality of maths education in the training colleges through institutes and correspondence courses;
- b) In cooperation with local personnel, to review, adapt and produce in Africa suitable common math textbooks based on the Entebbe Mathematics Series and other existing texts;

- c) To give local personnel experience in the preparation adaptation and trial testing of teaching materials to help to build up a nucleus for ongoing curriculum development and research in mathematics.

In general, the program is intended to make possible the implementation of primary school mathematics curriculum reform by training middle level personnel who will be responsible for pre-service and in-service teacher education and at the same time, to make available suitable local primary materials which will be used in this implementation."

The full implementation of new modern mathematics curricula, however, is not expected to be accomplished during the tentatively scheduled four years of the project. Even from the beginning of the present regional program, it was noted that, "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 (African Mathematics Program [EDC] Final Report to AID, April 2, 1971, p. 35)." Furthermore, the workshops planned for West Africa were designed to complete the draft revisions, trials, and re-revisions only of the Primary I-IV Pupil Books and Teachers' Guides, Secondary I-IV Teachers' Guides, and the Teacher Training Materials. The remaining primary materials, secondary pupil texts, and other volumes were to be completed after the termination of the project.

The program includes the participation of five African countries: Ethiopia and Kenya in the East African Regional Mathematics Program (EARMP) and Ghana, Liberia, and Sierra Leone in the West African Regional Mathematics Program (WARMP). As illustrated in the map on page 41 (Figure 1), this phase of the program does not include five countries with extensive earlier AMP participation: Malawi, Nigeria, Tanzania, Uganda, and Zambia. Headquarters of EARMP is located at Addis Ababa, Ethiopia. The staff there, aside from Professor Roy Dubisch, the EARMP Mathematics Editor/Educator, consists of the Program Administrator, Ato Makonnen Eunatu, and a Secretary, Mrs. Haile Egidayehu. WARMP Headquarters is located at Accra, Ghana. The staff there, in addition to Mr. Roger Hartman, the WARMP Mathematics Editor, and Mr. John T. Norris, the Mathematics Educator, consists of Mr. D. A. Brown, the WARMP Program Administrator, and Mr. Stephen Haynes, Secretary. The role of the

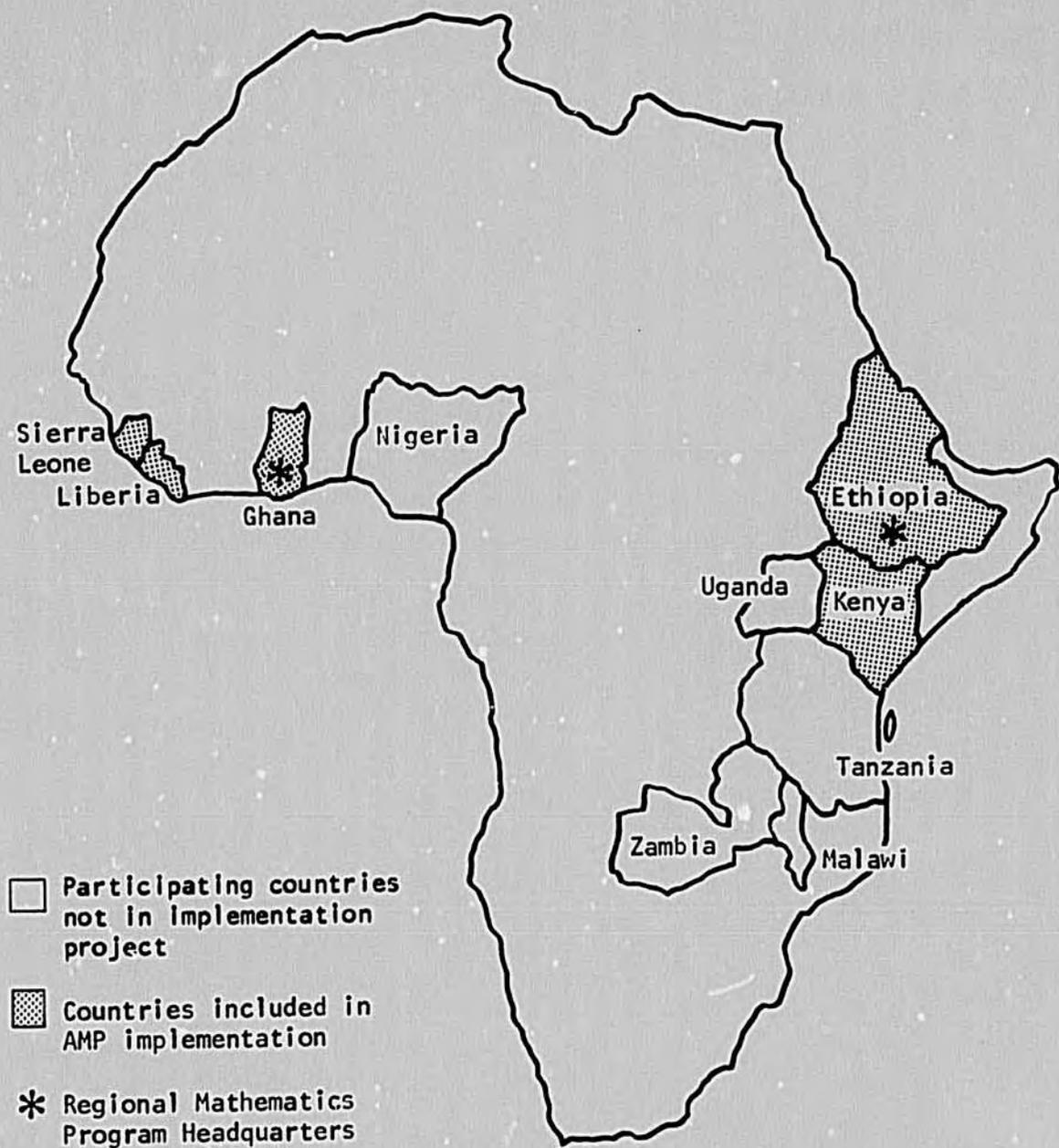


Figure 1

Fully participating countries in the African Mathematics Program

Program Administrators, who are EDC employees, is to "arrange for the implementation of program decisions and be responsible for the day-to-day administration of the program" in the sense of "proper fiscal management, planning and operating teacher training institutes and workshops, and preparing proposals and budgets for ongoing activities (Progress Report to the Agency for International Development on the Regional Mathematics Programs, February 1, 1971 to October 5, 1971, pp. 89-90)." The responsibility for technical and managerial direction of the program now rests with EDC, which has invited advice and guidance from the two regional Management Committees. At the end of "an interim period estimated to be eighteen months to two years" from the beginning of the implementation phase, it was contemplated that "full control of the fiscal, administrative and educational responsibilities of the program will pass on to the Management Committee (Progress Report to the Agency for International Development on the Regional Mathematics Programs, February 1, 1971 to October 5, 1971, pp. 89-90)." According to this schedule, announced in July 1971, control should have been turned over to the Africans by late 1972. Further consideration on Management Committee participation in WARMP and EARMP policy making and planning is included in Section III-C of this report.

### C. African Primary Science Program

Plans for science curriculum reform in Africa began in 1965, although EDC cooperated with several African nations working on the development of science programs following the 1961 Summer Study at Endicott House. In Nigeria, for example, workshops to develop elementary science curriculum materials were held during 1963 and 1964. Some materials from the EDC Elementary Science Study (ESS) project were locally adapted to the Nigerian setting in addition to the local creation of materials. The Kenya Science Center, operational for more than three years, introduced new materials and techniques into Kenyan elementary science classrooms. Similar work was ongoing at Ghana, Rhodesia, and Tanzania.

#### 1. Planning

Based on the general objectives for the reform of elementary science education stated at Endicott, two planning meetings were held: one on 4-5 September 1964 at Rome, Italy, and another on 22-26 February 1965 at Kano, Nigeria. The Rome conference was sponsored by the Ford Foundation and the Kano conference was jointly sponsored by the Ford Foundation and AID. The Rome conference was attended by fourteen participants, eight non-Africans from the United States and United Kingdom, and six Africans representing Nigeria, Kenya, and Ghana. They developed the following goals for APSP activities:

- a. to support existing science education activities in Ghana, Nigeria, Rhodesia, and Tanzania by creating science centers on a scale appropriate to local resources;
- b. to form science center staffs capable of developing and demonstrating new curriculum materials as well as providing in-service teacher training;
- c. to employ materials already developed under the ESS project as a basis for experimentation and adaptation within local settings; and
- d. to provide curriculum materials to teachers distant from the centers via a low-cost mailing system.

At the 1965 Kano meeting, representatives from the ten African countries likely to be involved in the program were invited to discuss potential program direction. There were 64 participants, including 32 Africans, 22 non-Africans, 9 observers, and 1 Ford Foundation Observer. They listened to presentations, observed classroom demonstrations of ESS materials, and discussed their educational experiences to clarify their thinking about curriculum reform. They generally agreed that the "inquiry" method of learning was superior to the traditional rote learning approach used in elementary classrooms in the English-speaking countries of tropical Africa.

## 2. Development

In 1965, primary APSP objectives were to extend to interested African educators innovative ideas from the United States relevant to curriculum reform in science education. These ideas were to be extended basically through development of a body of materials for teaching primary school science and establishment of a network of science centers where field trials and continued materials development could be conducted. To expand the roles of these science centers, it was hoped that a liaison would emerge with existing institutions such as the universities, Ministries of Education, and teacher training colleges. In discussing the development and use of APSP materials, it is important to note that the science project was initiated with the assistance of several staff members who were then also participating in the Elementary Science Study (ESS), a curriculum project being carried out by EDC. As one direct result of this earlier experience, the APSP workshops concentrated on the development of teachers' manuals which would utilize easily accessible local supplies to implement the "discovery" method of teaching. In addition, the approach used in creating the ESS student materials was examined and, wherever appropriate, adapted to fit local and regional needs.

During the development phase, three materials development workshops were held: Entebbe, Uganda (1965); Dar es Salaam, Tanzania (1966); and Akosombo, Ghana (1967). At the 1965 Kano meeting, the following activities were suggested for each of these workshops:

- a. development of guidelines for an elementary science curriculum;

- b. preparation of text and teaching materials plus some laboratory experiments; and
- c. coordination of programs being conducted in the participating countries.

The 1965 Entebbe Workshop established the procedures followed by subsequent materials development workshops. There were 52 participants, including 34 Africans and 18 non-Africans. These participants included Ministry of Education officials, university scholars, and classroom teachers. They worked informally to develop both student and teacher materials, all of which underwent field tests in at least one Ugandan classroom during the workshop period. Following the workshop, each African participant received copies of 8 units in draft form, out of 22 units begun, useful for adaptation to local needs. The remaining units needed further editing and additional revisions before they could be field tested.

In 1966, Tanzania hosted the second workshop at Dar es Salaam. Fifty-six scientists, science educators, and Ministry of Education officials representing the participating African nations worked with personnel from the United States, the United Kingdom, and Canada. They continued the development of materials for teaching science to African primary school children, with heavy emphasis on the use of locally available supplies in the design and production of units. Groups representing the physical and biological sciences were subdivided into working teams of three to six members, and each team prepared units in specific subject areas. Seventeen units were drafted and, as at Entebbe, each unit was field tested in at least one Tanzanian primary school during the workshop. Again, participants returned home with a sample of six units useful for local classrooms.

In addition to materials development, activity began in producing films which illustrated how APSP was being taught in local African classrooms. The primary purpose of these films was to be in teacher training.

The third materials development workshop convened in 1967 at Akosombo, Ghana. The 50 participants included 35 Africans and 23 non-Africans. They continued development of new materials for primary school science students in Africa. Participating countries included Ethiopia, Ghana, Kenya, Lesotho,

Liberia, Malawi, Nigeria, Sierra Leone, Tanzania, Uganda, and Zambia. Fifty-five units had reached various stages of completion, and were prepared primarily as teacher guides to employing local resources for teaching primary school science. Additional materials also were being prepared, such as pupil books, science readers, and pilot films. It was recognized by 1967 that the APSP curriculum materials could be implemented in one of three forms:

- a. as a unified curriculum science package;
- b. as material supplementary to existing science education curricula; or
- c. as models for local adaptation.

Program direction was redefined by 1968, as the African countries actively worked to implement APSP materials in primary schools. The initial goals were to create a set of curriculum materials and, implicitly, to give a large number of African educators curriculum development experience. The aims also included development of new science centers, or the expansion of existing ones, from which field tests of these materials could be conducted. The science centers also would operate as the institutions through which African curriculum development capability would be enhanced.

The need to develop teacher training programs closely relates to the development of curriculum guides to assist teachers in using the "discovery" approach in teaching primary science. Although teacher guides had been created during the 1965, 1966, and 1967 workshops, major emphasis on in-service teacher training did not begin until 1969 when the majority of tutor positions became occupied by Africans rather than expatriates. These teacher training workshops convened in teacher training institutions; outside resource people contributed ideas about teaching techniques and strategies. Some APSP training workshops attempted to involve teachers in the development of classroom materials. This was done not only to create a curriculum development capability but also to increase their ability to implement these materials in the classroom. Pre-service teacher training occurred sporadically throughout countries participating in APSP. For example, Tanzania concentrated on the development of pre-service teacher training and adopted APSP materials for inclusion in the teacher training college syllabuses.

A critical element of the APSP development phase was the organization and establishment of the science centers. Staffed by African scientists and teachers, each center is designed to function as the nucleus of national curriculum reform activity. The original objective called for the establishment of 15 science centers in 11 African countries. As the project developed, EDC personnel met with Ministry officials in English-speaking tropical African countries concerning the extent of their participation in APSP and the possible formation of a science center as the institute for creating curriculum materials and conducting field trials. APSP also joined forces with the existing centers in Kenya and Nigeria. By 1967 efforts were directed toward assisting seven countries, committed to improving science teaching in their primary schools, to establish operational science centers: Kenya (1965); Nigeria (1965); Ghana (1966); Malawi (1966); Tanzania (1966); Sierra Leone (1967); and Uganda (1967). (See Figure 2, p. 48.)

### 3. Workshop Products

A total of 54 units are currently available. The majority of these were created at the three materials development workshops from 1965 to 1967. Following completion of the materials development workshops, materials were edited and brought to final form at three writers' workshops: Nairobi, Kenya (1968 and 1969); and Takoradi, Ghana (1969). Products at the conclusion of the workshops phase include: teacher guides, student materials, science readers, mini-units, and teachers' background books.

Table 8 (see page 49), adapted from Final Report (EDC) Beginning Science Curriculum, December 1, 1971, pp. 80-82, summarizes the curriculum materials completed by 1971, and the suggested class levels where they could most appropriately be used.

A sample of the APSP curriculum appears on the following pages. This unit, prepared by the Physical and Chemical Sciences group, is designed for students in Standards 5-7.

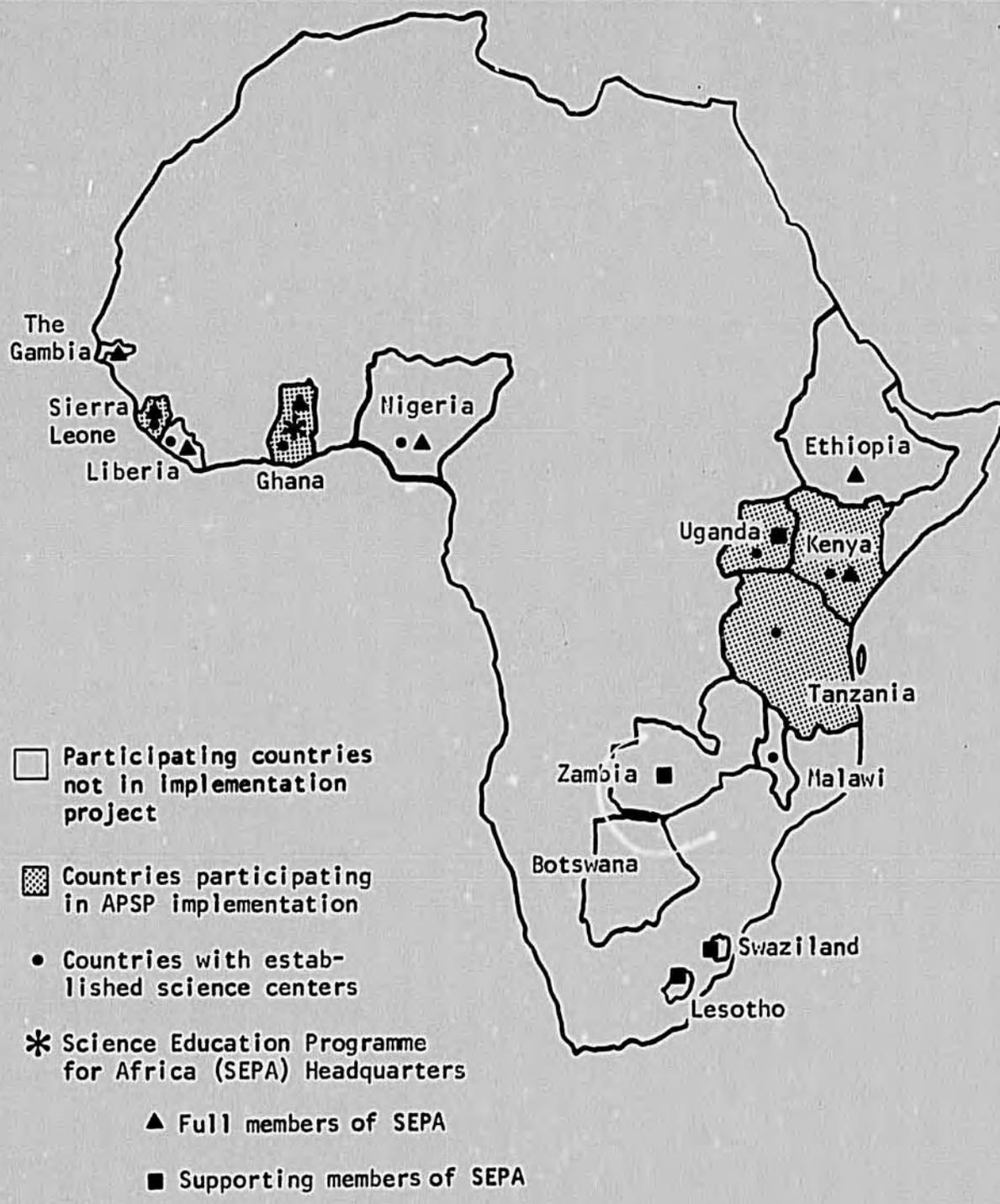


Figure 2

Countries participating in the African Primary Science Program

TABLE 8

Suggested Class Levels for  
APSP Printed Curriculum Materials

TITLE	LEVEL	TITLE	LEVEL
A Teachers' Guide to the APSP . . . . .	1-7	<u>Physical and Chemical Sciences</u>	
Making a Start . . . . .	1-7	Making Paints . . . . .	3-5
LOWER PRIMARY		Colours, Water and Paper. . . . .	4-5
Introduction . . . . .	1-3	Sinking and Floating . . . . .	4-5
Arts and Crafts . . . . .	1-3	Torch Batteries and Bulbs . . . . .	4-5
Construction . . . . .	1-3	Changing Solids . . . . .	4-5
Cooking . . . . .	1-3	Making a Magnifier . . . . .	4-6
Dry Sand . . . . .	1-3	Friction . . . . .	4-6
Exploring the Local Community . . . . .	1-3	Estimating Numbers . . . . .	4-6
Plants in the Classroom . . . . .	1-3	Making Things Look Bigger:	
Playground Equipment . . . . .	1-3	Teachers' Handbook . . . . .	4-7
Water . . . . .	1-3	A Scientific Look at Soil . . . . .	5-6
Wet Sand . . . . .	1-3	Inks and Papers . . . . .	5-6
Wheels . . . . .	1-3	Construction with Grass . . . . .	5-6
Woodwork . . . . .	1-3	Powders . . . . .	5-6
MIDDLE AND UPPER PRIMARY		Chima Makes a Clock . . . . .	5-6
<u>Biological Sciences</u>		Measuring Time: Part I . . . . .	5-6
Exploring Nature . . . . .	3-6	Bricks and Pots . . . . .	5-7
Seeds . . . . .	4-5	Tools for the Classroom . . . . .	5-7
Small Animals . . . . .	4-5	Making a Microscope . . . . .	5-7
The Water Book . . . . .	4-5	Balancing and Weighing . . . . .	5-7
Ask the Ant Lion . . . . .	4-6	Sound: A Look at Musical	
Juba Beach . . . . .	4-6	Instruments . . . . .	5-7
Mosquitoes . . . . .	5-6	The Moon Watchers . . . . .	5-7
Ourselves . . . . .	5-6	Stars Over Africa . . . . .	5-7
Chicks in the Classroom . . . . .	5-7	Strangers in the Sky . . . . .	6-7
Tilapia . . . . .	6-7	Using the Sky . . . . .	6-7
Buds and Twigs . . . . .	6-7	How the Sky Looks . . . . .	6-7
		Common Substances Around the	
		Home . . . . .	6-7
		Measuring Time: Part II . . . . .	6-7
		Pendulums . . . . .	6-7
		A Book about Pendulums . . . . .	6-7
		Liquids . . . . .	7-0



# Sound:

## A Look at Musical Instruments

Teachers' Guide / Trial Edition



African Primary Science Program

*Sound*, a preliminary teaching unit, was developed at the 1966 Workshop in Dar es Salaam. Further versions of the material have been tested in African classrooms and, after several modifications, *Sound: A Look at Musical Instruments* was written. While many people have contributed ideas to this unit, principal contributors were Dr. D. M. Lapp and D. Kiyimba, Uganda and M. B. R. Savage and W. U. Walton, Kenya. The photographs show children and musical instruments of Uganda. Comments of teachers using this material are needed and will be appreciated. Correspondence should be addressed to your nearest Science Centre:

Elementary Science Unit  
Ministry of Education  
P. O. Box M 188  
Accra, GHANA

Science Curriculum Centre  
Njala University College  
Private Mail Bag  
Freetown, SIERRA LEONE

Natural Sciences Education Section  
Kenya Institute of Education  
P. O. Box 30231  
Nairobi, KENYA

Science Education Department  
Morogoro College of National Education  
Box 691  
Morogoro, TANZANIA

Science Centre  
Domasi Teachers College  
P. O. Domasi, MALAWI

Uganda Science Centre  
National Institute of Education  
P. O. Box 7062  
Kampala, UGANDA

Science Curriculum Centre  
Department of Education  
University of Lagos  
Lagos, NIGERIA

These materials have been developed with assistance from Education Development Center, Newton, Mass., U.S.A. operating under US/AID Contract csd-772, as part of the African Primary Science Program.

JULY 1971

## **SOUND: A LOOK AT MUSICAL INSTRUMENTS**

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# **SOUND: A LOOK AT MUSICAL INSTRUMENTS**

## **INTRODUCTION**

This unit is about sounds: low sounds and high sounds, soft sounds, loud sounds and sounds that are musical. The children are given opportunities to make and play musical instruments, form bands and enjoy the experience of making music in groups.

Other activities are presented for the children to explore the ways in which different sounds are made. Simple equipment, interesting questions, and problems are suggested to encourage exploration, construction and experimentation.

Before you begin work on the unit, it would be valuable to read through the entire guide and to be familiar with what is to be done in the various lessons, as there are many ways in which you, the teacher, can use this unit.

### **Beginning**

The order in which you use the lessons, you will decide upon. You may decide to begin by:

following the lessons in the order given in the unit;

introducing one activity as an extension of work you are doing in some other subject, for example, a study of sets in mathematics may lead you to look at the classification of musical instruments; a music lesson may involve discussion of high and low notes and this may lead you to the lessons on making high and low notes with different kinds of instruments;

making musical instruments in your classroom;

talking about the music in your region and having your pupils bring in a variety of musical instruments;

encouraging those pupils who may have made musical instruments at home to bring them to school;

visiting a local expert who makes musical instruments.

(1)

As you look over the various lessons and the activities in the lessons, you will see they can be arranged in the following way:

**The Activities**

1	2	3 - 4 - 5	6
<p>Playing and listening to instruments</p> <p>(1 and 2 go together)</p>	<p>Classifying instruments</p>	<p>Making high and low notes with:</p> <p>Instruments that are beaten</p> <p>Instruments that are blown</p> <p>Instruments that are plucked</p> <p>(do one or all of these)</p>	<p>Making high and low notes with strings</p>
7	8	9	10
<p>More work with strings</p> <p>(systematic experiments with strings)</p>	<p>How do traditional instruments work?</p>	<p>How can the sounds of instruments be made louder?</p>	<p>Making instruments</p>

You, of course, may want to change this order and should feel free to do so. You may want to start with "making your own instruments" (10) and then take the activities in order 1-9. Alternatively, your order may be 3-4-5, 8, 7, 1-2, 6. Enjoyment and learning should go together. You, as the teacher, can decide the order of activities which will encourage both learning and enjoyment in your classroom.

(2)

## LESSON 1: PLAYING AND LISTENING TO INSTRUMENTS



In this first lesson, your pupils will have a chance to discover by themselves how various instruments make sounds. At the same time, the children will have the pleasure of playing different instruments and can begin to think about how the various instruments are alike and different.

### Preparation

You should try to obtain two or three of each of the following kinds of instruments:

Instruments that are blown

Stringed instruments

Ringing instruments that are struck, such as bells, gongs, earthen jars, bottles

Drums of various types, and various sizes of tins

Instruments that are pinched or plucked, such as a thumb piano

Rattles and other instruments that are shaken.

Ask the children to bring from home whatever instruments they can. Borrow those that you can from friends. Perhaps you can talk with children and their parents who have instruments and explain to them what your class will be doing and that the instruments will be well cared for. However, some instruments may be of high value and not able to be borrowed, and you will have to construct models as in the pictures shown with the final activity in this guide.

(3)

Some children will enjoy helping you make these models before the sound activities are begun.

Although the children may not be sure in the beginning exactly why the instruments are made as they are, they will be learning many things as they work with tools. During the activities in this guide, it is hoped that your pupils will gain a better understanding of why instruments are made in certain ways. In the final activity, the children will have a chance to make their own instruments, and will know ways to improve the instruments to make pleasant sounds which satisfy themselves.

When you have collected and made enough instruments, plan to begin this first lesson.

You will need some place to keep the instruments between lessons. A table, a shelf, some baskets or some cardboard cartons will do. You will have to decide whether they can be kept in the classroom, or in a place such as the school store when they are not being used by your pupils.

You will also need a place where the children can play the instruments and make noise without disturbing the other classes in the school. (This may not be necessary for all of the lessons.) Perhaps you can find such a place under a tree across the compound from the school.

### **The Activities**

Take your pupils to the place where you have put out the instruments. Explain to them that they are going to be working with musical instruments, making music, and perhaps later making their own instruments. Today they can play the instruments you have collected and find out how the instruments make different kinds of sounds.

Let them begin. Most pupils will pick up instruments and begin to play them with other children. Small groups will form. A few pupils will like to work by themselves and find out just how to make different sounds with the instruments they have.

Drums are always popular. Many of the children will soon be beating on tins and bottles as well as on any real drums you might have been able to collect. From time to time, you may need to join in and play with a group to show them various ways of using the instruments. Sit down and carefully select different-sized tins, and drum on them yourself. Pour water into bottles to see if the water changes the sound produced when you tap the bottles. Children, seeing you do this, will soon take your lead and begin to experiment with the instruments they have to find out what different sounds they can make.

Not every child can use the blowing instruments and, indeed, there may be some instruments that you cannot play. But almost always, all of the instruments can be played by one child or another.



Ask your pupils to show you how to play the instruments. See how many different sounds children can make with them. With what other things can sounds be made by blowing? Encourage your pupils to try bottles, tins, pieces of bamboo, grass, their hands, or anything else they can suggest.

Let your class continue playing the instruments for about thirty minutes. The children will probably make a lot of noise but do not worry; since they are outdoors, they will not be disturbing other classes.

Encourage the children to make as many different sounds as they can. You can best do this by showing your appreciation of what they are doing and by joining in and playing with them.

When you feel it is time to stop, you may have some of the children demonstrate the sounds they can make with their instruments. Then have your pupils gather up the instruments and take them back into the classroom. As they put the instruments away, ask them to put instruments together that they think belong together. They may ask you which ones belong together, but tell them to use their own judgement. There is no one right way or no completely wrong way. In the next lesson, they can talk about the different things that make certain instruments belong together.

(5)

Throughout the developmental phase, several articles about APSP were published. A list of these publications appears below, as adapted from "Final Report (EDC) Beginning Science Curriculum, December 1, 1971, pp. 118-120."

- 1965 Martin, W. T. & Aldrich, J. L. The African education Program. EDC Quarterly Report, Summer-Fall 1965, pp. 107-116.
- 1966 Osiyale, A. O. Primary school science in Africa: An educational experiment. ESI Quarterly Report, Spring-Summer 1966, pp. 64-76.
- Yoloye, E. A. Trends in elementary science curricula. West African Journal of Education, February 1966, pp. 18-21.
- 1967 Godfredsen, E. A. Teaching science in primary school. The Tanzanian Education Journal, January 1967, 9(3), 23-26.
- Kimball, R. L. The science center. Malawi Science Teacher, pp. 39-40.
- Maximon, L. C. An African sojourn. International Science and Technology, June 1967, pp. 14-15.
- 1969 Elstgeest, J. Science education in the General Teachers' College. Rehovoth Conference on Science Education in Developing States, Israel, 18-26 August 1969, p. 11.
- Godfredsen, E. A. Aims of a science experience in primary schools. Teacher Education in New Countries, February 1969, p. 223
- Lapp, D. M. Science through discovery. The Teacher, 1969, Vol. 1, pp. 13-17.
- Osiyale, A. O. The challenge of science teaching today. Teacher's Journal, 1(1), 10-11, March/April 1969.
- 1970 Ayankogbe, A. Investigations with the ant lion. Journal of the Science Teachers Association of Nigeria, 9(1), 33-36, 1970.
- Gornall, F. A. The African primary science program. Commonwealth Education Liaison Committee News-Letter, 2(9), 3, 6 & 7, May 1970.
- Lawrence, J. A. Field support and in-service work in new primary science. The British Council, Dar es Salaam, Tanzania, August 1970. (Mimeographed 13 pp.)
- Yoloye, E. A. The African primary science program. Journal of the Science Teachers Association of Nigeria, 9(1), 28-32, 1970.

Yoloye, E. A. A study of teacher response to training on APSP materials. Journal of the Science Teachers Association of Nigeria, 9(1), 21-25, 1970.

Yoloye, E. A. The readability indices of APSP units, Newton, Mass.: Education Development Center, 1970.

1971 Nigerian Educational Research Council. The potential of APSP units for teaching scientific processes. Report of the Science Group, National Workshop on Primary School Curriculum, Lagos, Nigeria, May 1971.

Osiyale, A.O. African primary science program. Journal of the Science Teachers Association of Nigeria, 9(3), 1971

Seawell, J. P. The elementary science unit and the development of elementary school science. Journal of the Ghana Association of Science Teachers, 12(2), 8-11, June 1971.

#### 4. Materials Evaluation Activities

APSP evaluation activities have expanded steadily following the initial attempt at the Entebbe materials development meeting in 1965. The EDC Final Report (1971, pp. 52-58) summarizes the activities and the personnel involved. A more detailed compilation of APSP evaluation activities appears in "Evaluation for Innovation," an APSP evaluation report prepared by Dr. E. Ayotunde Yolote in November 1971. At the time of the 1966 Entebbe meeting, preliminary thoughts on the nature of evaluation for APSP were documented by Dr. Anthony Elite, a psychiatrist from Massachusetts General Hospital. Discussions specifically related to initiating evaluation activities were led in 1966 by Dr. Robert Chin, a social psychologist from Boston University. A paper outlining his opinions about evaluation concludes by suggesting that the dialogue between the science educators and program policy groups be expanded to include evaluation, and that evaluation activity eventually be the responsibility of individual countries.

At the Akosombo workshop in 1967, a full-time evaluator was appointed to conduct evaluation activities, Dr. E. A. Yoloye of the University of Ibadan. Dr. Yoloye worked with seven people to clarify the goals of APSP and to begin development of evaluation instruments specifically designed to measure these goals. Preliminary evaluation instruments received trials in some Ghanaian classrooms during the workshop meeting.

In 1968, Kenya hosted the first workshop devoted entirely to evaluation activities. Eleven full-time participants, representing four academic disciplines, worked closely on evaluation procedures with staff members of the Curriculum Development and Research Center in Nairobi. These procedures were compiled by Dr. Yoloze in a "Source Book for Evaluation,"<sup>6</sup> which contains the evaluation instruments produced from various meetings on evaluation. These instruments were preliminary, as only limited assessment of their usefulness and validity had been undertaken.

Evaluation activities encountered difficulties, and were implemented less extensively than desired. For example, although materials development was concurrent in several countries over a wide geographic area, the coordination of evaluation efforts was based at Ibadan University. During the civil war in Nigeria in 1966-67, evaluation activity was terminated rather than relocated.

Partly to compensate for these difficulties, an evaluation was undertaken by Eleanor Duckworth, a psychologist knowledgeable about ESS who had conducted evaluation activities during 1968-69. Her 1970 monograph, "Evaluation of the African Primary Science Program,"<sup>7</sup> reported the results and conclusions. She visited several science centers and administered some of the previously developed evaluation instruments as part of the first general evaluation of the project. The primary purpose of this evaluation was to "develop ways to help people judge when their ideas are working well and when they are working less well [p. 1]." The data collected were used to provide teachers with indicators to judge the effectiveness of their courses and Ministry officials with ways of judging how the program "as a whole can help large numbers of teachers to help children become competent, confident, resourceful individuals [p. 31]."

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<sup>6</sup>Yoloze, E. A. African primary science program. Source book for evaluation. Ibadan, Nigeria. University of Ibadan, November 1968.

<sup>7</sup>Duckworth, E. R. Evaluation of the African primary science program. Newton, Mass.: Education Development Center, September 1970. (Monograph series.)

A second evaluation study was conducted in 1971 in Kenya.<sup>8</sup> The study was divided into two phases: Phase I examined the resourcefulness and independence demonstrated by children when performing tasks with materials in accordance with specific directions or tasks; Phase II required individual children to solve specific problems without detailed directions. Results of this evaluation suggest that children exposed to the APSP materials displayed an ability to develop ideas for using materials, indicated self-confidence in using their ideas, and interacted compatibly with one another when pursuing their ideas.

Based on the exploratory evaluation studies, teacher training has been identified as the weakest area of the program and the one which needs most attention. Therefore, Dr. Yoloye has directed recent evaluative efforts toward teacher training activities and this has resulted in the development of classroom interaction analysis techniques and child observation techniques. Research now in progress includes studies of cognitive preferences of primary school children, and of the reading abilities of primary school teachers and pupils in Africa.

#### 5. Personnel

Representatives at the Kano meeting decided that APSP would operate under the overall direction of an Advisory Committee, whose responsibility would include monitoring program development to assure that APSP activities responded to local needs. The success of the program was viewed as dependent upon the expertise of people experienced in developing materials for use in elementary science classrooms, plus an organization within which program participants could gain necessary training or experience and share ideas with members from different national educational systems. These conditions would be created by conducting science workshops during summer vacation periods and by receiving EDC assistance to develop science centers in the participating countries.

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<sup>8</sup>Duckworth, E. R. A comparison study for evaluating primary school science in Africa. Newton, Mass.: Education Development Center, October 1971.

Committee composition changed from 1964-67 to reflect an increasing commitment to and involvement with APSP by Africans. In 1964, the committee consisted of 26 non-Africans and 3 Africans. By 1967, membership had changed to 7 non-Africans and 5 Africans. The following table from the Final Report (EDC) Beginning Science Curriculum, December 1, 1971 [p. 79], illustrates the increased Africanization of the Steering Committee which began in 1968. By 1969 the existence of the official Steering Committee had ceased.

TABLE 9  
Countries Represented at the APSP  
Advisory Meetings from 1968 to 1970

Countries	Dates and Locations			
	Kampala 1968	Takoradi 1969	Freetown** 1970	Kampala 1970
Botswana . . . . .				X
Ethiopia . . . . .			X	X
The Gambia . . . . .			X	
Ghana . . . . .		X	X	X
Kenya . . . . .	X	X	X	X
Lesotho . . . . .	X	X		
Liberia . . . . .			X	X
Malawi . . . . .				X
Nigeria . . . . .	X	X		X
Sierra Leone . . . . .	X	X	X	X
Swaziland . . . . .			X	
Tanzania . . . . .	X		X	X
Uganda . . . . .	X	X	X	X
Zambia . . . . .				X
<b>Total</b>	<b>6</b>	<b>6</b>	<b>9</b>	<b>11</b>

\*The Science Education Programme for Africa (SEPA) was formed at the Freetown meeting.

EDC was asked to identify the key personnel who contributed the most to APSP planning and development. These six persons, with brief comments on their contributions to APSP, are the following:

- a. Robert W. Carlisle: Project Director. Mr. Carlisle served on the APSP project from 1968-1972. During this time, he was responsible for coordination of instructional materials and policy decisions in the seven English-speaking APSP countries,

and guided a number of workshops during the development and implementation phases.

- b. Daniel E. B. Chaytor: Director, Science Education Programme for Africa (SEPA) teacher training. Dr. Chaytor, former Dean of the Faculty of Science, Njala University College, University of Sierra Leone, contributed a scholarly background in science to APSP. His primary current function is to direct teacher training activities.
- c. Hubert M. Dyasi: Executive Secretary, SEPA. Since the 1970 creation of SEPA, Dr. Dyasi has expanded his APSP involvement from Acting Executive Secretary on a part-time basis to full-time Executive Secretary. His current responsibilities include recruiting membership from African governments interested in curriculum reform in science education, in addition to expanding the current training and program activities within individual African nations.
- d. Jack S. Goldstein: Academic Director. From 1965 to 1972, Dr. Goldstein participated in a number of workshops as a technical consultant in science. Based at EDC, he was a prime decision maker in the selection and development of curriculum materials. He currently serves as a program consultant.
- e. Ralph H. Robins: Director, APSP. From the beginning of APSP to the present, Mr. Robins has been responsible for non-academic programming activities. He currently directs all aspects of APSP.
- f. E. Ayotunde Yoloje: Director, APSP/SEPA Evaluation. From 1965 to the present, Dr. Yoloje's association with APSP focused on evaluation. In 1967 he directed the initial attempts at developing evaluation instruments to measure achievement of the APSP objectives. Since then, evaluation activities have increased to include teacher training and in-service workshops at the Evaluation Centre at the University of Ibadan in Nigeria, directed by Dr. Yoloje.

Table 10, adapted from "Final Report (EDC) Beginning Science Curriculum, December 1, 1971 [p. 19]," shows the location and length of service of the APSP professional field staff. Members of the field staff were assembled from a variety of sources. EDC perceives early recruitment tasks as very difficult because of limited availability of experienced personnel in curriculum development. The largest single source has been EDC's Elementary Science Study (ESS): five Science Educators were employed directly from ESS and three other Science Educators had participated in some ESS-sponsored activities. The second largest source of personnel was the Peace Corps: three staff members transferred directly from their field assignments to APSP and three others had Peace Corps experience prior to EDC employment. Ten field staff members originated from educational settings and a "variety of other working experiences (Final Report, p. 18)." Of these individuals, eight held Bachelors' degrees, primarily in science, seven Masters' degrees, and three received either a Ph.D. or an Ed.D.

TABLE 10

## APSP Professional Field Staff: 1965 to 1971

	1965	1966	1967	1968	1969	1970	1971
KENYA		Warren					
			Savage			Hale	
			Walton				
			Zubrowski				
			Christiansen				
GHANA			Bassett		Seawell		
				Manning			
NIGERIA EAST	Savage						
MID-WEST		Walton					
LAGOS		Bassett					
			Osiyale				
MALAWI		Kimball			Woomer		
SIERRA LEONE			Francis			Drew	
TANZANIA		Godfredsen			Tilson		
UGANDA			Lapp			Seager	

## 6. Financial Support

The financial information contained in Table 11 was provided to the evaluation staff by the APSP Director. The table depicts expenditures during the research and development phase and the committed funds through June 1973 of the initial implementation phase.

TABLE 11  
APSP Financial Support from 1964 through 1973

Dates	Contract	Source		Cumulative (AID and Ford)
		AID	Ford Foundation	
Oct 1964 to Apr 1965	Grant	---	\$218,000	\$ 218,000
Jul 1965 to Aug 1966	csd/772	\$ 418,603	---	636,603
Jul 1966 to Jun 1968	Amendment #1	1,329,323	---	1,965,926
Jun 1969 to Mar 1970	Amendment #5	430,036	---	2,395,962
Mar 1970 to Jun 1971	Amendment #6	559,000	---	2,954,962
Jun 1971 to Jun 1973	afr-791	<u>647,366</u>	<u>---</u>	<u>3,602,328</u>
Totals		\$3,384,328	\$218,000	\$3,602,328

## 7. Implementation Phase Goals

The science centers served as implementation vehicles on a limited basis throughout the development phase. In June 1971, the implementation phase was initiated in five participating countries: Ghana, Kenya, Sierra Leone, Tanzania, and Uganda. AID has funded a two-year effort through EDC (AID/afr-791) to supply the necessary services for implementation in these countries. As outlined in the current contract, the objectives of the program (July 1971-June 1973) are as follows:

- a. workshops to produce materials for tutors to use in their courses in the 151 participating teacher training colleges, training of tutors in use of these materials, and assistance for primary teachers;
- b. training of staff members in curriculum development centers through special programs developed for this purpose; and,

- c. support to the Science Education Programme for Africa (SEPA), an African based and directed organization which will ultimately assume complete responsibility for leadership and coordination of African science programs.

The implementation phase was carried out by five staff members at the EDC home office in Newton, Massachusetts, who spent about 84 man-months on this phase. This staff consisted of a Project Co-Director, an Administrative Director, a Secretary, an Editor, and a Science Consultant. Those posted in Africa include three expatriate Science Educators assigned to Tanzania, Uganda, and Ghana. Three Africans, an Executive Secretary, a Science Educator, and a Secretary, provide the current staffing of SEPA at Accra, Ghana.

A major emphasis during the implementation phase has been on pre-service training. In 1971 at Nairobi, a Pan-African group sponsored by SEPA/APSP developed prototype materials for use in the teacher training colleges. Led by Dr. E. A. Yoloye, representatives from 13 English-speaking African countries prepared materials which they could then try out in their individual countries. Results of these trials would be discussed at a subsequent meeting in 1972 (APSP Report, 1 July 1971 to 30 December 1971, p. 5.). In February 1972, a 17-member Planning Committee on Teacher Education met at Accra to discuss the results of the individual country field trials. The Committee recommended that, because of the diverse needs among member countries, pre-service teacher training should be conducted through in-country workshops rather than Pan-African workshops. The first response to this decision resulted in the July 1972 workshop at Sierra Leone, which stressed tutor training and continued development of science education materials. Another country workshop was tentatively scheduled for Nairobi in December 1972.

SEPA has now assumed responsibility not only for tutor training but also for training others interested in introducing modern science methods and materials in primary schools. Therefore, in a May 1972 program three Liberians, three Ghanaians, and one Kenyan were trained for six months, under SEPA auspices, in the implementation process required to introduce new primary science curricula in their own countries. Details for future similar courses were being discussed during the evaluation team's visit.

### III. UTILIZATION AND IMPACT

#### A. African Mathematics Program

Five countries are participating in the implementation phase of AMP: Ethiopia and Kenya make up the East African Regional Mathematics Program (EARMP), and Ghana, Liberia, and Sierra Leone comprise the West African Regional Mathematics Program (WARMP). All five countries were visited for the evaluation. Some general observations were made on mathematics instruction throughout these five countries. These are presented first, followed by more detailed observations on the program status and impact within each individual country.

First, acceptance of the concepts of "modern" mathematics seems to be virtually universal. A few individuals interviewed expressed concern, and some expressed reservation, over the value of extreme educational approaches which strive to improve the appreciation of theoretical relationships while almost eliminating the development of everyday computational skills. The fundamental goals of modern mathematics, however, have almost completely replaced the traditional approach in Africa. Even the so-called "traditional" texts still used in Africa tend to contain many attributes and a structure typical of modern mathematics materials, and for this reason they often are referred to as "transitional" texts.

A second general observation is that modern mathematics has been promoted by many influential sources in Africa, and not exclusively by the African Mathematics Program. The impact of various British organizational efforts, particularly the Nuffield Foundation and the British Mathematics Association, was noted in almost every country visited. The British and American approaches, which tend to be distinguished by Africans, are differentiated largely in terms of their degree of mathematical rigor. Africans describe the British position as more practical and intuitive, and label the

American orientation as more theoretical and more insistent on proofs. However significant these conceptual differences might be to a mathematician, they have little real impact at the classroom level where differences in writing style, cost, and appropriateness of examples are more important in evaluating a text.

Thirdly, although mathematics is a high priority school subject at the primary and secondary level, the overriding concern expressed by African educators was not the problem of choosing among alternate curriculum approaches. Rather, the concern rests with the more basic difficulty of training teachers so that they have even a minimum mathematical competency and of supporting and affording production and distribution of textbooks.

### 1. Ethiopia

Mathematics in Ethiopia ranks high in the Ministry of Education's order of academic priorities. Examination success in mathematics, English, and Amharic (the national language) essentially determines university admission. A number of activities in curriculum revision, teacher training, and production and distribution of materials are in progress. However, overshadowing these activities is the possibility that within a few years the entire educational system may be restructured. This restructuring will be decided by the Ministry following review of a recently completed comprehensive study, "Report of the Education Sector Review. Education: Challenge to the Nation (August 1972)." A task force consisting of over 80 educational specialists produced this study, sponsored by the World Bank. The following comments about current activities in Ethiopian mathematics should be evaluated in light of this report, and its implications for Ethiopian education.

In 1967, modern mathematics was introduced into the Ethiopian school system on a nationwide basis. The Entebbe texts adopted by Ethiopia are the Primary Series and the Secondary C Series prepared under the African Mathematics Program. The Primary Series consists of six books while the Secondary C Series consists of four volumes with the first three having separate books for algebra and geometry and the fourth prepared as a single volume of both algebra and geometry.

Representatives from the Mathematics Section of the Ministry of Education indicated that these Entebbe texts will be revised by reordering topics in order to fit the current 12-year school structure. A tentative time schedule for the preparation and implementation of the revised texts indicates their completion by 1973.

Primary school in Ethiopia includes Grades 1-6; the first five grades use Amharic as the language of instruction. Beginning with Grade 6, students receive instruction in English. Primary 1 and 2 of the Entebbe mathematics series has been translated into Amharic for Grades 1 and 2, but only the first-grade book has been received by primary school teachers. In some of the remote provinces of Ethiopia, the first-grade book has not yet been received by the teachers. Grade 2 is being prepared for distribution during the current school year. Grades 3-6 use the Highway Mathematics Series (Kenya: Longmans, first published in 1962) which has been translated into Amharic. Although teacher training programs in modern mathematics are ongoing, traditional approaches are still being used in the classrooms even though a textbook oriented toward modern mathematics has been officially adopted.

Grades 7-12 (junior and senior secondary school) all use the Entebbe mathematics series, Modern Mathematics for Ethiopia (Addis Ababa: Ministry of Education and Fine Arts), with English as the language of instruction. The Ethiopian School Leaving Certificate Examinations (ESLC) taken at the completion of secondary school is based on the Entebbe Mathematics texts. According to a university scholar who helped write the Entebbe series, however, this examination does not reflect the discovery teaching approach.

The Mathematics Section of the Curriculum Division of the Ministry of Education has recently outlined a proposed scheme of work to revise the mathematics syllabus for Grades 3-12. This document has been submitted to faculty members at Haile Selassie I University, tutors at the six teacher training colleges, and instructors at the vocational and technical schools. Each individual has been asked to comment on the proposed revision. Following receipt of these comments, a committee of mathematics specialists will be formed to complete the revised syllabus.

Teacher training is the weak link in implementing new pedagogical approaches to teaching modern mathematics. In Ethiopia, teacher education programs are based on the grade level to be taught. For example, primary teachers complete ten years of academic training and two years of teacher training college while senior secondary teachers must successfully complete a bachelor's degree university program. Potential primary school teachers do not specialize in one academic area. They usually enroll in only one or two courses of a subject area which they will be expected to teach. This means that a primary teacher will probably have received only one or two courses in mathematics (including both content and methodology) prior to beginning teaching experience. Because no materials are provided during the teacher training college years, a student must rely on personal resources for reference texts after he completes the course. The same textbook situation applies to students training to be junior and senior secondary teachers.

The need for in-service teacher training was underscored in the team's visit to the Minister of State. He wanted to make certain that the evaluation team left Ethiopia knowing two things: 1) that more in-service training for primary school teachers was needed, and, 2) that an Academy of Pedagogy was being established to train tutors in teacher training.

When modern mathematics was introduced in Ethiopia (1967), the training colleges preparing primary school teachers needed to change their instructional approach from a traditional to a modern emphasis. The materials produced by AMP (the Basic Concepts texts) for these training colleges were too advanced for the students. The East African Regional Mathematics Program (EARMP) is attempting to fill this vacuum by creating a revised set of materials for use in the teacher training colleges. At the same time, EARMP has been sponsoring two-year programs for teacher training tutors and primary school supervisors to provide them with training and experience in both pre-service and in-service training. Workshops held at Nairobi in 1971 and 1972, staffed by three or four expatriates, have resulted in the production of Volumes I and II of teacher training materials for the method and content of modern mathematics. Volume I has been field tested in two Ethiopian teacher training classrooms, and then revised at the 1972 workshop; Volume II is currently being field tested in one Ethiopian teacher training

college. The EARMP Mathematics Educator/Editor in Ethiopia is now writing Volume III, a primary teachers' guide supplementing Volumes I and II. The camera-ready copy of the three volumes will be submitted to the Ministry of Education for production and distribution to the teacher training colleges.

The EARMP Mathematics Educator/Editor is conducting a two-year training program for teacher training tutors and primary school supervisors. An initial two-week institute is followed by a correspondence course in which participants are requested to complete assignments in modern mathematics, and the Mathematics Educator/Editor periodically visits the schools. The first group, 55 supervisors and all 12 teacher training tutors, is nearing the completion of its two-year course. The correspondence course was specially tailored for both types of participants because the tutors often found the mathematics assignments too elementary and the supervisors experienced difficulty because the mathematics level was too advanced. In 1971, of 18 lessons assigned, only 26 percent of the Ethiopian supervisors completed more than 40 percent and none completed more than 60 percent of the lessons. Follow-up visits had been made to about 90 percent of the tutors and supervisors. Expectations in amount and quality of participation for 1972 are about the same. In spite of their limitations, the Mathematics Educator/Editor feels that these courses should be continued.

Transport is a major problem in Ethiopia, both for distribution of textbooks and for organizing teacher training workshops. School supervisors often are assigned to posts so remote that a two-week journey is required to visit them. Their own contact with teachers is similarly limited because the Ministry of Education has no mandatory visitation scheme, the provinces are very large, and little financial support is provided for supervisors to visit schools within their districts. The transport problem is equally difficult for the Mathematics Educator/Editor, and he has difficulty in successfully performing his follow-up visits.

In the second teacher training program, the Mathematics Educator/Editor plans to more carefully tailor the course to the participants. Even though all the tutors were trained in the first institute, their high turnover rate has seriously diluted the long-range effects of the training program.

Only 3 or 4 of the original 12 tutors remain at the conclusion of the first two-year training cycle, as there appears to be little incentive to remain as a tutor in the educational system. Long-term influences on teacher training, therefore, appear to be limited.

A classroom visit to one of the foremost secondary schools revealed that an algebra class was being taught in the traditional way by the teacher, a university graduate. Over 90 percent of the instruction time was teacher directed, with students spending 15 minutes out of a 45-minute class copying problems and mathematical proofs in their exercise books. The traditional approach was also being used in a primary class to teach the modern concept of sets. The teacher spent over 90 percent of her time instructing the class while students copied problems in booklets; the materials (bottle caps and string) were used only a minimum period of time. It was also reported that only 3 out of 41 teachers in that school were using the new mathematics texts.

The distribution of materials to the schools is an additional problem faced by Ethiopia in implementing the AMP program. Textbooks are published by the Ministry of Education, and storekeepers for each of the country's provinces are to collect and distribute them to the schools within their province. This system has been inefficient and has not met the distribution needs of the schools or AMP. The problem is compounded by the transportation and communications difficulties encountered in the remote regions, which often delays, and sometimes precludes, materials distribution.

Although Ethiopia has officially adopted the Entebbe Mathematics for Grades 1-12, the interviews indicated that modern mathematics is not really being taught on a wide scale and the expectation for improvements are minimal. In five years, the participants now in the in-service training programs probably will have accepted employment outside the educational system. Many of the teacher trainers are expatriates, and in some cases counterparts have not been provided for continuation of existing programs following expatriate departure. Although a counterpart for the Mathematics Educator had been selected, no official action had been taken to establish him in the position or to have him begin working with the present Mathematics Educator. A trainee evaluator was in Ibadan, but it appears that his role will include many responsibilities beyond evaluation activities in the mathematics program.

## 2. Ghana

A new mathematics syllabus which stresses the language and approaches of modern mathematics recently has been prepared for primary schools in Ghana. This syllabus is not tied to a specific text. In the primary schools, the standard textbook has been Modern Mathematics for Elementary Schools prepared by a group of Ghanaian educators led by B. A. Brown, formerly Chief Education Officer, which includes J. W. L. Mills and T. Q. Armar. This series of books, covering all primary grades, was published by Macmillan & Co., Ltd. during the period 1962-1970. The series follows a traditional mathematical approach, and stresses familiar computational problems. Examples, illustrations, and monetary values were selected specifically for use in Ghana. In Ghana, the texts are in the form of workbooks, although the students copy the problems from these workbooks and write answers in their own personal exercise books. (Exercise books are merely bound tablets of blank lined pages.)

A new series, clearly representative of modern mathematics, was first introduced in 1968. This series was prepared by Lucy Addy Tagoe, an Education Officer, and T. Q. Armar, one of the authors of the previously-adopted text. It is published partially by Macmillan, London, under the title, An Elementary Mathematics Course, and partly by the West African Books & Stationary Co., Accra, under the title, A New Elementary Mathematics Course. Four books, corresponding to the first four of seven primary school years, have been issued. The first two received widespread distribution to classrooms, but the latter two books received limited use due to the lack of foreign exchange needed to buy published copies or to purchase paper for local printing.

Miss Addy participated in the primary education writing group at the AMP workshops in Entebbe and Mombassa each of the seven years the group met, except for 1965. Mr. Armar participated in the secondary education writing group in 1962, and in the testing group in 1963, 1964, and 1967. These contacts undoubtedly influenced the Addy-Armar series, but the Addy-Armar books were not patterned directly from the Entebbe series.

The Addy-Armar series uses the same educational approach as the Entebbe materials, but is regarded by one expert as less thorough and less well sequenced than the Entebbe books. Another expert suggested that the Entebbe series was culturally sterile and verbally sophisticated, while the Addy-Armar series added relevant classroom activity and emphasized simplicity of language. It was estimated that less than one percent of all primary students in Ghana use the original Entebbe materials. Approximately 25 to 30 percent now use the Addy-Armar books, including almost all pupils in the first two years and some pupils in the third and fourth years of primary school. The remaining 70 to 75 percent of all primary pupils continue to use the traditionally oriented Brown-Mills-Armar books.

A textbook committee formed by the Ministry of Education decides which texts will be distributed by the Ghanaian government. At the present time, the Addy-Armar series is the one approved for primary mathematics. When the West African Regional Mathematics Program (WARMP) materials become available, they will be submitted to the committee for consideration. There is some hope that both sets of materials will receive approval, although it is very doubtful at the present time that sufficient funds will be available, even in the next several years, to enable the Ministry to provide alternate texts. If only one text is selected by the committee, it presumably will be one most suitable for Ghanaian children and teachers which can be provided at the lowest cost. Most of those interviewed felt that the Addy-Armar series was not likely to be replaced. The few schools which did use the Entebbe materials on a trial basis are switching to the Addy-Armar series since, even if they wanted to continue, they cannot because both the experimental version and the SRA London version of the Entebbe materials have been out of print since 1969.

At the secondary level, individual schools choose mathematics textbooks. The Mathematical Association of Ghana provides consultation when requested. Possibly because the Mathematical Association of Ghana was founded through efforts of the British Mathematics Association, there has been a consistent preference for British-oriented mathematics texts in the secondary schools.

In particular, a British sponsored project from 1964 through 1971 led to the development of a series of five secondary texts known as the Joint School Project (JSP) Mathematics under the editorship of Michael C. Mitchelmore of the Mathematical Association of Ghana. This series is published by Longmans, Green & Co., London.

About 40 to 50 percent of Ghanaian secondary pupils use the recently completed JSP mathematics series. The remaining pupils use any one of a variety of commercially-published British traditional texts. At the present time, almost none of the schools, including those once in the trial program, continue to use the Entebbe secondary texts. The JSP mathematics series appears to be preferred because it was prepared in Ghana, although almost exclusively by British expatriates. It is oriented toward much the same modern mathematics content as Entebbe. Compared with the Entebbe series, the JSP books are regarded as more intuitive with respect to underlying concepts, and more heavily computational in the content of exercises.

As neither the Entebbe nor JSP programs matched the existing mathematics syllabus coordinated by the West African Examinations Council (WAEC) among The Gambia, Ghana, Nigeria, and Sierra Leone, a special examination was required for both the School Certificate and General Certificate of Education. WAEC records indicate the following selections in the version of the mathematics examinations by Ghanaian "Ordinary Level" candidates for the years 1969-1972: standard mathematics, 40,365; JSP mathematics, 2,927; and Entebbe mathematics, 746. The proportion of students selecting the Entebbe examination is expected to decline due to the unavailability of texts while the proportion selecting JSP is expected to increase now that the entire series is available.

Although there was little expectation that Ghana would turn to the WARMP materials now being developed for primary and secondary mathematics, there is considerable dependence on WARMP for needed pre-service and in-service teacher training in modern mathematics. No teacher training texts or programs appear to have been developed for either the Addy-Armar primary or the JSP secondary series. The AMP teacher training efforts in Ghana began in 1961. As a result, a large number of Ghanaian teachers have attended one or more teacher training institutions, and several Ghanaian teachers and educators participated in the ABC Institutes.

Part of the present implementation phase of the mathematics project, begun in 1970, includes teacher training. The WARMP staff has undertaken the first of two planned two-year programs of instruction in modern mathematics for mathematics tutors, the faculty members of teacher training institutions which train primary school teachers. The Ghanaian program presently includes about 50 tutors, approximately half of the tutors to be trained. The two-year program began with a two-week institute, followed not only by a correspondence instruction course but also coupled with semi-annual staff visits of about three days each to the tutors at their own teacher training institutions. A two-week follow-up institute will complete the program. The correspondence phase proved ineffective from the start because of the inability to distribute the materials necessary to complete the assignments, including copies of the original Entebbe teacher training texts, Basic Concepts of Mathematics.

Other implementation efforts of the mathematics project in Ghana appear to have had the same lack of success. For example, while the new teacher training program being developed by WARMP was judged as satisfactory for both the Addy-Armar primary and JSP secondary texts that are more than likely to be used in place of corresponding WARMP materials, the teacher training materials could not be introduced in one institution on an experimental basis in 1972 as was planned. Permission must be obtained two years in advance for such a deviation and, because no one sought this permission, the materials could be introduced only as supplemental material in that school.

Non-project efforts to improve mathematics teaching in Ghana seem to be more successful. The government has created a group of mathematics "organizers" to assume responsibility for in-service teacher training programs. These organizers presently are being recruited and trained by specially assigned District Education Officers. The Mathematics Association of Ghana offers three-day training sessions which have, so far, reached about 9,000 of the roughly 50,000 primary teachers in Ghana. Finally, pre-service teacher training has been oriented to contemporary mathematics for the last four years, and about 50 percent of the teachers graduated during this period received training in modern mathematics. Presumably, this training results largely from the influence of tutors who participated in the WARMP tutor training program.

Because of the current absence of teacher training materials in modern mathematics, the Curriculum Research and Development Unit (CRDU) at the Ministry of Education prepared six units in modern mathematics to supplement the traditional content during the last two years of enrollment in teacher training institutions. If the WARMP teacher training materials fail to be completed, CRDU feels it can continue to develop its own set of training materials by amplifying these six stop-gap units. However, CRDU has a limited staff of personnel trained in mathematics. At the present time they receive assistance from a Peace Corps Volunteer assigned full-time to their office. One CRDU staff member currently is in a participant training program through the University of Illinois and another is in Australia on a Commonwealth Fellowship.

Ghana would like to develop further the CRDU training materials in mathematics to become independent of expatriate assistance. A request to help train Ghanaians in this capability was submitted to AID, but was rejected because it was not regional in scope. The proposal was then taken to WARMP, but EDC has not yet indicated that anything has been done about the request. The present feeling is that three properly trained people would allow CRDU to carry on development of mathematics curriculum materials without further external assistance.

Finally, it is important to note that the "inquiry" and "discovery" teaching approach adopted by AMP was mentioned only rarely in Ghana, in contrast to the program content. Although teachers evidently tried to adopt this teaching method in many cases, they seemed poorly trained to do so. Even more important, however, is the fact that the usual class size is so large, often 40 or more pupils, that recognizing and interacting with each child even once during a typical class period is a formidable obstacle. Classroom observations in schools revealed a heavy emphasis on seat work copybook exercises, the use of lesson plans which contained too much information to hold the attention of beginning primary school children, and stress on such problems as the definition of null sets or the difference between number and numeral, reflecting the erroneous perceptions of teachers about the content of modern mathematics.

### 3. Kenya

Primary education in Kenya consists of seven years of formal education: Standards 1-7. Until 1968, 25 of 6,800 primary schools used the Entebbe series. The Kenya Institute of Education (KIE) is currently preparing a new course of study in primary mathematics called Kenya Primary Mathematics (KPM). KIE is the curriculum development and research arm of the Ministry of Education which creates new curricula, revises existing curricula, and field tests the materials developed. Upon completion of this process, the Inspectorate at the Ministry assumes the responsibility for implementation of a curriculum into the educational system.

Although KPM began in 1965 as an intended seven-year program, by 1971 only Standards 1 and 2 had been completed. According to Ministry officials, these two years of course material are being implemented in 90 percent of the elementary schools. The KPM work plan now calls for the introduction of this curriculum at the rate of one revised standard per year. By 1978, all primary mathematics classes should be using the new curriculum.

Each year of the KPM series contains a book for students and a teacher guide. It was reported by the developers of this new curriculum that the series differs from the original Entebbe texts and cannot be considered an adaptation. The KPM program has simplified the level of presentation of mathematical concepts, designed guidelines for instructional techniques to meet teacher needs, and reduced the cost of the materials.

The teacher guide contains directions which facilitate the use of KPM if a teacher has received no training in the use of these materials. The guide includes the appropriate syllabus; a scheme of work; a set of general, background, and lesson notes for the teacher; lists of teaching aids; suggested games; and a series of work cards. Partly in response to this program, Ministry officials would like to increase the number of primary school inspectors from 34 to 300 by 1976 in order to effectively lead in-service workshops for those teachers who have no KPM training.

The Jomo Kenyatta Foundation publishes KPM, with some royalties from the sale of the books going to the schools. Although no formal evaluation procedures have been undertaken, informal feedback indicates that the KPM has been well received by teachers and pupils.

Standards 3-7 currently use a traditional text, the Highway Mathematics Series (Kenya: Longman, first published in 1962). The Ministry hopes to replace this series with KPM by 1978 although they are already behind their original schedule. In order to meet this schedule, the KIE staff reportedly would have to be increased from two to twelve full-time staff.

The majority of personnel involved in secondary mathematics are British expatriates, many of whom at one time participated in AIP or the ABC Institutes. In 1964-65 a few secondary schools were used as pilot schools for field testing Entebbe mathematics. The evaluation team was informed that there also were some earlier short trials of the materials in Kenya around 1967 or 1968, but that they were not carried to completion. At present, the mathematics texts used in approximately 700 of the 900 secondary schools were written by British authors (Modern Mathematics for Secondary Schools. V. W. Ferris & J. N. Busbridge. London: Evans Bros. Limited, 1967). The remaining 200 schools use a revised series of the original School Mathematics Project (SMP), a British series in secondary mathematics called SMEA (School Mathematics of East Africa. East African Publishing House and Cambridge Press, 1969). The current objective is to complete the implementation of SMEA into the entire secondary system (Forms 1-4) by 1967. SMEA is viewed as a compromise in mathematics approaches between KPM and SMP. The acceptance and adoption of modern mathematics is reflected in the offering of a national examination in modern mathematics in addition to that in traditional mathematics.

The SMEA materials are being developed by a small group of expatriates. Few Africans are working on any secondary materials and it was reported that any personnel changes to include Africans were improbable. Only four or five students would graduate from the University of Nairobi in 1973 qualified to teach secondary mathematics, and the probability of these individuals remaining in the field of education are low. Income and career potential within industry were cited as the reasons for the loss to the education field of these trained people.

The SMEA developers also indicated that production and distribution of the secondary texts were creating implementation problems. Production of secondary mathematics textbooks is not high, and mathematics workbooks are not available for students. Problems are copied from a master book into a notebook in order to reduce wear and prolong the use of the master text, with the result that instructional time during class periods is reduced.

It was suggested that the focus was on SMP/SMEA rather than Entebbe because the British expatriates who predominate in secondary mathematics education felt more comfortable with the familiar language structure of SMP. In addition, the SMP approach was less academic and more intuitive and the Entebbe separation of algebra and geometry into two volumes was undesirable.

One of the most critical needs in Kenya is teacher training in both the content and pedagogical approaches of modern mathematics. EARMP is preparing a two-volume text for teacher training institutions and conducting training institutes for primary school inspectors and teacher training college tutors.

Volume I of the teacher training institutions texts has been written, field tested, and revised, while Volume II is currently being field tested and will be revised at a 1973 Workshop. These volumes are based on the Entebbe Basic Concepts which were developed as textbooks for teacher training institutes. The current volumes are less elaborate, less dependent on mathematical proofs, and designed to more appropriately meet the ability level of the users. Camera-ready copy of the texts will be completed by 1973 and turned over to the Ministry of Education for publication. The Ministry has agreed to accept this as one of the three or four recommended texts for use in the teacher training colleges.

The two EARMP training institutes planned under the present contract each run for two years. Teacher training college tutors and primary school inspectors receive a two-week preliminary orientation in an institute, then continue with a correspondence course where each participant receives assignments which he completes and returns to the Mathematics Educator in Nairobi. These assignments are keyed to material contained within the Basic Concepts, and each participant is supposed to have copies to use as a reference in completing assignments. The Mathematics Educator also visits each participant as a follow-up on their correspondence course activity.

In 1970, 17 of 75 tutors and 24 of 120 inspectors attended the first institute session. The correspondence course has produced disappointing results, with only 50 percent of the tutor participants and 33 percent of the inspectors completing their assignments regularly. One difficulty in successfully completing this training program lies in the fact that inspectors frequently had little or no previous mathematics training.

In-service training appears to be a major problem in teacher training. The inspectors who receive training at the institutes are to pass on the training to primary school teachers by conducting in-service programs. It was reported, however, that in-service training by the inspectors was practically non-existent. A primary level classroom observation in Nairobi revealed that although the teacher was using the KPM materials and had received six days of instructional orientation, it was easy to slip into a traditional rote pattern of teaching while using the modern mathematics materials. The continuation of in-service training on this scale, after completion of the present contract, is being discussed, but at this time no counterpart for the present Mathematics Educator has been chosen.

#### 4. Liberia

Very noticeable changes have occurred recently in the educational sector, along with most other sectors in Liberia, as a result of the efforts of the new national administration. These changes are likely to accelerate both the pace of progress and the use of innovations. AMP, with its long history in Liberia, would be expected to be a major influence on these changes except that the program appears to have lost some of its earlier momentum and is expected to miss important upcoming opportunities.

Perhaps the most significant opportunity for AMP to have an impact on mathematics education in Liberia will be as a result of the newly-instituted committee of educators charged with the responsibility of recommending totally new syllabuses and curricula guides by the end of 1973 at both the primary and secondary levels. The primary mathematics committee, which meets weekly at the Kakata Teacher Training Institute, includes several members who are sympathetic, or at least acquainted, with the AMP and WARMP materials, but it is likely that this group will have to make content decisions long before the new regional WARMP materials will be available for review. And, because several of the committee members, as well as their UNDP-furnished technical advisor, are not yet convinced that the AMP approach is the best one for Liberia, it seems unlikely that the curriculum units now being prepared by WARMP will be accepted for use, at least not without substantial revision.

The secondary mathematics committee based at the Teachers' College of the University of Liberia seems somewhat more likely to adopt the WARMP approach, although any further delay in the availability of the materials also is likely to influence this decision. One possibility under consideration will be to have the available secondary school mathematics materials produced locally for tryout following the next scheduled WARMP workshop. There is some question, however, whether sufficient WARMP materials will have been completed, even then, to encourage the committee to follow this path. The syllabus revision project does not extend to teacher training, so it is likely that later changes in teacher training programs will reflect whatever changes are made in the primary syllabus.

A parallel effort to improve mathematics education at the primary level has been introduced by UNESCO, and a recommended new syllabus for the first six years of primary school was submitted last year. This syllabus, like the WARMP program, presents modern mathematics but is viewed as placing more emphasis on computation and less on explanation. Another influence in Liberia is an IDA/World Bank project which also is attempting to influence syllabus selection, teacher training, and curriculum development. At various times it was indicated that the government is "committed" to the UNESCO program and "committed" to the WARMP program. Interestingly, no one who was asked had heard of the Lucy Addy Tagoe series on primary mathematics being used in Ghana as a possible alternative for curriculum materials or, if they had heard of it, had not considered it for adoption in Liberia.

The present primary school mathematics program is based on a U. S. mathematics series, Elementary School Mathematics by R. E. Eicholz and P. G. O'Daffer, published by Addison-Wesley in 1963. These texts can be characterized as "transitional" in that they contain several of the concepts of modern mathematics but are more similar to traditional mathematics in their emphasis on computational problems and their overall approach. A variety of texts, typically from American publishers, are used both for secondary mathematics and teacher training programs. The students purchase their own texts in Liberia. Because the cost of these texts is high, resale of the books to pupils in the subsequent class is routine and the Ministry of Education would be hesitant to make frequent changes in the approved texts.

There was considerable consensus among those interviewed in Liberia as to the kind of mathematics curriculum that was wanted; in essence, a "contemporary curriculum for Liberia." As one individual expressed it, such a curriculum would emphasize modern mathematics, but it also would make some provision for the needs of the large proportion of primary school students, about 80 percent, who do not continue on to secondary school. Some doubt was raised as to whether or not the WARMP materials currently in preparation would be satisfactory for these needs, whether or not they would be suitably priced, and whether or not they would be designed so as to be appropriate for the "typical Liberian child." Understanding quantitative concepts is very much preferred as an educational objective, however, over mechanical skill; as one person in the Ministry of Education expressed it, "you can teach a monkey by rote, but then he still won't understand." Despite several attempts, it was not possible to elicit responses toward the AMP teaching method in contrast to the content. The training provided to Liberian participants may have been minimal in this respect.

Experiments with the original Entebbe materials were very limited in Liberia and, at their maximum, affected substantially less than 10 percent of the students. One evaluation effort that was recalled compared these experimental students with students who were taught more traditional mathematics. The AMP students did better on the mathematics portion of the National Examination than the remaining students, in spite of the examination questions favoring the traditional mathematics program. Present use of the Entebbe materials is limited to an occasional private school, although a few teachers who are familiar with the approach are improvising modern mathematics instruction in their classrooms. The very modest use of Entebbe materials in Liberia is mirrored by Liberia's participation in the writing workshops; only once, in 1963, was Liberia represented by as many as three participants, and in three of the seven years they were not represented at all.

Several early teacher-training sessions were held in Liberia, on the other hand, and several Liberians participated in the ABC Institutes. These earlier programs seem to have had little effect except that one trainee, Mr. John Dennis, personally prepared a local adaptation of the Entebbe series which

he submitted to Macmillan in London for publication. This text did not generate any interest in Liberia, however. One individual who was interviewed attended a variety of training sessions during the entire AMP period. For him, training began with a two-week workshop held in Freetown in 1963. This workshop, presented by two American educators, was designed as an introductory briefing on modern mathematics. In 1965, he attended a four-week session in Liberia along with some forty other tutors and teachers. This institute included demonstrations of the Entebbe materials with children and instruction on how to prepare curriculum materials. A repeat of this session was held the following year in Liberia for a new group of forty tutors and teachers, and he did not attend. In 1966 he went to an ABC workshop in Nairobi, and then participated in a follow-up session held in Liberia a few months later. He again attended an ABC institute in 1967 in Nairobi. In 1970, he participated in the group that established WARMP and, in 1971 he was one of twenty Liberians chosen to receive the correspondence course as part of the implementation phase of the project. Despite all of this training, however, he has been unable to implement AMP in his own pre-service teacher training program.

Several sources reported on difficulties that had been experienced with WARMP's present tutor-training program in Liberia. To begin with, all but one of the Liberian participants expected at the two-week institute which initiated the program received his invitation from the WARMP secretary after the sessions had ended. Although at least part of the delay was due to insufficient time for the Liberian Ministry of Education to forward the letters, there was no follow-up prior to the session to insure the letters had been received. The one individual who did receive notification arrived three days after the sessions began. A distribution of text materials, including the Entebbe Basic Concepts volumes, was to have been made. However, the initial shipment of materials was inadvertently destroyed before they could be distributed. More significantly, no effort was made to replace them, so that the tutors and teachers who had been participating in the correspondence phase of the program for a full year have not yet received the texts needed to complete the correspondence exercises. It is not surprising that eleven of the original fifteen participants already have dropped out.

From comments made by several of the people interviewed, it is clear that Liberia does not, at the present time, have a capability for producing or adapting curriculum materials in modern mathematics, nor is it presently capable of sustaining the kinds of in-service or pre-service programs that would be needed to adopt AMP or WARMP materials on a national scale without extensive expatriate technical assistance. Future teacher training will depend heavily on the availability of instructional materials specifically suitable for Liberian teacher training candidates. The original AMP Basic Concepts text is considered too voluminous and too thorough for Liberia and the WARMP materials, while potentially more appropriate, are not available. In the meantime, a program of in-service teacher training institutes for groups of 60 primary and secondary mathematics teachers will begin at the Teachers' College of the University of Liberia early in 1973 and a program of one-year refresher training for 50 primary teachers per year is planned for the Teacher Training Institute at Kakata. The absence of usable instructional material for these programs is an unfortunate loss of an excellent opportunity to promote modern mathematics. WARMP was asked to participate in the program at the university, and to supply whatever curricula materials were available so they could be reproduced locally if funds were obtainable.

Public school classes were not in session during the visit to Liberia because of an examination period, so it was thus not possible to visit primary or secondary schools. It was possible, on the other hand, to spend some time with a teacher training class in mathematics. To the extent this one session might be regarded as typical, both the mathematical content and the approach to instruction were very traditional. It is likely that students who learn this way will teach this way after leaving school.

## 5. Sierra Leone

In Sierra Leone, only about half of the children in the eligible age group are enrolled in school. It is the opinion of the Ministry of Education that the core of the problem is the shortage of qualified classroom teachers and, for this reason, the emphasis in any program to improve education has to be on teacher training. Mathematics has been recognized as a particular weakness and several steps have been taken, including bonus salaries for mathematics teachers, to encourage improvement in mathematics teaching. The problem of achieving minimum educational standards was reported as far more severe in the Provinces than in the Freetown area. One estimate was that while perhaps 80 percent of the teachers in Freetown were qualified, only about 10 percent of those in outlying districts, where 90 percent of the schools are located, could be considered as satisfactory.

To a large degree, this lack of skilled teachers has shaped all of the Ministry's plans regarding the development and adoption of new curricula in mathematics. Past changes have occurred slowly and no dramatic modifications are expected in the future until the overall level of teaching competence has reached the point where new programs are likely to be successful. The direction of change is far clearer than its timetable, on the other hand. Modern mathematics is highly regarded both inside the Ministry and at the universities, and whatever changes do occur undoubtedly will be in this direction. One apparently significant reason for this interest seems to be the participation of the Acting Chief Education Officer and other Ministry officials in early AMP workshops.

The mathematics textbooks now studied in Sierra Leone primary schools are a modest adaptation of the Longman Highway Arithmetics series used extensively in East Africa. These textbooks, Sierra Leone Primary Mathematics, were prepared by F. B. Harding and E. M. Williams, and published by Longman in 1964. Mr. Harding was a participant at the first Entebbe workshop in 1962, and continued to participate at all subsequent workshops. Mrs. Williams was one of the original authors of the Highway series. The principal changes made in the British-based texts were to adjust examples involving monetary systems and to localize the presentations for Sierra Leone.

Books 1-7 in the series correspond to the seven years of primary school. Books are purchased by the pupils in addition to their regular school fees. Interestingly, the sole source of all textbooks is a single store in Freetown, so students in remote areas often cannot obtain needed texts unless their own school purchases quantities for resale to the individual pupils.

Secondary school texts are selected independently by each school, most of which are supported, at least in part, by various religious groups. No suitable materials are presently available in modern mathematics for use at the teacher training institutions.

Substantial changes have occurred recently in the way curricula in mathematics are chosen. A primary school curriculum committee was recently established which will have responsibility for selecting all texts at the primary level. The current mathematics text is considered unsatisfactory, because of its fairly traditional approach, and probably would be replaced if an acceptable alternative was available. Factors likely to affect the decision include the degree to which the materials represent modern rather than traditional mathematics, the availability of appropriate teacher training texts, the suitability of the student materials for Sierra Leone, and the cost of the materials. There is an organized Mathematics Association of Sierra Leone which is expected to be influential with respect to curricula changes in primary school mathematics.

At the secondary level, the Mathematics Association is taking a more substantial role. Together with the newly-organized Institute of Education, they are in the process of preparing a new syllabus for secondary students, one that generally favors modern mathematics. One goal of this revision is to enable schools to prepare students for the new modern mathematics examinations to be offered by the West African Examinations Council. Another goal is to attempt to reduce the variety of texts and programs that are used, although it is felt that there should be at least a few options and that alternative texts could be approved. Some effort also is being made by this group to prepare curriculum materials at the secondary level with the support of a Canadian advisor and financial help from IDA/World Bank. Both the original Entebbe materials and the British Joint Schools Project materials are being used as source materials in this effort.

The materials now being prepared by WARMP as part of the ongoing AID supported project will be considered in selecting new curricula. Doubts were expressed, however, as to the suitability of the WARMP secondary-school materials and it does not appear likely that these materials will be chosen over the materials now being prepared through the efforts of the Mathematics Association. If two programs are endorsed, as expected, the other is likely to be more traditional in orientation.

The primary materials being developed by WARMP will be considered for adoption if they are submitted in time. However, it now is expected that the curriculum committee will make its decisions relatively soon, before the complete series of WARMP primary materials are available for review. One influence favoring the WARMP texts, on the other hand, is the present effort to create a national or regional book center in Sierra Leone. If such a facility is created, preference might be given to texts that would be reproduced locally, as is intended for the WARMP materials.

It also is expected that consideration will be given to the WARMP materials being developed for use in teacher training. Since no alternatives now exist, it is likely that these materials will be used providing they sufficiently parallel the primary and secondary materials that are adopted.

Continuing use has been made in Sierra Leone of the original AMP materials prepared in Entebbe. Some 2 percent of the primary schools and perhaps 8 percent to 10 percent of the secondary schools have participated in this pilot program. Local evaluations have been conducted, but it has been difficult to interpret the results because, in most schools, only the teacher was provided with copies of the materials. Student materials were not routinely offered because of their cost. Deficiencies in the backgrounds and guidance of participating teachers also affected outcomes, so it was likely that these trial uses have been important in the Ministry's recognition that teacher training is a major factor to be considered in planning a new mathematics curriculum. The absence of systematic follow-up to the initial training given teachers during the pilot program also may have affected results.

Although there is presently a rather modest use of modern mathematics in classrooms, some effort is currently underway to provide in-service training to mathematics teachers in Sierra Leone. AMP has been an important part of this undertaking, both in conjunction with the pilot program based on Entebbe materials and for other teachers as well. In the opinion of the Ministry, understanding the fundamental approach of AMP is more important than thorough familiarity with the content of modern mathematics since it is felt that the approach can usefully be applied even in a curriculum based on traditional texts. In-service teacher training is being offered by individual members of the Mathematics Association on a voluntary basis, by Peace Corps Volunteers in Sierra Leone, and through periodic WARMP institutes. Most teachers are generally "afraid of mathematics" and they do not feel comfortable with traditional mathematics concepts. Thus, there is a certain attractiveness to new approaches although the training now being received appears insufficient to make teachers comfortable with modern mathematics.

Mathematics curriculum development is a responsibility of the Institute of Education. However, it is generally felt that the three-year old Institute is not yet strong enough to exert a strong influence in curriculum development. Present efforts in mathematics are mainly being devoted to developing a new teacher training curriculum. There is a general impression that Sierra Leone has a lack of curriculum development capability. Although AMP was credited with having considerable impact on the overall preference for modern mathematics, and for having a useful influence on teacher training, there was no indication that anyone was being trained in curriculum development or that counterparts were being prepared to assume functions now filled by contractor personnel.

Feasible teaching approaches are restricted by the large number of pupils in each of the classrooms visited, to the extent that these sizes are typical. In one third grade classroom, the teacher had divided the 46 children into 4 ability groups. She then went from group to group explaining what to do and assigning exercise problems to be completed while she was instructing the other 3 groups. There was no time to answer student questions, or to attempt an inquiry approach. This class was being instructed in the transitional mathematics characterized by the Highway Arithmetics series.

The only observed example of modern mathematics being taught was in a pre-school class of 46 five-year olds. This teacher had had some prior experience with the Entebbe materials and was now using her own adaptation, including a considerable variety of game-like materials, to very successfully teach these children sets, number concepts, and the writing of numerals. The skill of this teacher and her approach were unusual, particularly after it was learned that she had been unable to obtain a teaching certificate because of her specific inability to pass the mathematics examination.

## B. African Primary Science Program

A common feature among countries involved in the APSP is a strong commitment by educators to the discovery approach in teaching primary school science, the basis upon which APSP was developed. A prevailing attitude existed among the educators that the traditional rote method of instruction was an unacceptable alternative to the activity-oriented, problem-solving, discovery method. This method stresses non-formalized classroom structure and attempts to achieve self-expression while instilling confidence into each student's classroom behavior. Those who support this pedagogical approach also endorse the idea that the use of this instructional technique is more important in the learning process than acquiring specific knowledge about science. Although verbal commitment to this approach was widespread, field observations suggested that actual implementation of this method was not as widespread as was expected on the basis of verbal commitment.

In those countries where primary school science is being taught, the use of adaptations of APSP has either replaced or now supplements formerly existing educational programs in nature study. APSP consists of a series of non-sequential teacher guides which includes topics such as soil, light-bulbs, and batteries. APSP influence is evident, as witnessed by the philosophical attitude of science educators and the use of the materials in teacher training programs and syllabus revisions.

The present use of the materials in the classroom, while not yet widespread, appears to be growing. In most countries, science is not yet considered one of the more important academic subjects. Although not appearing to hamper the development and production of materials, there also are pragmatic problems in the distribution of materials to the schools which contribute to their limited use. Even when materials are available in the schools, the lack of appropriate teacher training reduces the effectiveness of their impact as the materials frequently are used in a traditional way. Efforts to improve pedagogical approaches are underway, and it appears that the impact will benefit from further efforts directed at having the materials used as intended.

The creation of the Science Education Programme for Africa (SEPA), a Pan-African organization to encourage and improve science teaching at all levels in Africa, is endorsed and supported by African educators. At this time, the potential function of this organization is viewed in diverse ways. For example, some rely on it to provide both personnel and material resources for training workshops while others hope to use it as a clearinghouse for the acquisition of science materials.

### 1. Ghana

There is no long-standing tradition of science education in Ghanaian primary grades, other than occasional use of units on personal health and hygiene or on topical problems such as mosquito eradication. Because of this lack of emphasis, there had been no British science texts in use and very few primary teachers have any knowledge of natural or general science to pass on to their pupils. In 1961, science was singled out as a significant deficiency in the Ghanaian educational program and the Ministry of Education established an independent Elementary Science Unit (ESU) to promote science instruction at primary and middle school levels. This unit is distinctive within the Curriculum Research and Development Unit of the Ministry of Education.

Beginning in 1961, several science lessons suitable for middle school, students equivalent to grades 7-10, were drafted and tried out by a group of teachers. By 1965, the year the APSP was initiated, there were sufficient text materials, teacher guides, and additional components to provide a full four-year program in science. Mr. Samuel M. Adu-Ampoma, head of ESU until his recent appointment as Ghanaian High Commissioner to Kenya, collected and organized these materials into a series of four workbooks, Experimental Science for Elementary Schools, published in 1968 by MacMillan, London. Basically, the program was developed along lines of the UNESCO source book of science experiments for developing countries, with additional content derived from a number of conventional science textbooks.

The APSP project was associated with the ESU when it began in Ghana in 1967. Since its inception, there has been a gradual introduction of selected APSP lessons into the primary grades and approximately 20 to 30 percent of the primary schools use at least some of the units. Several problems will inhibit more widespread adoption of the materials.

First, at the time of the evaluation team's visit, a moratorium was in effect on the printing and distribution of all textbooks aside from those essential for mathematics and English. This restriction had been applied to the printed APSP materials even though only one teacher copy per class is required and there are no student texts. The moratorium was particularly difficult for the primary science program in that 1972 was to have included large-scale materials reproduction. Although this situation may improve, there is no assurance that sufficient quantities of the units will be made available in the near future.

The second problem inhibiting adoption of the APSP units is that they are considered inappropriate for Ghana without substantive revisions and additional field testing, and in this sense the program is still regarded as experimental within the Ministry of Education. Units presently in use remain under the direction of the ESU, and the Textbook Committee of the Ministry of Education has not yet approved the materials for routine distribution.

The third obstacle to adoption is teacher training, although the ESU has taken steps to overcome the historic deficiency in science education among primary teachers. Teachers who are presently using the materials on a trial basis reportedly feel a lack of confidence in their ability to use them and often use the units incorrectly. A group of 18 Science Organizers, or district field supervisors, has been established to improve primary science education in Ghana. The ESU has initiated a series of three-week workshops for teachers who then receive follow-up assistance at their own schools through visits by the Science Organizers. In addition, a pre-service program in teacher training institutes has been initiated to speed the process of improving primary science teaching.

The ESU, which has a curriculum development unit consisting of nine professionals, is now at work on a science teaching project for secondary schools. Assistance for this project is being provided by the Ghana Association of Science Teachers and by technical advisors supplied by UNESCO and the Commonwealth Education Development Program. Some materials from this project, which began in 1970, are now being tested in a few secondary schools. There has been no apparent coordination between this project and SEPA although it was stated that additional help was desired,

particularly in the form of curriculum preparation training for the ESU professional staff.

The people who were interviewed in Ghana all emphasized the importance of the APSP teaching method and its consequences on student interest. The approach is felt to be very desirable and some persons noted the spread of the teaching method to other subjects taught by primary teachers. On the other hand, there was some feeling that more appropriate objectives about scientific principles could have been associated with some APSP units. In other words, a method employing discovery by doing was effective in getting students involved, but the aim of each unit should be directed at the discovery of concepts which themselves might be useful to the child. This latter goal is felt to be more clearly stressed in the Adu-Ampoma series, although there was also the feeling that the series could be revised to enhance student interest.

Adequate equipment and supplies were available in the classrooms observed and the teachers appeared to be familiar with the format of the lessons. The children observed tended to engage in doing things, but the teachers seemed unaware of how these experiences could be structured to achieve instructional goals. In a few schools, local adaptations had been made in the materials, such as providing a set of directions for each activity which all the children could read. In one school, the teacher had constructed several units which were being presented in the format of APSP lessons utilizing simple approaches similar to those described in the UNESCO source book. However, the consensus at the Ministry of Education is that teachers have not been trained adequately to properly present APSP materials.

At the present time, some efforts are being made by ESU to evaluate the various science materials that have been distributed to schools on an experimental basis. In general, this evaluation consists of soliciting comments from teachers who are using the materials, based on their experiences with the lessons.

## 2. Kenya

Five years prior to the 1965 introduction of APSP, a Curriculum Development and Research Centre (CD&RC), initially sponsored by the Ford Foundation, had been established in Kenya. The Primary Science Section of the CD&RC provided a natural entree for the APSP program planner and developer who, with a Canadian-sponsored expatriate and two Kenyans, initiated trial use of APSP materials in a number of Kenyan schools. Because of this unique situation, and the request of the Ministry of Education for additional EDC staff members to supplement existing activities, Kenya has received heavy emphasis in the development and field trial of APSP curriculum materials.

Primary grades in Kenya are divided into lower primary (Standards 1-3) and upper primary (Standards 4-7). Nature study, usually taught about two hours per week, was the only science to which lower primary school children were exposed. Upper primary grades follow a list of suggested topics included in a series of Schemes of Work, with topics such as health, agriculture, and hygiene being emphasized. The lecture method of instruction was most commonly used as a supplement to the Schemes of Work. Information concerning field trials (e.g., number of schools involved, teachers and students who participated, and units taught) was not available. Currently, only 13 topical guides are ready for distribution and use in the lower primary grades.

The CD&RC became the Kenya Institute of Education (KIE) in 1968. This branch of the Ministry of Education assumed responsibility for development of curriculum materials, training of teachers, and other education related projects. In 1970, when EDC approved the quality and substance of the completed APSP units, a curriculum committee was formed at KIE consisting of teacher training tutors, primary school teachers, school inspectors, and KIE representatives. The purpose of this committee was to examine both the APSP materials and the existing Schemes of Work and to select a science curriculum for implementing the new approach to primary education, one which emphasized the problem-solving approach to learning.

The committee liked the APSP materials because of their activity and discovery-oriented approach, but felt that they did not fully meet the requirements of the existing syllabus. Topics such as health, for example, were not included in the units. Because no syllabus governs curriculum

selection for the lower primary grades, the committee decided to adopt the APSP materials developed for Standards 1-3 to be used during the twice-weekly activity period. The APSP materials created for the upper primary grades were not completely adopted because the committee felt there was no continuity among the topics and some topics had been omitted. In order to endorse and adopt APSP fully, the syllabus for Standards 4-7 needed to be revised and both in-service and pre-service training upgraded to meet the requirements of the new syllabus. Plans to act upon these changes were formulated and are currently in progress.

The Jomo Kenyatta Foundation publishes APSP materials for the lower primary grades. Data on the extent to which these materials are being used were unavailable. Twenty-five schools were recorded as having ordered the materials from the Ministry of Education and were, therefore, assumed to be using them. The evaluation team visited one of these twenty-five schools, considered one of the best primary schools in Nairobi, to observe the use of APSP. However, not only was APSP not being used, but no copies of APSP materials were available at the school. The team's guide, the District Education Officer (DEO), then brought the team to a second school on record as having ordered the materials. The same situation was found at this school. There were no materials available, and therefore no implementation. At the third school visited, the team observed a teacher using the APSP materials. The lesson was taught well and the students demonstrated enthusiasm throughout the class. At the conclusion of the class, however, the team was informed by the teacher that she had been handed the teacher guide only five minutes prior to the team's observation, a testimonial to the materials as well as to the ability of the teacher.

Additional activities currently underway include preparation of Guidelines for teaching Standards 4-7. These Guidelines, prepared at KIE, are to replace the existing Schemes of Work. They will be used experimentally in 20 schools beginning January 1973. Guidelines for each standard will be developed and field tested at the rate of one per year, with full adaptation for each standard scheduled to occur the year following the field trial. Following this plan, APSP will be fully implemented in Standards 4-7 by 1977.

Both in-service and pre-service teacher training programs are being conducted. In 1972, a 1-week orientation workshop was held for 24 (50 percent) of the primary school inspectors. During this workshop, the leaders described the new teaching approach and conducted demonstration classes. These inspectors would, in turn, conduct in-service training for the primary school teachers in their districts. The remaining 50 percent of the primary school inspectors will be trained in a similar workshop.

A workshop was scheduled for December 1972 for the teachers of the experimental schools where the Guidelines for Standard 4 were to be field tested. This 2-week seminar, totaling 60 participants, was planned to include classroom teachers, school inspectors, and head teachers. Although no specific outline had been prepared at the time of the team's visit, it was indicated that the workshop would incorporate demonstration classes, orientation in the discovery approach, and some sessions during which teachers could gain experience using the materials. The seminar was planned to be conducted by the head of the science section at KIE and the EDC representative. In addition, a request had been submitted to SEPA to supply two Science Educators to provide leadership assistance.

An attempt is being made by the EDC technical advisor in Nairobi to organize a training program for tutors at the teacher training colleges. Teacher training colleges are being visited to discuss such a training program. It was estimated that if the training program to equip tutors with the skills to teach APSP and the inquiry approach is successful, enough tutors could be trained in the teacher training colleges by 1973 to continue teacher training, but that it would be severely cut back if support were withdrawn as no one is currently available to continue the work on a full-time basis.

Although the Ministry of Education has stated (Inspectorate Circular Letter 71-44, July 1971) that the syllabus for the study of science in primary schools is being reviewed, the change is not expected to be completed in the immediate future. The Letter informed individuals associated with primary school science about the nature of the proposed changes to encourage schools to prepare for the revised syllabus. These changes incorporate the New Primary Approach, adopted officially in 1965, which is heavily influenced

by APSP. Teachers are urged to begin using the discovery method and the APSP units which are available, as the new syllabus will follow the approach and content of APSP.

In addition to the technical assistance received from AID and the Ford Foundation, KIE has obtained support from other agencies; for example, UNESCO supports teacher training in the in-service programs and SEPA will provide training seminar leadership. KIE is perceived as understaffed, however, and concern was expressed about its continued growth. One major problem is that individuals identified as counterparts to expatriate members often receive outside training and then return to Kenya to resume roles outside of KIE.

### 3. Sierra Leone

The science center at Njala University was established in 1967. Efforts of the SEPA Executive Secretary, a former staff member of the Njala science center, and the current Deputy Director of the Peace Corps Education Office in Sierra Leone, who also previously served on the science center staff at Njala, have had considerable impact on the Sierra Leone use of APSP materials.

It was not possible to visit the districts outside of the Freetown area, and data on the extent of use in other regions were unavailable because the Inspector of Schools was knowledgeable only about the activities within her assigned western region which includes the city of Freetown. She reported attending a one-day workshop at Njala University in 1967. There she received a package of APSP materials which were then introduced into five primary schools in the Freetown area. The number of participating schools grew to twenty-five, but has now been reduced to a more workable number of twenty. Although no interviews were conducted at Njala, it was reported that the efforts of the science center there, and those of the Peace Corps volunteers, have provided in-service teacher training and direct classroom assistance in implementing APSP units.

The Peace Corps, previously responsible for the Primary Education Workshop Program, has been requested to shift its efforts from primary teacher training to secondary teacher training. Through the Primary Education Workshop Program, teachers were introduced to curriculum materials and methodologies compatible with APSP. The personal involvement of the Deputy Director of the Peace Corps, and the proportion of the PCVs having science backgrounds (about 50 percent), has heavily influenced the use of APSP. However, now that a shift in training responsibility has occurred from the Primary Education Workshop Program to the Institute of Education at the University of Sierra Leone, it appears that this unofficial promotion of APSP implementation will be reduced. The Institute of Education, the educational research arm of the University, has limited personnel and financial resources to conduct its assigned functions of curriculum development, teacher training, and in-service education. Because of their limited capability, they unofficially rely on Peace Corps assistance in performing their functions.

The responsibility for promoting APSP implementation in Sierra Leone rests with the science center at Njala. Because of recent staff changes and limited funds to support the in-service training for which it is responsible, the center's impact has been limited. The present role of the science center ranges from supplying EDC-provided APSP guides needed by teachers in participating schools to collecting feedback information on classroom use. It also recently sponsored one workshop to revise existing units and develop new ones.

In light of present conditions, APSP has not yet been fully implemented in primary science education in Sierra Leone. In one workshop held in the western region, only 30 out of 940 teachers attended. The regional organizers meet only when workshops convene at Njala. For those teachers using APSP materials, the experimental program has been dependent on CARE for classroom supplies sometimes needed to carry out APSP projects. Teaching of APSP science units is limited to the use of 3 to 5 units within a 14-week time period. Most available classroom time is devoted to more traditional topics, a consequence of the examination structure and

the importance of the traditionally oriented examinations for secondary school admission offered at the conclusion of the seventh year of primary school. In addition, few teachers appear comfortable not only teaching science but using APSP, so they quite often revert to traditional teaching methods regardless of the resources.

Despite the very slight use of APSP materials and the absence of any coordinated effort to expand the use of the materials, those currently participating in the program reported consistent enthusiasm about the value of science education at the primary level and the desirability of the APSP approach to science teaching. The activity-discovery method promoted by APSP was viewed as particularly significant because it reduced the teacher's need for a scientific background. By emphasizing process, content became subordinate. The APSP materials are regarded as better suited to these teachers than any approach which emphasizes traditional facts and concepts although, through lack of training in correct application of the process, traditional teaching methods continue to be used with APSP materials.

Classroom observations confirmed the lack of training received by participating teachers, as well as their overall deficiencies in scientific knowledge. In one classroom, for example, the teacher distributed jars containing a layer of earth to each of seven groups of six pupils each in her class. She added some water to each jar and told the children to stir the contents and record their observations in their copy books. One child recorded that she saw "a stick," when there was none in her jar. Another wrote "worms," which also were visually absent. A third wrote "a stone," and when asked to identify it, pointed to a floating particle. While the children were writing their "observations," the teacher was attempting to get them to understand why this soil was a loam, in contrast to another soil they had studied earlier. This observation suggested that not only were the students gaining limited skills and knowledge, but also that the teacher was unaware of the basic objectives of APSP and their corresponding proper use.

#### 4. Tanzania

*At the suggestion of AID field staff, the visit to Tanzania was not completed as scheduled. The following summary of the current status of APSP in Tanzania is based on an interview with the most recently posted EDC staff member in Dar es Salaam who is currently posted in Nairobi. The summary is supplemented with information from a progress report (July 1966-March 1972) on the Tanzania Primary Science Programme.*

Educational reform in primary school science (Standards 1-7) blended appropriately with the reform of the Tanzanian educational system, begun in 1966. Tanzanian educators reexamined the traditional teaching methods and objectives at all levels of education. The problem-solving approach endorsed by APSP was compatible with the philosophical changes being considered. The primary science program consisted of a series of small experiments, Life and Living. Under this program a teacher demonstrated a lesson to prove a hypothesis, with the children seldom participating in classroom activity. Tanzania hosted an APSP curriculum development workshop at Dar es Salaam in 1966, attended by three Tanzanian Science Educators. The commitment to experiment with these materials in Tanzania was demonstrated by conducting field trials not only in four primary schools near Dar es Salaam, but in the schools associated with the Morogoro and Butimba Colleges of National Education.

During the initial stages of APSP involvement, many curriculum units were developed. These were revised and prepared for publication. Thirty-three units in Swahili are currently available for primary school use. To supplement use of local materials, efforts have been made to supply basic sets of equipment to science teachers at various primary school levels. To date, four kinds of materials are available:

- a. activity kits for Standards 1 and 2. By March 1972, 561 had been distributed;
- b. activity kits for Standards 3 and 4. By March 1972, 41 had been distributed;
- c. primary school science kits for use in the upper primary classes. By March 1972, 845 had been distributed; and

- d. a set of "attribute" blocks consisting of 20 sets of plastic pieces for use in games and in logic problems. Included in the distribution of these 571 sets was a teacher guide and a set of activity cards.

Prior to the following curriculum development workshop at Akosombo, Ghana, which was attended by five science educators from Tanzania, three in-service teacher training courses were conducted in Tanzania. These courses were based on the experiences of the field trials conducted in 1966 and 1967.

Recognizing the need for more permanent institutional changes, efforts were also directed toward pre-service education programs. In October 1967, the first group of teachers with special training in the use of the problem-solving approach graduated from Morogoro and Butimba Colleges of National Education. The Ministry of National Education expanded this training effort by encouraging science tutors in the problem-solving approach. There were 13 tutors representing 6 colleges and, in addition, there were 5 diploma students and 2 staff members from the Institute of Education, at a seminar in 1968. The seminar concentrated on ways in which APSP could promote intellectual self-reliance which hopefully would replace the traditional rote learning in many Tanzanian schools. By 1968, approximately 200 more students graduated from Colleges of National Education with special certificates documenting their ability to teach using the problem-solving approach.

By 1968, a second science educator had joined the program at the Institute of Education. This staff developed materials and conducted training programs for tutors and teachers. The gradual phasing of APSP into the educational system increased when, in 1969, a staff of 37 science educators temporarily became part of the teaching staff at Morogoro College of National Education. These science educators worked for four weeks with potential teachers and conducted demonstration classes which reached about 400 students of the college. Seminars for primary school inspectors and in-service training projects continued in 1969 and 300 additional teachers were graduated with special training in the new teaching approach.

Tanzanian participation in the APSP program continued during the early 1970's, even though some Ministry of Education changes had occurred. For example, careful screening of interested primary school teachers resulted in the selection of primary school teachers to participate in a special course at Morogoro College, seminars for science tutors were conducted in two Colleges of National Education, 600 additional teachers completed training at Colleges of National Education, and Tanzania became a participant in the support of SEPA.

By March 1972, at the completion of the EDC technical advisor's tour, all six Colleges of National Education were staffed with Tanzanian science tutors who had received some training in the use and techniques of the APSP. These tutors are viewed as the primary base for the implementation of APSP and the problem-solving approach in Tanzanian schools. Through their efforts, pre-service education has become a part of the educational system. In addition, many are also involved in the in-service training programs which have received assistance from UNICEF. Current estimates indicate that 1,400 primary school teachers, of 18,000 in Tanzania, have graduated from Colleges of National Education during the past five years with some special training in the new approach; several hundred teachers have attended some in-service courses orienting them to APSP and the problem-solving approach; and it was estimated that APSP materials were being used in 75 percent of the Tanzanian primary schools.

#### 5. Uganda

*At the suggestion of AID field staff, the visit to Uganda was not completed as scheduled. The following summary of the current status of APSP in Uganda is based on an interview with the EDC staff member who had most recently been assigned there.*

A primary target in Uganda has been revision of the 1965 school science syllabus. Revision of this syllabus is the responsibility of the Science Panel, a 14-member group consisting of inspectors, tutors, and Ministry of Education representatives. About 60 percent of these members are familiar with, and favorable to, the use of APSP in the classroom. Although the present syllabus does not incorporate the use of APSP materials, teachers

are encouraged by District Education Officers to phase in APSP units and to use an activity- and discovery-oriented approach to teaching.

The most recent version of the revised syllabus outline includes 31 APSP suggested topics with approximately 75 percent of Primary 3 to 7 syllabus reflecting APSP influence. Although this syllabus does not yet have official approval, it has been approved by the Science Panel and submitted to the Chief Inspector of Schools for final approval. No unexpected delays are anticipated at this stage of implementation. The Chief Inspector also serves on the Board of Directors of the Uganda Publishing House, which publishes the lower primary APSP teacher guides and activity booklets.

When the syllabus is finally approved, the expected implementation date is January 1974 at the earliest. Details regarding implementation of the materials have not yet been formulated.

It is anticipated that APSP units will be expensive when available to the schools. EDC will deliver camera-ready copy to the Ugandan Ministry of Education, which will then be responsible for production. EDC originally paid for these units to be printed in Kenya, and 1,300 teacher guides were sent to Uganda at the time each unit was completed and then distributed to the teacher training institutes. This was deemed sufficient to undertake the various in-country trials and teacher training conducted as part of the research effort. The apparatus suggested for the units has been produced for in-service courses by the participants, then taken to individual classrooms, at a production cost amounting to about \$1,000 per year.

Primary school teachers receive training in one of the 28 teacher training institutes in Uganda. Most students enrolled in these institutions are Primary 7 leavers who, for a variety of reasons, have not entered secondary school. Many have not completed their O-level examinations. Each of these training institutions has a complete set of the published APSP guides. Approximately 75 percent of them use the APSP approach in teaching science, with the science courses including both content and methods.

Although the APSP discovery/activity approach is not incorporated into the present examination system, progress is being made in changing the examinations to include this approach. The current membership of the examinations panel is about equally composed of those favoring traditional educational methods and those favoring the discovery approach to teaching. The nature of the membership is shifting toward the discovery approach as members of the Science Panel join the examinations council panel.

Tutors teaching in the teacher training institutions receive their classroom training at the National Institute of Education at Makerere University. In 1972, 14 individuals were trained to teach science of whom 50 percent are non-Ugandans; occasionally some tutors are trained outside of Uganda.

The in-service training program has received reduced attention in recent months. An orientation workshop was offered to the regional school inspectors in four school districts, and a follow-up program was begun in which these inspectors were contacted every two or three months. Unfortunately, the EDC representative changed from this task to a full-time teaching job at Makerere which left a vacuum in the in-service education program. At the time of his departure from Uganda, no full-time counterpart had been assigned. Between 1967 and 1969, the counterparts selected for the former EDC technical advisor in Uganda had accepted other positions. The counterpart selected for the present EDC advisor was assigned in January 1970, but in August 1971 left for advanced studies in Canada.

The local AID Mission has provided some additional support for EDC activities in Uganda. Field tests conducted in 60 classrooms and the production of some apparatus (70 items) which can be used within Ugandan schools in the teaching of APSP science were supported by about 11,000 shillings (about \$1,500) of local AID funds.

The creation of a Ugandan curriculum development activity is at this time a low priority item. The concept of a Curriculum Development Center is being considered, but no estimate of its establishment could be predicted.

## 6. Liberia

*Although Liberia is not included in the implementation phase, and therefore, not in the overall evaluation, the science personnel at the University of Liberia occupied offices near the mathematics personnel. The evaluation team took advantage of this opportunity to enrich the evaluation by visiting these science educators, one of whom currently serves as a member of the Executive Council of SEPA.*

Emphasis on improving science education in Liberia, particularly at the primary level, reflects a changing mode in the Ministry of Education. Liberia was an earlier participant in the development phase of APSP but, although communications existed in the form of letters and personal visits to Liberian educators from the EDC Director, Liberia chose not to be involved in the implementation phase of APSP. So far, the use of APSP materials and the problem-solving approach has been supplementary to the regularly used American texts in Grades 1 to 6. Nevertheless, APSP has been encouraged by a science educator at the University of Liberia, who attended APSP workshops and who has continually supported Liberian participation in APSP.

However, Liberia changed its attitude toward improvement of science education by joining SEPA and by supporting a recently-established local science center. APSP materials are now being introduced through teacher training programs conducted at this science center. Financed by the University and the Ministry of Education, the science center is attempting to secure additional financial support from sources such as the World Bank and UNESCO in order to increase the staff and equip the center with instructional materials and other classroom apparatus.

The center's first activity, in January 1972, consisted of a workshop attended by 70 primary school teachers and led by a SEPA representative and other Liberian science educators who received six months' training at Accra, Ghana. These teachers received orientation to APSP through demonstration classes and opportunities to practice using the materials with a small group of students from nearby schools. In addition, the teachers constructed equipment for APSP units so that these units could be used in their own

classrooms. These teachers completed questionnaires describing the strengths and weaknesses of the materials as they emerged during classroom use. Many teachers who participated in this initial workshop requested a follow-up seminar to share experiences with one another after their first use of APSP materials in class. Twenty-two of the original 70 participants attended this feedback seminar. Their overall reaction to the materials was positive; they reported a similar response by their students. Some indicated the desire for another meeting in order to again exchange experiences in using APSP materials. Another workshop, organized along lines parallel to the first, is scheduled for January 1973 in order to increase the exposure of primary school teachers to APSP and to train these teachers to use the materials. A long-term objective of the science education in Liberia includes the increased development of APSP materials at the science center, units which will be appropriate to the Liberian setting.

As part of the overall curriculum revision activities in Liberia, a panel of science educators is now gathering information about ongoing and experimental programs to make recommendations concerning curriculum changes. The panel currently anticipates developing science curricula which emphasize a multi-disciplinary approach. Long-range goals of this committee include preparation of a secondary school syllabus, instructional materials, audio-visual aids, and appropriate teacher guides.

Science educators in Liberia appear to regard SEPA positively. A Liberian who serves on the Executive Committee was instrumental in the development of a science center at the University. She also assists SEPA representatives in leading the workshops and seminars. Liberia has granted SEPA a written Letter of Acceptance, but no financial support. The new fiscal budget reportedly will contain financial support. Meanwhile, Liberia looks to SEPA for leadership in training Liberian science educators, conducting in-service training workshops and providing instructional materials. Science educators in Liberia anticipate that SEPA will be a viable institution

contributing to the improvement of science education throughout Africa. SEPA's current limited resources, however, only partially support Liberian needs.

Liberia's science educators, now fully committed to the task of improving science education in Liberia with Ministry of Education support, are devoting energy to accomplish this goal. If the present trend of support continues, and Liberia receives the financial and material support she needs, a problem-solving approach to science through the use of APSP materials should become an integral part of Liberian science education.

### C. Regional Institutions

Assistance on a regional basis often is directed toward development of institutions to foster continued technical cooperation among the participating countries. Such institutional development requires considerable effort and resources even under optimum circumstances. For example, it requires formulating a legal basis for the new organization, identifying personnel and fiscal resources to initially supplement and eventually replace U.S. assistance, selecting and training an indigeneous staff capable of managing and further developing a new international organization, and initially choosing an organizational purpose which ranks high among the developmental priorities of the cooperating nations. Such formidable attempts are further compounded in newly-independent nations where scarcity of technically-trained personnel and fragile economies make any institutional development a high-risk activity.

A number of African international organizations have enjoyed a reasonable degree of success. Some such organizations, however, are sometimes formed as economic funnels, primarily to tap technical assistance funding sources restricted to support of regional projects. In such cases, where the motivation for regional cooperation is extrinsic, rather than intrinsic and spontaneous, difficulties often occur in organizational development and in having continued institutional viability following cessation of external technical and financial assistance. It was reported to the evaluation team that the regional organizations proposed to continue the work of AMP were initiated partly to secure technical assistance funds available for regional development. In contrast, the notion of a Pan-African program for science actually preceeded any proclamation by AID of new regional modes of operation.

#### 1. African Mathematics Program

The implied objective of the African Mathematics Program is the establishment of two regional associations whose purpose is to continue the work

of this Program in the five participating countries following the termination of United States assistance. These two organizations and their respective member countries are the East African Regional Mathematics Program (EARMP) (Ethiopia and Kenya), and the West African Regional Mathematics Program (WARMP) (Ghana, Liberia, and Sierra Leone). EARMP and WARMP have evolved from the Steering Committee of the two predecessor contracts (Nos. AID/res-21 and AID/csd-1567) which led to the present implementation contract (AID/afr-711). Although the contractor and AID implicitly recognize the formation of these two organizations as work targets in the current implementation phase of this effort, it should be noted that establishment of viable regional institutions is not among the specific contractual responsibilities listed in Annex A (Statement of Work) of the basic contract. Neither does the PROP for this contract mention any specific institution building effort in its statement of objectives [page 3]. The PROP does mention that Management Committees of EARMP and WARMP are to assume policy and executive responsibility for the Programs within two years [page 14], but it does not specifically identify the establishment of regional institutions as a Program target. Any evaluation of contractor achievements in this domain should be made with this in mind.

a. East African Regional Mathematics Program. At the time of the field trip of the evaluation team, five meetings of the EARMP Management Committee had been held. Their times and places were as follows: 20 July 1970 (Kenya Institute of Education, Nairobi, Kenya); 11 January 1971 (Ministry of Education, Addis Ababa, Ethiopia); 27 July 1971 (United Kenya Club, Nairobi, Kenya); 6 January 1972 (Ministry of Education, Addis Ababa, Ethiopia); and 14 August 1972 (United Kenya Club, Nairobi, Kenya). Transactions of the first four of these meetings are included as appendices to the contractor's reports to AID, and a draft of the fifth meeting's proceedings was made available to the evaluation team at the EARMP offices in Addis Ababa, Ethiopia.

Country representation at the Management Committee meetings has been complete at each session except for Tanzania which, although written into the original contract as an implementation target country, declined to participate in any EARMP activities because of their national policy of self-reliance. The Management Committee was chaired by an African from the

second meeting onward, and at this same meeting the post of Program Administrator was filled following public advertisement. There has not been sufficient progress toward institutionalization of EARMP to meet the implied goals of having the Management Committee assume policy and executive responsibility for the Ethiopia and Kenya Mathematics Programs within the immediate future. The target date of July 1972 has already been missed.

Effective participation in planning and policy making by African members of the Management Committee has been hampered by lack of sufficient advance information about topics to be covered at each meeting. Although provided with a brief topical agenda for each meeting, no papers were circulated elaborating these topics. Such papers could have encouraged Committee members to discuss the topics with their professional and governmental colleagues prior to the meetings, provided them with alternatives from which to select regarding plans and goals, and facilitated more active participation in the business of the meetings. What has actually happened at the meetings has been a rather routine reporting of past accomplishments and presentation of plans for future activities by the contractor's home office and field staff, rather than an active involvement by Africans in selecting and refining goals, then devising appropriate means for their achievement.

Progress toward formal institutionalization has been very slow. What most surprised the evaluation team was the expectation, expressed by one major Ministry of Education official and two of the contractor's field staff, that there will then be no necessity for the continuation of EARMP and it will not continue to exist after the termination of U.S. support. With such an expectation about continuation, and judgment concerning necessity, among key persons involved in the institutional development of EARMP, the prognosis for its future viability is indeed poor.

A major obstacle in the progress toward institutionalization has been the delay in the preparation of a charter, or some sort of constitution, for EARMP. Such a document was presented in draft form at the fifth meeting of the Management Committee in August 1972. The contractor had earlier prepared a Mode of Operation paper, following the third meeting of the EARMP and WARMP Management Committee meetings. This paper, however, was not a charter. It was prepared in August 1971, at the request of the EARMP Management Committee, "to define the relationship between the [Program] Administrator

and the Educators and the Editor (Progress Report, 1 February 1971 to 5 October 1971, p. 87)." The text of this paper is given on pages 88 to 91 of the above-referenced report.

Without specific guidelines for goals and operation, efforts toward institutionalization are difficult. At the second meeting, on 11 January 1971, a decision was made to seek affiliation with an existing African organization, the Regional Council for Education (RCE), then the East African Regional Council for Education. This idea was reacted to favorably by the RCE but was later dropped (Progress Report 1 February 1971 to 5 October 1971, p. 84) because the Committee felt such an association was "unacceptable to the Ministries since the Council was an association of universities and not of governments as EARMP is." Had this matter been handled appropriately, of course, this objection would have been raised earlier and no time wasted contacting the RCE.

The third meeting was held on 27 July 1971, a full year after the first meeting. Two major organizational problems faced the Committee at this meeting and a third one surfaced at the Committee's fourth meeting on 6 January 1972. The first problem was the basic issue of committee membership, which should have been settled at an earlier meeting as part of the development of a charter or constitution. The second issue was more basic, and also should have been discussed and reconciled earlier: supervisory responsibility for the Mathematics Educator, the Mathematics Editor, and the local Program Administrator. This question was answered by the Mode of Operation paper, in which the contractor clarified for the Management Committee that it was the contracting organization who, for an interim period of from 18 months to 2 years, holds general responsibility for the mathematics program "professionally, educationally, and financially." This paper indicated that the Management Committee was expected only to advise and guide the contractor during the initial, formative period.

The third problem faced by EARMP, which was discussed at length both at the fourth and fifth meetings of the Management Committee (6 January 1972 and 14 August 1972) concerns the problem of fiscal information and control. This problem was subject to a lengthy discussion at the fourth meeting. At the fifth meeting, a Ministry of Education representative specifically asked

the contractor whether the committee could be informed of the general financial situation. The contractor responded that this was outside committee responsibility, while some members of the committee felt that policy control without full fiscal information and control was ineffective. Discussions with a number of persons interviewed indicated that the concern of the Management Committee over fiscal information and control is far greater than reflected in the formal records of the fourth and fifth meetings.

Progress toward counterpart development has met with two major difficulties. Since EARMP is not an established institution, there are neither full- nor part-time posts open for any of the counterparts who have been identified as Trainee Editors and Trainee Evaluators by the contractor (Progress Report 6 October 1971 to 3 March 1972, p. 13). The second difficulty is that those persons identified as Trainees occupy full-time positions elsewhere and there are apparently no plans for them to transfer to EARMP. Furthermore, any plans for their return do not fully take their recent training into account.

Thus, at the time of the evaluation, no institution was established for implementing the African Mathematics Program in Ethiopia and Kenya, and the implied target of the Management Committee having policy and executive responsibility within two years, as indicated in the PROP, had not been met. There was no adopted charter, constitution, or terms of reference, although there was a draft of such a document. There had been minimum African participation in management of the program, and controversy between the contractor and the Management Committee members over matters of fiscal information and control. At least one Ministry of Education official, and two of the contractor's field staff, do not expect EARMP to exist beyond the term of U.S. technical and fiscal support. Nor do they feel the need for its continued existence. Unless action is immediately taken, and perhaps not even then, there will be no lasting organizational framework to carry on the work of the African Mathematics Program on a regional basis in Ethiopia and Kenya.

b. West African Regional Mathematics Program. Five meetings of WARMP were held prior to October and November of 1972, the time of the evaluation team's field trip. Times and locations of these meetings were as follows: 8 July 1970 (Curriculum Resource Centre, Accra, Ghana); 5 January 1971 (Women's Teachers' College, Port Loco, Sierra Leone); 22 July 1971 (Fourah Bay College, Sierra Leone); 10 January 1972 (Booker Washington Institute, Kakata, Liberia); and 3 August 1972 (University of Ghana, Legon, Ghana). Proceedings of the first four meetings are included as appendices to the contractor's reports, and a draft summary of the fifth meeting was reviewed at the WARMP office in Accra, Ghana.

Country participation in the WARMP Management Committee has been virtually complete, based on meeting attendance. Actual progress toward institutional development, however, has been minimal. The expectation in the PROP, of a regional organization assuming policy and executive responsibility for the Program within two years, has not been met. Several persons interviewed expressed the opinion that there would be no need for WARMP to exist beyond the period of contract support, and they did not expect it to continue.

The local Program Administrator was selected at the first meeting of the Management Committee. This position was not advertised and was thus filled non-competitively, constituting a procedure which opened the possibility that the strongest candidate for the position may not have been obtained. The Management Committee functioned for the first two years under the chairmanship of an American. It was not until the fourth meeting, 10 January 1972, that an African was elected as Chairman.

African participation in planning and decision making has been restricted by insufficient circulation of information about agendas prior to the meetings. Only a brief topical list of agenda topics was circulated prior to each meeting. There was no preparation of detailed papers which elaborated upon the implications of these topics, suggested alternative ways of achieving Program targets, or provided committee members with sufficient information to arrive at the meetings with additional ideas from their national colleagues. This procedure has resulted in almost complete determination of Program

direction by the contractor, with much meeting time devoted to presentation of contractor-prepared reports, from home office and field staff, about past activities and future plans.

Further deficiencies emerge in the areas of fiscal information, fiscal control, and the development of fiscal management experience by the local Program Administrator. The Management Committee of WARMP has never seen or reviewed the WARMP budget. The WARMP budget always has been prepared at the contractor's office in the United States, then given to the local Program Administrator as a lump sum figure, with no line item breakdown as a guide for expenditures. Furthermore, the Program Administrator has experienced considerable difficulty maintaining his local accounts using procedures which are in accord with those required by the contractor's accounting procedures. Additionally, a lack of precise written instructions to the local Program Administrator from the contractor regarding appropriate fiscal procedures has added to the difficulties.

Progress toward forming an institutional basis for WARMP has thus been slow. Neither at the first meeting of the Management Committee, nor at any subsequent meeting, for example, was a charter document prepared or drafted which specifically stated the purpose and operating rules of the Committee (i.e., terms of reference, constitution, charter, etc.). This has delayed an attempt (still pending) to affiliate with an existing West African regional organization, the West African Council for Teacher Education. The Mode of Operation paper, prepared by the contractor in August 1971, following the third WARMP and EARMP Management Committee meetings, does not constitute such a document. This paper was prepared in response to the EARMP (sic) Management Committee's request for the contractor "to define the relationship between the [Program] Administrator and the Educators and the Editor (Progress Report, 1 February 1971 to 5 October 1971, p. 87)." The Mode of Operation paper is given on pages 88 to 91 of the above-mentioned report.

Assessment of counterpart development is complicated by the same two factors encountered by EARMP. The first is that WARMP is not an existing institution with established full- or part-time posts for the two types of

counterparts referred to in the contractor's reports: Trainee Editors and Trainee Evaluators. The second is that those persons designated by the contractor as filling these roles (Progress Report, 6 October 1971 to 3 March 1972, pp. 12-13) actually occupy full-time local positions which leave little time to perform the functions of editing and evaluation. They are thus not counterparts in the sense that the contractor's Mathematics Editor presently assigned to the WARMP offices at Ghana, will very likely not be replaced by any of the persons designated by the contractor as Trainee Editor. The Ghanaian indicated as being in this role by the contractor, for example, does not perceive himself as the counterpart of the contractor's Mathematics Editor.

At the time of the evaluation no charter or terms of reference existed, and there was no draft of such a document. There was certainly no legal status, no affiliation with any existing institution or government body, minimum African participation in actual planning or formulation of policy decisions, no fiscal control or even awareness of WARMP's fiscal resources on the part of the Committee, and hardly any program activity on the part of committee members between meetings. Thus, the implied goal of this Committee taking over policy and executive responsibility by mid-1972 was not met and probably will not be met within the next year.

## 2. Science Education Programme for Africa

A specific objective of the APSP implementation contract (afr-791) is to support SEPA, a regional organization "...which will ultimately assume complete responsibility for leadership and coordination of African science programs (page 1)..." This goal is clearly stated both in the PROP and in the contract, and is incorporated into the Logical Framework analysis for this contract as project output #5: "Pan-African organization (SEPA) established to continue Inter-African Technical Assistance in science education." Progress toward the three indicators associated with this project output are discussed below. At the beginning of the present implementation contract (1 July 1971), considerable progress had already been made toward the establishment of SEPA. As the PROP indicates (p.3) work under the implementation contract is to make SEPA more viable and independent, and for it to attain complete autonomy by mid-1973.

The formation of SEPA was an outgrowth of the APSP. As reviewed earlier in this report, APSP began in 1965 at Kano, Nigeria. Financial assistance for the beginning phase came from AID (93 percent) and the Ford Foundation (7 percent), with the present contractor as the implementing agent. Although the contractor participated in the development of APSP for the first four years of the program, African science educators were closely involved in program management. By 1967 five of the twelve members of the APSP Advisory Committee were Africans, and by mid-1969 African science educators expressed a desire for complete control of the program. This desire was realized in September of 1969, when a group of African science educators met at Takoradi, Ghana, to formally transfer the program to African control. Shortly afterward, in February of 1970, AID sponsored a meeting at Freetown, Sierra Leone, where representatives of nine African nations first formed SEPA. Acting quickly to formally establish SEPA, an ad hoc executive committee met two months later at Nairobi, Kenya, to draft a constitution and develop a plan of action for future consideration by the Representative Council of SEPA.

Through 1970 there was a lack of clear distinction between APSP and SEPA, but this is not currently the case. SEPA is presently a functioning regional organization with an adopted Constitution, a Representative Council, an Executive Committee, and a Secretariat. No non-Africans hold positions in the Secretariat, nor are they members of either the Representative Council or its Executive Committee.

The Constitution of SEPA is available in booklet form both in English and French. The Constitution required endorsement by at least three member countries, through formal Letters of Acceptance, before it came into force. Although issuance of such letters involved complex processing within participating nations, often requiring parliamentary action and clearance through Ministries of Foreign Affairs, the requisite three were received by the Secretariat prior to June of 1972. Two additional Letters of Acceptance had been received at the time of the evaluation. In addition to these five full members of SEPA, two others have paid their assessments and are simply awaiting formal approval by the Representative Council. The five full

members are Ethiopia, Ghana, Kenya, Liberia, and Sierra Leone; the two awaiting formal approval are The Gambia and Nigeria. In addition, formal statements accepting and supporting SEPA in principle have been received from Lesotho, Swaziland, Uganda, and Zambia; and an expressed interest in participating in SEPA as an Observer has been received from Tanzania.

At present SEPA is predominantly supported by AID funds, through the contractor. The contractor acknowledges, in its report (Progress Report, 1 July 1971 through 31 December 1971, p. 10), that the goal of fiscal independence by mid-1972 will not be met. Substantial progress toward this goal, however, has been made in the past year. Membership dues were only \$600 per year, for example, until the July 1972 meeting of SEPA's Representative Council at Lagos, Nigeria. At that meeting the Africans increased their own annual assessments to between \$3,300 and \$5,500 per member, depending upon the size and wealth of the member country.

In addition, funds from other donor agencies have been given directly to SEPA. Support has been obtained from the Centre for Educational Development Overseas (CEDO) and from the Carnegie Corporation of New York. The support from Carnegie is rather substantial, and consists of \$92,000 for the initial year of a SEPA Evaluation Centre at the University of Ibadan in Nigeria.

The likelihood of further funding from non-AID sources seems high. The Executive Secretary of SEPA visited the United States in November of 1971, to contact several funding agencies as possible sources of program support. These included AID, Ford Foundation, Carnegie Foundation, UNICEF, and UNDP. The general response from these initial contacts was a request for specific programs, each accompanied by an associated cost, which might be reviewed for possible support. A description of programs and their costs was prepared by the Executive Secretary, as part of a general background paper on SEPA, and brought to the United States in November 1972 by the Executive Secretary. The results of this fund-seeking trip were not available at the time of the writing of this report.

The operating expenses of SEPA are approximately \$170,000 per year, and are expected to increase to between \$250,000 and \$300,000 within five years if all of the planned programs are implemented. Approximate costs for some representative SEPA activities and operations are as follows: \$33,000 for the Secretariat; \$37,000 for the training program planned by SEPA's Science Educator; \$23,000 for meeting of the Representative Council (every two years); \$15,000 for Executive Committee meetings; \$15,000 or more for each workshop; and \$18,000 for specialist meetings.

The staffing of SEPA consists of two full-time professionals, both presently funded through the contractor. One of these serves as the Executive Secretary and the other as Science Educator temporarily assigned to SEPA. Both of these are Africans, and thus the staff of SEPA is fully Africanized. Whether these two African professionals remain with SEPA over the next few years will determine to a great extent the continued success of this organization. Its rapid development to date and its present wide acceptance is largely due to their dynamic leadership and organizational skill. These active staff members are well known within Africa through their frequent trips promoting SEPA's growth and their participation in numerous training programs.

In summary, then, all institutional development goals of the APSP either have been met or will be met in the very near future. SEPA is an existing Pan-African organization presently supported to varying degrees by eleven member countries, well staffed with strong and active African professionals, currently receiving financial support from two donors other than AID, and well on its way to institutional independence. It is the opinion of the evaluation team that the development of SEPA, with strong African leadership from its very early stages, constitutes a model of regional organizational development.

## IV. CONCLUSIONS AND RECOMMENDATIONS

This section presents conclusions and recommendations for program planning regarding the African Mathematics Program and the African Primary Science Program. For discussion purposes within this section, AMP is treated as two separate projects, the East African Regional Mathematics Program, and the West African Regional Mathematics Program.

The conclusions and recommendations are grouped into the following six categories for EARMP, WARMP, and APSP: Curriculum Development; Teacher Preparation; In-Country Utilization; Evaluation Expertise; Project Administration; and Institutional Structure. Much of the supporting data for these conclusions appears in earlier sections of this report, primarily in Section III (Utilization and Impact), and only the conclusions are summarized within this section. Recommendations within this section are numbered consecutively.

### A. East African Regional Mathematics Program

#### 1. Curriculum Development

##### Conclusions

a. In each of the EARMP countries, Ethiopia and Kenya, a nationally developed modern mathematics curriculum is being written and installed. In Ethiopia, the basic Entebbe series was introduced in 1967 at both the primary and secondary levels. Subsequently, slightly adapted Amharic versions were prepared for Primary I and II. The Primary I text is in use in almost all schools and Primary II is being distributed. All students in grades 7 to 12 use an Ethiopian-printed version of Entebbe texts. A revised syllabus is being prepared for grades 3 to 12, and the development of revised texts for this syllabus is expected. In Kenya, new modern mathematics texts for Primary I and II have been completed and are in use in most schools. The development, testing, and installation of texts for the remaining five years

of primary school mathematics is expected to proceed at the rate of one grade level per year. New secondary materials in modern mathematics are being developed by a group of expatriates at the Kenya Institute of Education (KIE).

b. In both Ethiopia and Kenya, curriculum development in mathematics is being undertaken by national institutions attached to the Ministries of Education. Although both of these institutions are staffed primarily by Africans, both have depended significantly on the contributions of locally hired and externally furnished expatriates. The continued growth of these curriculum development efforts, particularly in Kenya, is likely to depend on outside technical assistance for another several years.

c. A new series of teacher training texts in modern mathematics is almost complete. Volume I, drafted at the 1971 EARMP workshop, has been field tested, tried, revised, and printed. Volume II, prepared at the 1972 workshop, has been reproduced and is being field tested. Volume III, which is a teacher guide to the presentation of modern mathematics in the classroom, rather than a text on the content of modern mathematics, now is being prepared largely by contractor personnel. Both Ethiopia and Kenya have indicated their intention to use these volumes in their teacher training programs.

### Recommendations

1. Continue support for the present EARMP curriculum development program in teacher training until the materials have been completed. Progress on this effort is on schedule and the materials are urgently needed to prepare teachers to use the primary materials that are now being implemented. To insure adequate time to complete, try out, and revise Volume III, which is a supplemental but very desirable segment, support may have to be continued through mid-1974. This also would permit greater African participation in the development of that volume, which would be a valuable learning experience for those involved.

2. More systematic contributions to the further development of national capabilities in mathematics curriculum development should be considered.

Although direct support for the development of new mathematics curricula in Ethiopia and Kenya is not part of the present EARMP program, the need for additional technical assistance in on-the-job training of curriculum development personnel should be ascertained. Individuals staffing the present institutions have not had formal curriculum development training, although one individual from the Kenya Institute of Education was out of the country for this purpose at the time of the team's visit. Providing support in the form of intensive, on-site formal training, and consultation in mathematical knowledge and pedagogic approaches, and participant training at established curriculum development centers would strengthen these in-country institutions to the point where their long-term potential could be realized.

3. Any direct assistance to current curriculum development efforts for primary and secondary mathematics education should be phased out gradually.

Both Ethiopia and Kenya have demonstrated their interest in reducing their dependence on expatriate and contractor assistance. On the other hand, some limited continued technical contributions are needed to insure the quality of materials now being prepared and to avoid lapses which could damage the growth of these institutions. In Kenya particularly, efforts now depend heavily on expatriate personnel because of the small size of the African staff. Therefore, this direct assistance should be made contingent on increasing the size of the staff to a more appropriate level.

2. Teacher Preparation

Conclusions

a. There are insufficient numbers of teachers trained in modern mathematics and in the activity oriented method of teaching to successfully implement the new primary curricula being introduced in Ethiopia and Kenya. Past AIP teacher training institutes, offered between 1963 and 1970, trained close to 4,000 teachers, but these groups included no more than 1,000 or so from the approximately 70,000 teachers in Ethiopia and Kenya who need this training.

b. Secondary school teachers are generally university graduates in both Ethiopia and Kenya, and include a large number of expatriates in Kenya. Teacher training problems are not as pressing at this level as they are in primary education although these too may grow with increases in the proportion of students who continue on to secondary school. Before that happens, however, the fruits of curriculum reform efforts may be recognized and larger numbers of students will enter the universities with interests in mathematics and mathematics education.

c. In-service teacher training in Ethiopia is recognized as a major need, and the government would like to make substantial progress in this area. The problem is made quite difficult, however, by the remoteness of many rural schools and the realistic limitations which exist in terms of trying to assemble groups of teachers for training sessions or of trying to increase district supervisor visits to outlying schools.

d. In Kenya, in-service teacher training is assigned to the primary inspectors who are responsible for developing all the skills of primary teachers. The present number of inspectors is too small to have much impact, although the Ministry hopes to greatly expand this number in the next few years. Part of the problem of helping primary teachers has been overcome with the preparation of a Teacher's Guide to accompany the Kenya Primary Mathematics texts.

e. The three teacher training volumes now being prepared by EARMP are less elaborate than the Entebbe Basic Concepts and are texts believed appropriate for the teacher training programs in both countries. Availability of these texts is expected to facilitate pre-service training, and possibly in-service training.

f. The recent emphasis on training tutors and supervisors, rather than teachers, is more realistic in terms of the numbers of teachers who will need to be trained. The tutor and supervisor program has been hampered in the EARMP countries, however, by the large turnover among individuals holding these positions and the differences in backgrounds between tutors and supervisors. This has affected participation in the correspondence portions of the program, where fifty percent dropped out in the first year.

### Recommendations

4. Revisions should be made in the tutor and supervisor training program. Several steps could be taken if the Ministries would agree. First, the present two-year program should be shortened to maintain participation to completion of the course. Second, the formal two-week institutes which are part of the program should be made longer to reduce the amount of instruction left to the correspondence lessons. And third, the training of tutors and supervisors should be separated so that the tutors can receive more intensive assistance and so that the supervisors can be given an abbreviated program better suited to their backgrounds and responsibilities.

5. Consideration should be given to the planning and preparation of a brief course for primary teachers to be offered when the new texts are introduced for their grade. The goals of this course should be limited to an explanation and review of the mathematical content of the specific student text these teachers will employ and to demonstrations and discussions of the pedagogic approach they are to use. If a modest team of perhaps 25 tutors, inspectors, and educators could be assembled and trained, and then if each of these presented four workshops to twenty teachers each year during the vacation period, some 2,000 teachers could be given at least minimum training each year. This approach would greatly facilitate the work of the inspectors during the school year.

6. Consideration should be given to the use of radio or other innovative approaches for in-service teacher training in the more remote areas of Ethiopia and Kenya. Although not a responsibility of the present project, training teachers located in less accessible regions of Ethiopia to correctly use new curriculum materials will be a significant determinant of the success of the materials in their classrooms. Radio could be used as a substitute for supervisors' visits and provide help to the teacher in the presentation of lessons on a weekly, or even daily, basis.

### 3. In-Country Utilization

#### Conclusions

a. In both of the EARMP countries, the adoption and implementation of a new curriculum in modern mathematics began before the initiation of the current phase of the project. Kenya initiated the development of its own Entebbe based primary curriculum in 1965 and Ethiopia began the preparation of Amharic translations of the Entebbe primary texts in 1967. Although these efforts proceeded at a slow rate, the commitment of the two countries was evident from these initiatives. Both countries continue to make some use of the original Entebbe materials to fill interim needs.

b. There are government or government-affiliated textbook printing facilities in both countries which appear to be capable of meeting the requirements for materials reproduction for the new curricula. If necessary, there are still other resources which could be used, including the substantial government printing office and plant in Nairobi and private printing and publishing concerns. The EARMP workshop in 1971 was able to obtain printed copies of the first volume of the teacher training text for tryouts in only two weeks.

c. Distribution of text materials to the schools where they will be used is expected to continue to be a problem in both countries, and especially in the more remote areas of Ethiopia. It should be recognized, however, that these problems affect the availability of all textbooks and that solutions to these problems were not in the scope of the present project. Because of their cost and lack of ready replacements for texts that do reach schools, the practice of transcribing exercises into copybooks is expected to continue for some time.

d. The shortage of in-service teacher training to accompany the distribution of new curriculum materials is evident from classroom observations even in districts surrounding the capital cities of the two countries. Teachers who were observed tended to rely heavily on traditional teaching methods that are not well suited to obtaining maximum benefits from the new curriculum. Their knowledge of the principles also was less than needed for teaching modern mathematics. These observations were supported by comments from a number of officials and educators who were interviewed.

e. The Ministry officials interviewed in both Ethiopia and Kenya were enthusiastic as to the desirability of continued curriculum reform and the choice of modern mathematics as the goal of this reform for their countries. In large part this must be attributed to past contributions of the AMP project and to current efforts of the EARMP project staff. Less emphasis was given to the pedagogic approach encouraged by the program, particularly as these techniques might be viewed independently of the content of the program.

f. Language problems have consistently interfered with the use of program materials in the early primary grades, especially in the more remote schools. An effort had been made to take a serious look at the language problem in 1963 when a group of linguists was asked to participate in the Entebbe workshop that year. However, the materials developed from that point on continued to be in English only. In both Ethiopia, where Amharic is the language of early primary instruction, and in Kenya, where regional languages are used to a greater degree than the government would like, teachers find it difficult to present certain concepts that are essential to modern mathematics in languages that do not have the needed terms and shades of meaning.

#### Recommendations

7. Efforts should be made, within the present project, to assist the governments in the two EARMP countries in the development of solutions to textbook distribution problems. The planning of AMP materials seems to have largely ignored the very real difficulties inherent in supplying texts to schools in East Africa. Since the use of copybooks is not likely to change for some time, the production of texts which assume exercises will be copied should be encouraged. One step in this direction would be the selection of binding methods and types of paper stock that would facilitate reuse and minimize the possibility of damage. Another would be the use of a volume size and format that might simplify transportation problems. Still another would be more careful tryouts to insure that copies which are distributed would not have to be replaced too quickly.

8. Efforts should be made to strengthen the in-service training of teachers at the time materials are introduced. The proper implementation of the new curriculum materials should include more intensive, systematic, and deliberate training of the teachers who use the materials, particularly in the intended teaching methods (see recommendation under Teacher Preparation above.) Strain on teacher preparedness also could be lessened by introducing the materials more gradually and not into all classrooms at a given grade level in a single year.

9. A valuable adjunct to the current project could be a workshop of leading East African educators to consider the problem of presenting and explaining modern mathematics concepts in regional languages. At a minimum, this workshop could be expected to produce a set of reference materials for the use of teachers in each major language area. These reference materials might comprise a valuable supplement to the Teacher's Guide being developed as Volume III of the EARMP teacher training series.

#### 4. Evaluation Expertise

##### Conclusions

a. Evaluation did not receive high priority in the AIP curriculum efforts. Possibly because of the reduced need for evaluation during the current EARMP project, which is concerned only with teacher training materials, this lack of emphasis has continued. Tryouts are being conducted and information from them is being used to revise the materials. No more formal assessments were reported.

b. The curriculum materials being developed by Ethiopia and Kenya are not being thoroughly tested before publication and distribution. However, experience was obtained with the Entebbe materials in both countries and, to the extent this experience can be generalized to the Ethiopian translations and Kenyan revisions, this experience can contribute to the quality of the materials.

c. Overall assessments of the contribution of the new curriculum were not made in either country, particularly with respect to the value of modern mathematics for primary students who rarely continue on to secondary school.

In Ethiopia, primary leaving examinations are based on the content of the Entebbe series. In neither country has sufficient effort been made to test rigorously whether program goals relate to student interest in and appreciation for mathematics, or to assess the significance of the recommended pedagogic approach to the learning of modern mathematics. The decisions each country made to proceed with the development and implementation of new curricula in mathematics seem to have been reached without systematic investigation and evaluation.

### Recommendations

10. If further assistance is provided to increase curriculum development capabilities in Ethiopia and Kenya, evaluation should be emphasized. The further growth of mathematics curriculum development capabilities in the two countries will depend on increments in several skills. The proper use of evaluation is one of these. Any contractor personnel assigned to work with the curriculum development units should be instructed to emphasize the role of evaluation and the methods appropriate for securing valid and useful evaluative data.

11. Additional individuals assigned to the curriculum development units should receive training in evaluation. One trainee evaluator from each country currently is attending the course on evaluation at Ibadan, Nigeria. Although this may contribute to each country's curriculum evaluation capability, it is likely that each of these individuals will be expected to furnish assistance to all ongoing curriculum development efforts and not only those in mathematics. More trainees should be selected and given formal education. Furthermore, some intensive, short-term training in evaluation for all curriculum development personnel would be beneficial to the program.

12. Comprehensive technical assistance should be given in formulating and implementing evaluative instruments to assess curriculum contributions in areas other than the mastery of information. How much students learn of what was presented is an important component of curriculum evaluation, but not the only component. It also is necessary to assess the effects of the choice of content on subsequent education, on career choice, and on everyday adult needs. It is necessary to consider the attainment and importance of non-cognitive goals such as interest, appreciation, and attitude. Finally, it

is necessary to measure the contribution of the teaching method used on problem solving ability, curiosity, and resourcefulness. These all have been goals of the African Mathematics Program, but no evaluation of how well they are, or could be, produced by the new curriculum mathematics has been conducted as part of this project.

## 5. Project Administration

### Conclusions

a. Both of the contractor field personnel assigned to EARMP were interviewed. Each displayed dedication and commitment to his respective assignment despite many on-site obstacles which had to be overcome, such as the difficulties of transport which restricted periodic visits to up-country schools. Both field personnel joined EARMP with prior educational experience in Africa. The Mathematics Educator in Kenya served nine years in the Ethiopian Ministry of Education and was instrumental in the adoption of modern mathematics in Ethiopia. When he joined the EDC staff in 1970, he was responsible initially for the EARMP project in both Kenya and Ethiopia. The current Mathematics Educator/Editor, posted in 1971 at Addis Ababa, Ethiopia, has an outstanding reputation as a professional mathematician both in the United States and Africa. He is immensely respected by the Africans with whom he works and is personally credited by them for the success of in-service training in Ethiopia.

b. The local Program Administrator for EARMP was selected, after public advertisement for the position, by three members of the Management Committee. For 20 years, he had been employed in an administrative position in the Ethiopian civil service. Data collected from the interviews in both Kenya and Ethiopia reveal that he successfully performs his assigned duties related to such tasks as setting up workshops. His performance of other administrative duties has been criticized by the current Project Director as discussed in the section on Regional Institutions (III-C); many Africans indicated that the attempt to resolve these difficulties have disrupted the primary tasks of the Management Committee.

c. The present Project Director, who manages both EARMP and WARMP, and who has held this position since September 1971, is not equivalent in background and prestige to his predecessor. Timing of his appointment as

Director was unfortunate with respect to the scope of EARMP activities. In addition, EARMP Management Committee members regretfully report that the attempt to resolve administrative problems by the Project Director with the local Program Administrator have hampered an effort by the Management Committee to achieve some decision-making responsibility for the EARMP project.

d. The current field personnel represent the contractor's first resident advisors in East Africa throughout the entire AMP. Prior to the implementation phase, technical inputs were dependent on periodic visits by both home office representatives and occasional consultants, the latter especially evident during the summer workshops. The absence of continual resident personnel over such a long-term project reduces field coordination and effective planning directed toward timely achievement of project goals.

#### Recommendations

13. The local Program Administrator should be provided a set of defined tasks agreed upon by this individual, the Management Committee, and the Project Director, accompanied by necessary guidelines. The tasks assigned to the local Program Administrator and the procedures by which they are to be carried out are not understood in the same way by the Program Administrator and Project Director. These tasks and procedures should be set forth so that clarification of them does not continue to occupy the semi-annual Management Committee meetings.

14. The EARMP project should be assured of sufficient resources to carry out its program. The major area of deficiency seems to be in transportation both to and from the in-service workshops by the participants as well as in visitation by the Mathematics Educator to up-country schools. This has hampered efficient conduct of the training programs, which reduces the outreach of the implementation effort.

15. The EARMP project should have formal commitment by the member countries of relevant utilization of the individuals currently receiving evaluation training at Ibadan University, Nigeria. Based on the data gathered during the interviews, the returning trainee evaluators might not be assigned positions directly related to the evaluation training they are currently

receiving at Ibadan, despite the assurances EDC has received to the contrary. If this is not guaranteed, no future training should be provided.

## 6. Institutional Structure

### Conclusions

a. The implied target of the EARMP Management Committee to assume AMP Program policy and executive responsibility by mid-1972 has not been met. The Management Committee has not thus far participated sufficiently in planning and decision making. Program management has been predominantly contractor determined. One Ministry of Education official and two of the contractor's field staff expect that EARMP will not exist following termination of U.S. support and do not view its continued existence as necessary.

b. Legal status will not likely be achieved by EARMP within the time period currently planned for project support (i.e., before mid-1975). Progress toward institutionalization has been slow. After two and one-half years there is still no formally adopted charter stating EARMP's purpose and operating rules, although one now exists in draft form. The Mode of Operation Paper does not constitute such a charter. This document, presented in the contractor's Progress Report covering the period 1 February 1971 to 5 October 1971 (pp. 88-91), was prepared in response to the EARMP Management Committee's request at its third meeting (27 July 1971) "to define the relationship between the [Program] Administrator and the Educators and Editor." (See p. 87 of same report.) Organizational development has been hindered by basic problems such as the focus of supervisory responsibility for the contractor's field staff and conflict involving fiscal information and control with respect to the EARMP budget.

c. No substantial progress has been made toward EARMP counterpart development. The person identified as a trainee by the contractor occupies a full-time position elsewhere and there apparently are no plans for him to transfer to the EARMP staff. The only African member of EARMP is the Program Administrator, who has full responsibility for EARMP's day-to-day activities. So far, however, he has not had a broad enough range of managerial experiences to have prepared him to administer a regional institution still in its developmental stages.

## Recommendations

16. Support for the institutionalization of EARMP should be discontinued. Insufficient progress toward institutionalization has been demonstrated and there is little likelihood of institutional viability after support is withdrawn. Since there is little likelihood of legal status within the coming two years, and because EARMP serves no function that could not be assumed by others, there is no apparent basis for investing further funds and manpower in continued attempts at EARMP institutional development. This recommendation refers to support of EARMP as an institutional structure and does not mean that all EARMP activities should cease. The teacher training volumes, as recommended elsewhere, should certainly be completed.

17. Establish national sources for guidance of any future in-country AMP Program activity. Presumably these sources would be the Ministries of Education, and they should be closely involved in any future EARMP-type Program activities in Ethiopia and Kenya. This would offer three advantages: funds and manpower previously directed toward organizational goals could now be redirected toward national Program planning and implementation; national programming decisions would be more responsive to local needs; and there would be no expenses for a regional office and its associated travel and subsistence expenses.

18. Local AID Missions in Ethiopia and Kenya should be involved, along with the Ministries of Education, the contractor, and AID/Washington, in planning any future activities. This should not only involve planning of project purposes, but also detailed decisions about development of goals, means to achieve these goals, selection of indicators of their attainment, and plans for periodic evaluation. Each country should be made fully aware of the amount of funds to be spent on country projects and be given details of their disposition of these funds. Participation by professional and program staff of the local AID Mission is especially critical, as they are often more aware of variable local conditions than are Washington-based AID personnel.

## B. West African Regional Mathematics Program

### 1. Curriculum Development

#### Conclusions

a. Completion of the present WARMP curriculum development program would require continued technical assistance and support for at least four more years. Even so, the only assurance so far received from Ghana, Liberia, and Sierra Leone as to their use of the materials is that they have agreed to consider them upon receipt of camera-ready copy.

b. In Liberia and Sierra Leone, curriculum committees will decide on new modern mathematics programs within the next six to eight months. Both have indicated that the WARMP materials, even if available by then, probably would still have to be adapted to national needs before they could be used. Ghana is not likely to change from the competing Addy-Armar primary and JSP secondary texts for at least several years.

c. The WARMP curriculum development program is not adequately preparing Africans for the capability in continuing curriculum adaption, development, or reform: the workshops are too brief and too widely spaced; less than adequate attention has been given to the need for evaluative trials; and many important functions, particularly the assembly, editing, and production of texts, are being accomplished by contractor personnel without African participation.

d. At the time of the evaluation team's visit, officials and educators in all three countries stressed the need for suitable teacher training materials in modern mathematics. Unresolved disagreements over the scope and content of the teacher training texts being prepared at the WARMP workshops not only have delayed their availability but also have resulted in the possibility that the products of the two completed workshops will not receive wide use.

### Recommendations

19. Any further contributions to mathematics curriculum development in the three WARMP countries should be national rather than regional in orientation and be contingent upon prior Ministry commitments for production and implementation of the materials. Throughout the history of AMP, there has been consistent evidence that national preferences preclude the use of regionally-prepared materials without additional local adaptation. The West African regional program appears to have low priority in terms of the personnel assignment, explicitness of deadlines, and the planned allocation of resources, particularly in contrast to the independent curriculum activities currently ongoing within each country. To be realistic, efforts to encourage cooperation among these countries should focus on the improved exchange of experiences and ideas rather than on sharable products.

20. Terminate the present WARMP curriculum development program. The program had not resulted in any usable curriculum material at the time of the evaluation team's visit. Although improved planning, administrative support, and other remedial actions may increase the flow of texts, the likelihood that these materials will ever be adopted is doubtful. Furthermore, the workshops as now organized do not contribute to the establishment of curriculum development capabilities within the participating countries. This capability is needed to enable them to complete the series, make desired local adaptations, and initiate future revisions.

21. Assistance should be given to each of the three countries in selecting and obtaining existing curriculum materials to meet their short-term needs. Neither Liberia nor Sierra Leone currently have a source of curriculum materials in modern mathematics. Some existing texts, however, already are available from Ghana, Kenya, and Nigeria which are usable without adaptation as those being developed by WARMP. Others are certainly available from various British and American publishers. Classroom materials are often obtained from commercial sources, and interim needs would be more quickly and efficiently met at roughly the same cost were existing texts to be adopted. In Ghana, such assistance would be required only to meet the needs for Standards 4 through 8 because early primary and secondary materials are already available. (Requirements for teacher training materials are discussed below.)

22. Consideration should be given to the expressed need within the three countries for assistance in creating cadres of individuals with curriculum development capabilities to enable these countries to meet their long-term objectives in mathematics education. Creating such capabilities will depend on extended, full-time training and experience for individuals who would then be prepared to contribute mathematical knowledge, pedagogic expertise, writing talent, editorial skill, evaluative ability, and publication competency to the further evolution of mathematics education in their own countries. The productivity of such an effort would depend on careful planning to insure achievement of adequate breadth and competence, and the establishment of a framework to capitalize upon these capabilities within each country's educational system.

23. Any additional curriculum development assistance should be provided to a permanently staffed, full-time curriculum development organization.

Although it does involve many participants, the workshop approach to curriculum development may not be the most efficient method of building curriculum development expertise at the present time. Preparation of the Entebbe series, for example, required nearly 50 man-years of effort. This intensive input of technical expertise, of course, produced more than the 67 Entebbe volumes. As a planned result there was also the experience gained by many African educators, over several years, in the preparation of mathematics texts suitable for use in Africa. In addition, the fact that many African nations participated in this joint venture probably had a strong influence on national change in mathematics education. Had these materials been developed by a permanent, full-time staff, however, it would have been possible to reduce the time span between planning and implementation, and to achieve the level of professional and organizational competence needed for continued curriculum reform. While the workshop approach may have been most appropriate at the time, it is the opinion of the evaluation team that alternative approaches should be explored for future inputs, such as the one suggested in this recommendation.

## 2. Teacher Preparation

### Conclusions

a. There are insufficient numbers of teachers trained in modern mathematics and in the activity oriented inquiry method of teaching to successfully implement any new curriculum containing these two components. This is clearly the case in Liberia and Sierra Leone and is so to a lesser degree in Ghana. Nearly 4,000 teachers received training through AMP in-service institutes from 1963 through 1970 in all ten participating countries, but no more than 800 were from among the more than 60,000 teachers in Ghana, Liberia, or Sierra Leone who would need this training.

b. The in-service teacher training institutes have been, and continue to be, too brief and incomplete to produce the levels of teacher performance needed to successfully implement a new modern mathematics curriculum. Most African teachers will require more than one to three weeks of instruction to master modern mathematics content and the approach of the activity oriented inquiry method of teaching, particularly when this instruction does not include supervised practice.

c. No suitable texts were available for use by the three WARMP countries, at the time of the evaluation team's visit, for either in-service or pre-service programs. The planned WARMP materials were not yet available and may not be acceptable when they are completed. The Basic Concepts volumes from the Entebbe series are out of print and felt to be too long and too complex. No commercially available materials have been identified which are consistent with the goals of the AMP and which are appropriate for West African teacher training needs.

d. Redirecting priorities to promote training tutors and supervisors, rather than teachers, was a constructive step. However, it was consistently estimated that the full impact of this approach would not be realized for several years due to the long lag before the number of graduating teachers who had received the pre-service training program represented a significant percentage of all teachers in the educational system.

e. The present training program for tutors and supervisors in West Africa is deficient. Of the 119 participants who began the program, more than 30 percent had dropped out of the correspondence phase of training within the first year. Participants from Liberia have never received the text and reference materials needed to correctly complete the correspondence lessons. The pedagogic methodology which was felt to have been so important to the AMP curriculum has not been given sufficient emphasis in this training program.

#### Recommendations

24. The teacher training texts now being completed in the East African region could be made available immediately to the three West African countries. The scope and quality of these materials provide a ready solution to the problem of the non-availability of teacher training texts suitable for most African teacher candidates. They could constitute a satisfactory basis for most pre-service and in-service programs. Each of the three countries could adapt or supplement these volumes to meet their own particular needs, thus making them more acceptable for use in the WARM countries.

25. Further support for in-service training programs should be made contingent upon a satisfactory plan for implementing a new mathematics curriculum and the definitive selection of a specific curriculum series. Although in-service training appropriately precedes the distribution of new texts, much of this training will be wasted unless a corresponding curriculum is adopted to utilize this training. In-service training also could be improved and made easier if future in-service teacher training efforts more fully recognize the extent of deficiencies in the mathematical knowledge and pedagogic skill of most African primary teachers. The evaluation team recognizes that increased in-service training may require technical and fiscal inputs beyond those initially envisioned within the present contract. Nevertheless, these efforts are of such importance that they should be provided either by reallocation of present resources or by increasing inputs for this specific goal.

26. The present training program for tutors and supervisors should be continued and the second of the two planned groups enrolled, but only if outstanding deficiencies are corrected. The deficiencies to be remedied include: providing all participants with the necessary texts and reference materials; improving the quality and suitability of the correspondence lessons to increase the participation rate; resolving difficulties experienced by contractor personnel in making periodic visits to the participants; and initiating a more rigorous evaluation program for assessing and correcting learner difficulties. Training for the first group should be continued for a third year so that these participants can benefit from improvements in the program and come closer to achieving what had been the program goals.

### 3. In-Country Utilization

#### Conclusions

a. None of the three West African countries adopted the AMP curriculum or even used it except on an experimental basis. Even this trial use was limited to the modest number of copies of the Entebbe texts received free of cost by the participating countries. No initiative was taken to produce or purchase additional copies to expand materials utilization or to meet needs which arose subsequent to 1969 when the Entebbe materials went out of print.

b. As a result of the very limited use of the materials on an experimental basis, the classroom distribution of texts was not a problem, even though repetitive delays were encountered in editing the materials at the contractor's U.S. offices, in reproducing the volumes, and in shipping them to the participating countries in Africa. The limited use of the Entebbe materials in these three countries also obviated any problems associated with the availability of sufficient numbers of trained teachers for the experimental classrooms.

c. Reproduction of curriculum materials has been a sufficient difficulty in the WARMP countries and, despite the continuing pressure from this problem throughout the series of the Entebbe-Mombasa workshops, no effective solution has yet been reached. One expressed source of concern has been the

difficulty in arranging for textbook production in the three WARMP countries. Until this deficiency is remedied, possibly as a result of a United Nations project now being planned, many texts will continue to be purchased from external sources at relatively high prices.

d. Classroom observations were made on the use of Entebbe based instruction in Sierra Leone, the Addy-Armar materials in Ghana, and the training of teacher candidates in mathematics in Liberia. These observations indicated that teachers and tutors associated with the program do not tend to have the required grasp of modern mathematics content or the discovery teaching method to present the curriculum materials as designed. Class size and traditional pedagogic approaches may have detracted from the successful application of the materials. Very little generalization of teaching approach from mathematics to other school subjects was reported.

e. Minimum recognition was given to the importance of syllabus changes as an avenue of curricula reform and as evidence of national commitment. The West African Examinations Council cooperated fully when requested to prepare a special examination for Entebbe-trained students; it has not yet been asked to assist in the preparation of an alternate syllabus or examination for the WARMP materials now under development.

f. The most significant impact of AMP has been its influence on educational decision makers with respect to modern mathematics. Although not the only source of influence, which included a number of British and other American efforts, AMP was able to attract and interest leading educators in its program since the very beginning of the project. As a result of these influences, there is rather universal acceptance of modern mathematics throughout the WARMP countries.

g. A major restraint on the adoption of AMP, WARMP, or other curriculum in modern mathematics has been the very urgent problems of providing even minimum education to increasing proportions of the eligible school-age population in Ghana, Liberia, and Sierra Leone. National priorities have kept curriculum reform secondary to the tasks of constructing classrooms, providing teachers, and supplying textbooks. These activities have used

resources which otherwise might have been allocated to implement curriculum reform. Considering the high priority of these problems within the Ministries, AMP accomplished about as much as was possible.

h. Another significant contribution partly attributable to AMP has been the growing enlightenment in West Africa with respect to the need for and the process of curriculum reform. The African educators who were interviewed gave considerable credit to their participation in AMP for their understanding of curriculum planning and revision, not only in mathematics but also in other sectors of education.

### Recommendations

27. In any future curriculum development efforts in West Africa, greater recognition should be given to the educational priorities and resource limitations of the countries involved. One step in this direction would be to reduce targets to what practically can be achieved within a limited time. Full cognizance should be given to teacher capabilities, possible investment in skilled manpower, and funds available for the problem of curriculum reform as a series of increments, with only limited change required during each phase.

28. No further efforts should be made within the present project to reproduce and distribute WARMP materials in the absence of specific needs. As recommended earlier (Recommendation 21) short-term needs for curriculum materials in modern mathematics can be satisfied by purchasing or reproducing existing materials from Kenya, Nigeria, or Ghana for primary and secondary instruction, and from EARMP for teacher training. Long-term needs will be defined by future syllabus changes and it is unlikely that such materials, whether prepared regionally through WARMP or nationally by individual countries, would be ready for large-scale reproduction and distribution for another several years.

29. Future efforts to deal with the problems of reproduction and distribution of curriculum materials should be consistent with basic business and commercial practices. The planned establishment of a West African textbook printing facility should assist in resolving reproduction and distribution problems. However, it also must be recognized that textbook cost

should be a major consideration in new curriculum planning in Africa. More than six times as much paper is needed to print each copy of the Entebbe student volumes than the equivalent text from the Highway Arithmetics series. Most African students use copybooks to conserve their expensive texts for re-use. Selection of texts in Africa frequently hinges on authorship credits, royalties, promotional activities, and profit-making distribution systems.

#### 4. Evaluation Expertise

##### Conclusions

a. Evaluation consistently has failed to be a high-priority consideration in AMP, and no meaningful improvements have occurred the first two years of the WARMP implementation program. Plans for testing the curriculum materials now being prepared through WARMP are based on use of the draft version by only two classes in each of the three participating countries. Because of production and scheduling problems, it was often difficult to quickly reproduce these materials so that they would be available for trials at the beginning of the school year. Although the mathematical soundness of the Entebbe texts was assured through their assessment by expert mathematicians, it is the evaluation team's opinion that trials involving only two classes were not sufficient considering the diversity of the target population assumed for the series.

b. Evaluation of materials typically has consisted of obtaining comments from participating teachers, a practice recognized as deficient by consultants, the contractor, and several Africans who were interviewed. This practice, nevertheless, was the one recommended for assessment of the WARMP materials. Some sporadic comparisons also have been made contrasting AMP and traditional curricula materials on national examinations, and these generally have been interpreted as favoring the AMP materials.

c. Apparently, no efforts have been made or even suggested to empirically assess the fundamental goals of the curriculum, aside from the learning of specific modern mathematics content. There have been no attempts to measure attainment of such goals; to quantify the facilitating value of modern mathematics for subsequent educational achievement; to evaluate the appropriateness of modern mathematics for countries where the vast majority

of students terminate at or before the end of primary school; or assess the impact of the AMP curriculum on the students' interest in or appreciation of mathematics. Furthermore, no effort has been made to contrast the relative contribution of the mathematical content of the instruction with the methodological approach recommended for offering the instruction.

d. Evaluations of individual texts during classroom trials seemed to have had little impact on the process of revising materials for subsequent publication. Emphasis in the early stages of the Entebbe curriculum program seemed to have been more on the overall contribution of the materials to achievement in mathematics. This is a questionable undertaking to the degree that the aims of Entebbe and traditional mathematics are quite different. Emphasis could more appropriately have been placed on the diagnosis of weaknesses in the materials which could be corrected before further copies were reproduced and distributed.

#### Recommendations

30. Should the present WARMP curriculum development program be continued, far more attention must be given to evaluation as part of the developmental process. Toward this end, emphasis should be given to developing instruments and procedures for assessing draft materials diagnostically so they can be revised. Some provision should be made for trials to be conducted with a larger number of classes to insure representativeness. Better arrangements must be made for the early reproduction of draft material to permit more timely trials. Finally, more global evaluations of the curriculum should be planned and conducted to provide participating countries with the information they need to make valid decisions regarding the desirability of adopting the curriculum.

31. Initiate further efforts to make all participants conscious of the role of evaluation in curriculum development. Although the return of the trainee evaluators from their training program at the University of Ibadan, Nigeria, may help in this regard, one or more intensive institutes on evaluation should be offered for workshop participants and Ministry officials. These institutes should be planned to present an accurate view of curriculum evaluation possibilities and practices. Also, the contractor's

field staff in West Africa should more deliberately and systematically foster the desirability of evaluation as a component of curriculum development during their contacts with African participants.

32. Undertake the development of better and more useful approaches to curriculum evaluation as part of this or a parallel project. Curriculum development efforts are often deficient in their use of evaluation. Although certainly not unique in this respect, and despite the use of a number of consultants, the present contractor has been unable to create an approach to evaluation that is perceived as necessary and valuable. This problem is likely to continue until a significant effort is made to generate satisfactory guidelines, standards, and models on the use of evaluation in curriculum development.

## 5. Project Administration

### Conclusions

a. Only two of the three contractor field personnel assigned to VARMP were interviewed; the third was on leave. Both seemed interested and involved in project activities, and both had prior educational experience in Africa as Peace Corps Volunteers. On the other hand, neither feel they have the authority that would be needed to resolve project difficulties.

b. The Program Administrator for VARMP, who was selected by the VARMP Management Committee and who administratively reports to the contractor, has not exerted the leadership functions which VARMP would need to survive as an institution without contractor support.

c. The present Project Director has held this position since September 1971. As indicated in the EARMP conclusions, his appointment as Director was unfortunate in its timing considering the magnitude of what had been planned for the VARMP region.

d. During the entire AMP program, and until the current field staff was appointed as part of the present implementation project, no contractor personnel were residents in Africa to enhance the continuity of project activities between summer workshops. Technical inputs depended on periodic visits by consultants and home office personnel who, although apparently

well qualified, were unable to give the continuity or follow-through needed to provide the three African countries with functioning curriculum development capabilities. Even now, the absence of continuous on-site direction delays and inhibits project responsiveness to even simple problems.

### Recommendations

33. The WARMP project should be provided with strong, resident, on-site leadership. The individual added to the project for this purpose should be capable of influencing workshop productivity, coordinating the assignment and participation of counterpart personnel, guiding the development of the WARMP institution and supervising the activities of the field staff. This person should make all decisions needed to insure that schedules are maintained, problems are resolved, and Ministry obligations are met.

34. The WARMP project should be assured of sufficient resources to carry out its program. The continued problems of transportation, typing, supplies, and especially printing, have resulted in the waste of considerable manpower, both African and American. The contractor should specify what services, support, and facilities are needed to make success probable and these resources should then be assured either through contractor provisions or local agreements.

35. The WARMP project must have firm and agreed-upon plans for synchronizing the many components of curriculum development and implementation. At the present time, there is incomplete coordination of materials development, teacher training, curriculum evaluation, and syllabus preparation activities. As noted earlier, Liberia and Sierra Leone are likely to make syllabus decisions before the WARMP materials are available for consideration, and the needed supply of trained teachers will not be available for five to ten years. In addition, the recruiting and instruction of trainee evaluators was delayed more than a year and the materials are being prepared in final form although all three countries have indicated that local adaptations would be required before they could be used.

## 6. Institutional Structure

### Conclusions

a. As with EARMP, the implied target of the WARMP Management Committee to assume AMP Program policy and executive responsibility by mid-1972 has not been met. There has been insufficient Management Committee participation in planning and decision making, with Program direction almost entirely contractor determined. Preliminary preparations for meetings have not encouraged Management Committee participation in decision making. Although the African Program Administrator has full responsibility for WARMP's day-to-day activities, as outlined in the Mode of Operation document, he has not yet had a broad enough range of managerial and budgetary experience to enable him to develop and administer a regional institution.

b. It is unlikely that WARMP will become a legal entity within the time period currently planned for project support (i.e., before mid-1975). Progress toward this goal has been minimal. Several persons interviewed, including African and contractor personnel, perceived no necessity for WARMP to exist beyond present contract support, nor did they expect it to continue.

c. No persons interviewed viewed themselves as counterparts to any of the present WARMP contractor staff. The present WARMP Program Administrator is an African, but his experiences to date have not prepared him to assume administration of WARMP. There is, in effect, no counterpart for the new Mathematics Editor.

### Recommendations

36. Support for the institutionalization of WARMP should be discontinued. So far, progress toward institutionalization has been insufficient to insure viability after support is withdrawn. There is little likelihood of obtaining legal status within the expected period of contract support. Since the WARMP organization is serving no function that could not be assumed by others, then there are no apparent reasons to invest further funds and manpower in continued attempts at institutional development.

37. Establish national sources for guidance of any future in-country AMP program activity. These sources, presumably within the Ministries of Education in Ghana, Liberia, and Sierra Leone, should guide any future WARMP-type Program activities if they are supported. As with EARMP, there is a three-fold advantage of this approach over that of a regional structure. First, funds and manpower now devoted to organizational goals could be redirected toward national Program planning and implementation. Second, national programming decisions would be more responsive to local needs. And third, there would be no expenses for a regional office or its associated travel and subsistence expenses.

38. Local AID Missions in Ghana and Liberia should be involved along with the Ministries of Education, the contractor, and AID/Washington, in planning any future activities. (There being no Mission at Sierra Leone, AID field staff should be represented there from the AID regional office at Dakar, Senegal.) This planning should involve not only setting overall project purposes, but also making detailed decisions about development of goals, setting means to achieve these goals, selecting indicators to measure their attainment, and providing procedures for periodic evaluation. Each country should be made fully aware of the amount and planned disposition of any funds for any in-country projects undertaken. Involvement of the AID professional and Program field staff is especially important, as they are often more aware of variable local conditions than are Washington-based AID personnel.

## C. African Primary Science Program

### 1. Curriculum Development

#### Conclusions

a. The 54 curriculum units which currently exist are sufficient to achieve the project goals. One of these goals is to supply sufficient materials for a primary science curriculum. This goal has been met in Ghana and other countries. An alternative project goal is to use these materials as supplements to existing curricula; this goal is being met on a limited basis in Sierra Leone and elsewhere.

b. Many countries participating in the current implementation phase have locally adapted some of the curriculum units. These countries, however, have demonstrated only a limited capability to produce new curriculum units, despite recognized curriculum needs. Even though there are organizations such as the science centers, which are commissioned with the task of developing curricula, none of the countries visited felt they possessed curriculum development capability. This observation, however, should be viewed in terms of the rationale for the current implementation phase. Several earlier participants in the APSP program have developed sufficient national curriculum development capabilities to have no further need for implementation assistance. Because of the success of APSP in these countries, they are not participating in the implementation phase, and thus were not included within the evaluation team's visits.

c. Widespread use of the curriculum units is somewhat limited because of the necessarily restricted range of topics which are covered. Some African educators indicated that another problem is that the scientific principles included within the curriculum units should be strengthened to increase the relevancy of the units to African primary education.

#### Recommendations

39. Broaden the present curriculum development capability. Upon complete implementation of APSP, long-range goals include expansion of additional programs which will depend upon a curriculum development capability. An immediate

need for further development of this capability, however, is necessary to supplement existing curriculum units to make them more appropriate for use in some countries. For example, a curriculum development specialist may be called upon to develop a unit on health or agriculture, even though these two areas were specifically deleted as curriculum unit targets at the Kano planning conference. It is recommended that expansion of this capability be incorporated into the functions of SEPA. A small group of Africans should receive specialized university training in the area of curriculum development. By assigning them to the SEPA Secretariat upon completion of their training, many countries will be able to utilize their curriculum development services. An alternate approach would be to provide such capability on a national level, but assurance would be needed that the participating country would utilize the curriculum development skills acquired by the individual, and not assign him to a non-related position upon completion of training. Such an approach along national lines, of course, would considerably slow the implementation process.

40. Increase African involvement in the decision-making process for the planning of additional curriculum development or revision capability. The suitability of curriculum units developed in the future will be enhanced by having African science educators participate to a fuller extent in formulating the primary decisions regarding content. In this way, the subject matter most appropriate for African students will be covered more fully.

41. Emphasize increased utilization or adaptation of existing units in preference to developing more units beyond the primary level. Few countries fully capitalize upon use of the available 54 units. Reasons why these units are not fully utilized should be identified by each country and measures taken to increase their use. One such method would be to use the SEPA staff to make the necessary modifications. In this way, the potential of SEPA is recognized, the range of services which SEPA can offer to individual countries will expand, and modification efforts will not be duplicated. A less desirable alternative would be to modify weak units within each country, but the usefulness of the curriculum unit would then be limited. By selecting SEPA to perform this task, the organization would be given an additional opportunity to function on a Pan-African level. Until the 54 curriculum units already

developed are utilized to the fullest extent possible by APSP countries, it is strongly recommended that support for any curriculum development beyond the primary level be withheld.

## 2. Teacher Preparation

### Conclusions

a. A sufficient number of teachers have not yet been trained to implement the APSP curriculum appropriately. Although a large number of workshops for primary teachers have been held in all of the participating countries, the actual number of teachers fully equipped to present APSP materials in their classrooms is still limited.

b. The majority of the APSP curriculum units consist of teacher guides. Classroom observations, however, revealed that the APSP units are often inappropriately used. The reasons suggested by several interviewees for this are a lack of teachers' self-confidence combined with unfamiliarity of both the scientific content and the activity oriented discovery method of teaching APSP. Many teachers using APSP materials reportedly resort to a traditional teaching technique because they are uncomfortable with, and unequipped to use, the activity oriented discovery approach.

c. The length and nature of the in-service workshops as presently designed do not appear to provide primary school teachers with the skills and knowledge necessary to implement APSP materials. The workshop format focuses on materials demonstration rather than participant practice in materials use. In addition, the workshop participants often include primary school inspectors, head teachers, and classroom teachers. These individuals do not share common needs for APSP knowledge: a classroom teacher must know how to use the materials, and this cannot be accomplished adequately in one day. A primary school inspector, expected to conduct in-service workshops for classroom teachers following this orientation, requires training in skills to orient others. The merit of present workshop format to achieve both objectives is thus highly questionable.

d. One approach used to overcome the weakness of the in-service workshops was to conduct workshops to build curriculum development capability and

to produce materials for tutors in the teacher training institutions. This is a reasonable approach but will take years to be effective, even under optimum conditions. One estimate given was that ten years would lapse before a majority of Kenyan teachers would be trained in the APSP approach through pre-service training. The recent emphasis on pre-service training strategies reveals an attempt to strengthen this weakness and, through trial and error, in-country rather than Pan-African workshops have been chosen to develop science teacher education materials and tutor training capability. SEPA has been assigned responsibility for pre-service science teacher education.

### Recommendations

42. Provide additional support for improved in-service training programs, but only after establishment of reasonable plans and formats appropriate to the participants. Specific programs should be created which stress practical use of APSP for classroom teachers, and which prepare primary school inspectors to conduct workshops. Any workshop should establish goals and a program format compatible with the desired participant outcomes. To continue conducting workshops as presently designed, with a diversity of participants whose needs differ, constitutes an ineffective expenditure of manpower and financial resources. The evaluation team feels that this recommendation, and the one immediately following, should be given foremost consideration in future project planning.

43. Continue support for in-country pre-service education. Because SEPA and many program participants have recognized the need for improved pre-service training, and responded to this need through a variety of ways, their current choices deserve support. This option focuses on program-supported in-country tutor workshops. One shortcoming of this option is the dual purpose of materials development and tutor capability training. To maximize the resources available at these sessions, these goals should be dealt with separately. If this alternative is not feasible, the total effort deserves support.

### 3. In-Country Utilization

#### Conclusions

a. APSP planners and developers confined the creation of curriculum materials to a manageable series in three ways: by restricting materials development to teacher guides; by concentrating on the primary level; and by producing booklets which could be made available inexpensively.

b. Overall impact of APSP is significantly high when compared to the relative success of innovative educational projects in general, although it may be viewed as somewhat restricted when compared to the total primary school population in the participating countries. In Ghana, for example, estimates of APSP use ranged from 20 percent to 30 percent of schools throughout the country.

c. There are some indications that use of APSP materials in the participating countries is expanding. This is due partially to the nature of the materials. For example, African primary grades are divided into upper and lower. Many of the materials designed for use in the lower primary grades can be adopted without concern about syllabus guidelines or national examinations. In addition, the materials for the lower primary level fill an existing gap by providing some creative structure to activity periods scheduled once or twice a week. If schools can successfully adapt the lower primary materials, interest in implementing the materials for upper primary grades may increase.

d. There appears to be some limitation on a teacher's ability to use APSP beyond the instructions contained within the units without additional guidance. The directions seem to be too loosely structured for teachers, especially when appropriate use requires knowledge about the discovery method of teaching. However, Kenya is overcoming this weakness by creating guidelines for teachers, especially in the upper primary grades, which will facilitate the implementation process.

e. A critical aspect of any curriculum reform in Africa is teacher reliance on the syllabus as a guide to classroom instruction. This need is being, and has been, recognized in some of the participating countries.

f. Lack of availability of materials has almost universally hampered implementation. Problems of production and distribution of classroom and teacher training materials appear to be a fact of African life; for example, a moratorium in effect in Ghana at the time of the evaluation team's visit which forbid the additional printing of materials other than mathematics and English may reduce the rate of implementation in Ghana. In other countries, no readily workable channel of production and distribution now exists for the broad acquisition and implementation of APSP materials.

g. Although it has been indicated that less than 25 percent of the APSP units require apparatus, and these few focus on the use of local materials, the requirements of apparatus can often restrict the successful teaching of APSP units and hinder widespread implementation because even simple equipment may not be locally available. This shifts a major part of the burden of implementation on the teacher and may discourage use of the materials. In many cases, limited access to even simple equipment is a problem in implementing the units. For example, greater opportunities exist in an urban area to buy even simple apparatus. In Tanzania and Uganda, steps were taken to overcome this deficiency by creating equipment and activity kits designed to accompany the appropriate units. Support for this endeavor, however, was often dependent on non-project sources.

h. Distribution limitations restrict implementation of APSP materials. Even when schools have ordered materials from governments who have printed the curriculum units, evidence exists that these orders have not been filled. In some cases, it was reported that the lapse of time could be over one year between placement of the order and delivery of the material. The only effective distribution currently operating is through the workshops. Participants receive materials which they take directly back to their schools, where they can be put to use immediately.

#### Recommendations

44. Increase widespread distribution of currently available APSP materials as soon as possible. This can be accomplished by utilizing SEPA as a centralized distribution agency as SEPA presently has film positives of all APSP units from which copies can be made. In addition, a second set of film positives is available through the SEPA office in Accra, which can be

loaned to any participating country which wishes to produce its own materials locally. Not only would this distribution expand the services of SEPA in improving primary school science education, but it would also add to the cash flow of the organization, providing the Secretariat with program and fiscal management experience as a by-product of this effort. If there are APSP units unsuitable for use in some countries, then alternate SEPA units can be developed and offered to that country.

45. Increase the production of supplementary equipment required by some APSP materials. This equipment should be inexpensive and available for distribution in a manner similar to the APSP units. The procedures used in Tanzania, for creating activity kits which included articles such as crayons, paper cups, corks, and similar simple items, could be followed elsewhere. This program, as in the previous recommendation, could perhaps be handled through SEPA. Another alternative would be to produce the materials necessary to build equipment, such as fish tanks of plastic bags and wood frames, which could be assembled by teachers during in-service training workshops and then taken back to their classrooms.

46. More effective distribution plans should be developed by individual countries. If the materials are to be made available to interested countries, then more effective distribution plans must be established in cooperation with the appropriate agencies within these countries, such as the Ministry of Education or a science center. It is ineffective to develop innovative materials, train personnel, then have the effort diffused by the lack of effective distribution in the implementation process.

47. Initiate further activities leading to syllabus revisions in order to increase additional implementation. The educational system in Africa precludes teaching much content, beyond a limited trial basis, which is not included within the approved syllabus. In the upper primary grades, additional efforts should be made, perhaps through the influence of SEPA, to expand the modifications necessary to implement APSP. This action is especially appropriate when the APSP units have been adopted successfully in the lower primary grades and this success can then be used as an incentive for expansion into upper primary grades.

#### 4. Evaluation Expertise

##### Conclusions

a. Although given consideration throughout the project's history, it is the opinion of the evaluation team that insufficient progress was made in the conduct of evaluation and in the development of evaluation expertise. It was not until as late as 1967, for example, that Dr. Yoloye began the coordinate evaluation activities and directed them toward specific goals. His first task was to clarify APSP goals for project participants. Following that, some evaluation studies were conducted during the last few years of the development phase. These seemed to have contributed little toward project goals, but were instead designed primarily to "inform the producers themselves of the worth or otherwise of what they are producing." (Final Report [EDC] Beginning Science Curriculum, 1 December 1971, p. 54.)

b. Current evaluation activities within the APSP countries is informal and very limited. For example, following the experimental use of APSP materials in Ghana, teachers are requested to complete questionnaires relating their experiences and then return them to the Elementary Science Unit. Science organizers in Ghana receive additional information about program implementation through informal discussions with teachers using APSP. In Liberia, the first in-service workshop preparing teachers to use APSP materials requested similar feedback. None of these procedures, however, seems to have produced the necessary evaluation information. No evidence of any such feedback was noted by the evaluation team in Kenya, Tanzania, or Uganda.

c. A Training and Evaluation Center at Ibadan University, Nigeria, has been established under Carnegie Corporation sponsorship for a one-year exploratory period to test evaluation ideas. Emphasis will focus on training and research. A six-month evaluation course is currently in progress. The results of such a program cannot be assessed since the evaluation team did not visit Nigeria. The establishment of such a center is a positive step toward creating a framework within which evaluation can become an active component of curriculum implementation.

### Recommendations

48. Include evaluation as a higher priority component for all future APSP implementation and development. Procedures must be established for evaluating the materials currently in classroom use, and for those being prepared for future use in both the classroom and for teacher training.

49. Utilize the services of the newly created Training and Evaluation Center by developing a package of easily-used evaluation materials. The evaluation experts at the Center should direct the creation of a set of evaluation instruments by participants in a training course at the Center. Workshop participants in each country can later use these instruments to collect data regarding national program implementation.

50. Use personnel trained in evaluation expertise for that purpose in their own country. Any individual participating in evaluation training should be guaranteed a position upon return specifically related to the newly-acquired evaluation skills. If this is not guaranteed, the training should not be provided.

### 5. Project Administration

#### Conclusions

a. All five project contractor personnel in the field were interviewed. Each individual displayed keen interest, commitment, and dedication to his assignment. Their previous professional experience relevant to current APSP activities is commendable. Both members of the institutional organization are Africans with prior experience in science education. The SEPA Science Educator has been associated with the development of science education materials for primary school students since the early 1960's and was involved in the planning phases of APSP before joining the project in 1965. The Executive Secretary's experience in science education ranges from that of classroom teacher in a secondary school to a specialist lecturer in science education at Njala University College in Sierra Leone during the time of the establishment of the science center at Njala. The remaining three field personnel provided technical assistance to the program during the development phase which has continued through to the implementation phase. This link assisted in the uninterrupted of program activities from one phase to another.

b. The Executive Secretary of SEPA served as Acting Executive Secretary before assuming responsibility for the direction of SEPA in 1971. His qualifications for and interest in this program are discussed in the background section of this report and in the section on regional institutions, where his success in institution building efforts are emphasized.

c. The current Project Director in the EDC home office has held this position since the inception of APSP in 1965, a strong element in insuring consistency of direction and continuity of activities. His qualifications for this position are discussed in the background section of this report. His ability to demonstrate flexibility to changing field conditions appears in the implementation phase as witnessed by the reassignment of one member of the field staff to a country where considerable effort had been directed toward development and implementation of APSP.

d. There appears to be no formal periodic reporting procedure from the field staff to the home office. Home office knowledge of specific plans and activities is thus not always up to date. Periodic field visits, and unscheduled correspondence, seem to be the primary source of information about project plans and activities.

e. There was no evidence in the field of an appropriately detailed work plan outlining specific targets to be achieved within specific time frames. The field staff seemed very responsive to local needs, which independently is a positive characteristic, but which may not necessarily result in the satisfaction of specific contractual obligations. The absence of a detailed work plan or, an indication of knowledge by field personnel of specific contractual responsibilities, limits full and timely achievement of contract goals.

f. There is no resident field administrator. The absence of such a person reduces coordination of field staff activities. The presence of an on-site administrator would facilitate planning activity directed toward timely achievement of project goals.

## Recommendations

51. Continue the support of the existing personnel. No apparent reasons exist for the replacement of any current personnel. The preceding recommendations regarding expansion of SEPA services require simultaneous manpower expansion to help this organization continue its institutional development. For example, a full-time teacher training or curriculum developer would broaden the SEPA base of activities useful to participating countries. The SEPA Secretariat should be assured of sufficient administrative and clerical field support so that most efficient use can be made of SEPA's technical field personnel.

52. Create a mandatory periodic reporting system from the field. In order to be cognizant of ongoing field activities, each field staff member should be required to submit a weekly report of past activities and immediate future plans to the home office. Not only does this establish regular communication channels, but knowledge of these activities permits corrective action to be taken by the home office when needed.

53. Require each field staff member to submit an action plan of targets, with appropriate time frames, from the present until the end of the current contract. Unless such action is taken, it is difficult to assure completion of all project targets within the implementation phase. By creating a detailed scope of work, not only will a frame of reference relative to contract goals be established, but the home office will have an awareness of planned field activities which can be compared to the weekly reports.

## 6. Institutional Structure

### Conclusions

a. The goal of establishing the Science Education Programme for Africa as an independent and self-supporting regional organization within the two-year target period (i.e., by mid-1972) has not been met.

b. Remarkable progress, however, has been made toward this goal. This is reflected by evidence such as the following: SEPA is presently a functioning regional organization, though not fiscally and professionally viable; the organization has a formally adopted Constitution, a Representative

Council, an Executive Committee, and a Secretariat; and there are no non-Africans in the Secretariat, on the Representative Council, or on the Executive Committee. Staffing of SEPA is fully African. Both the Executive Secretary and the Science Educator are Africans; these individuals are well educated and highly competent persons with years of experience in the field of education.

c. Significant progress toward financial independence has been made by SEPA: several African nations have paid assessments; these assessments recently have been increased by the Representative Council; funds from two non-AID donors have already been received; and the Executive Secretary of SEPA is actively engaged in an aggressive program to solicit funds from other donors.

d. SEPA has five full members (Ethiopia, Ghana, Kenya, Liberia, and Sierra Leone) and two who are merely awaiting the formality of Representative Council approval (The Gambia and Nigeria). Formal statements supporting SEPA in principle have been received from Lesotho, Swaziland, Uganda, and Zambia.

#### Recommendations

54. Continue funding SEPA and a few of its programs, through the contractor, until approximately mid-1974. This will give the Executive Secretary the additional time he needs to secure further funding from SEPA's member nations and to continue his already successful efforts to increase SEPA membership. It also will allow him to continue his pursuit of funding from other donors and give him time to plan his detailed program while he receives advice and support from both the contractor and AID.

55. Contingent upon obtaining its formal legal status, fund a few small- and medium-sized programs by direct grants to SEPA prior to mid-1974. SEPA presently has no formal legal status, as this depends upon certain legal formalities yet to be taken within Ghana. This formal legal action is anticipated in the near future. The Executive Secretary of SEPA has prepared a paper for prospective donors, "The Science Education Programme for Africa and Science Education in Africa," which lists projects having a variety of size, term, and purpose. Their costs range from \$260 to \$65,000. Immediate

support of a number of these would give the SEPA Secretariat its needed support, and allow the Secretariat to continue to develop project planning, project management, and fiscal control skills necessary for management of the large program envisioned. (The Executive Secretary expects SEPA's expenses to increase from its present annual cost of about \$170,000 to between \$250,000 and \$300,000 within five years.)

56. Directly fund further SEPA activities after mid-1974, assuming successful program and fiscal management of AID and other funds subsequent to that time. By then SEPA should be receiving considerable funds from member nations and from other donors. It is not expected, however, that these additional funds will cover all of SEPA's annual operating expenses by mid-1974. AID should plan to contract directly with SEPA through at least the end of fiscal year 1976. During the forthcoming years, it would be expected that SEPA's prior relationship with the present contractor would be continued by some of the SEPA program activities being sub-contracted to EDC. This would provide valuable program continuity, at least through the first year or so of SEPA's independence.

## Appendix A.

### PERSONNEL INTERVIEWED

The following list includes the names and positions of the 47 persons interviewed regarding their formal association with the African Mathematics Program and the African Primary Science Program. A brief description of each person's responsibilities with respect to AMP or APSP is also provided. The list does not include the many headteachers, classroom teachers, and Ministry of Education officials also interviewed. Many of these were only indirectly involved with the programs, but often provided useful insights into the functioning and impact of AMP and APSP. In addition to persons in this list, the evaluation team also held numerous discussions with Department of State personnel at AID/Washington, overseas AID Missions, and U. S. Embassies.

#### 1. Mathematics

##### A. Ethiopia

1. Dr. Roy Dubisch  
Mathematics Editor/  
Educator  
East African Regional  
Mathematics Program  
(EARMP)  
Addis Ababa

Dr. Dubisch serves as both the Mathematics Educator in Ethiopia and EARMP Mathematics Editor. As Mathematics Educator, Professor Dubisch conducts the in-service training programs for the primary school supervisors and teacher training tutors. He directs the correspondence course taken by these participants and follows up this activity with periodic field visits. As EARMP Mathematics Editor, his chief responsibility is to edit the teacher training texts produced during the 1971-72 summer workshops and to develop Volume III, a guide to the classroom teaching of Modern Mathematics. His extensive association with AMP includes membership on the Steering Committee, predecessor committee to the EARMP and WARMP Management Committee, and participation in the development and implementation of AMP in African countries.

2. Ato Makonnen Eunatu  
Program Administrator  
East African Regional  
Mathematics Program  
(EARMP)  
Addis Ababa  
Ato Makonnen, the EARMP Program Administrator, is responsible for maintaining contact between the Kenyan and Ethiopian members of the EARMP Management Committee for reporting program activities to the director at EDC. He documents proceedings of the semi-annual Management Committee meetings, records EARMP budget-institutes and writing workshops. His previous administrative experience included 20 years in Ethiopian government service.
3. Ato Kebede Frisenbet  
Ministry of Education  
Chief Expert, Curriculum and Textbook  
Production  
Addis Ababa  
The production and distribution of textbooks, prepared at the mass media section of the Ministry, is the primary responsibility of Ato Kebede.
4. Ato Getachew Mekuria  
Ministry of Education  
Chief Expert, Head of  
Teacher Education  
Addis Ababa  
Ato Getachew coordinates both pre-service and in-service teacher education in Ethiopia. He supports the use of EARMP teacher training texts and relies on EARMP activities to supplement his teacher training efforts. He also serves on the EARMP Management Committee.
5. Ato Girma Mengistu  
Ministry of Education  
Head of Mathematics,  
Curriculum and Text-  
book Production  
Addis Ababa  
Ato Girma heads the Curriculum Committee to revise the mathematics program in Ethiopia. He has been instrumental in redesigning the scheme of work and revised mathematics syllabus for Grades 3 to 12. He was also actively involved in the earlier Ethiopian adoption of Entebbe Primary 1 and 2 which was translated into Amharic and is currently being used in Ethiopian schools.
6. Ato Yohannes Menkir  
Haille Selassie I  
University  
Mathematics Department  
Management Committee  
Addis Ababa  
A long-time associate of AMP, Ato Yohannes served on the Steering Committee of AMP and was also a participant in several workshops and institutes. Although his current university position has reduced his level of activity, he continues his activities in AMP as a participant in the EARMP Management Committee meetings.
7. His Excellency  
Ato Million Neqneq  
Minister of State  
Ministry of Education  
Addis Ababa  
A prime decision maker in Ethiopian education, His Excellency has taken an active interest in teacher training and curriculum development. He is involved in the newly formed Academy of Pedagogy which is being established to train teacher trainers.

8. Dr. Ayalew Silassie  
Ministry of Education  
Manager, Curriculum and  
Mass Media Section  
Addis Ababa

Dr. Ayalew holds a high ranking position in the Ministry. He is very knowledgeable about the educational system in Ethiopia and is a prime decision maker in the implementation of new programs and personnel placement within the curriculum section. He serves as Chairman of the EARMP Management Committee meetings which are held in Ethiopia.

B. Ghana

9. Mr. S.T. Addu  
Mathematics Education  
Officer  
Somanya District

A District Education Officer, Mr. Addu is responsible for overseeing the teaching of mathematics in primary and middle schools in his rural area.

10. Mr. D.A. Brown  
Program Administrator  
West African Regional  
Mathematics Program  
(WARMP)  
Accra

Mr. Brown served the Ghanaian Ministry of Education for 20 years preceding his recent retirement. At the time of his retirement he held the position of Permanent Secretary for Education. As Program Administrator for WARMP, Mr. Brown documents budgetary information, records minutes of the semi-annual Management Committee meetings, arranges for the writing and training workshops, and reports ongoing project activities to the AMP Director at EDC. He is responsible for current WARMP activities in Ghana, Sierra Leone, and Liberia.

11. Mr. E. Blaze Dogbe  
Senior Education Officer  
Curriculum Research and  
Development Unit  
Ministry of Education  
Accra

Mr. Dogbe is Head of Mathematics Section of the CRDU and is responsible for the Unit's activities in mathematics for primary schools and teacher training institutions. He also serves as a trainee mathematics editor for WARMP and has served as an instructor during several WARMP training institutes.

12. Mr. Roger Hartman  
Mathematics Editor  
West African Regional  
Mathematics Program  
(WARMP)  
Accra

Association with AMP began for Mr. Hartman in 1967. At that time he was a Peace Corps Volunteer in Ethiopia and was assigned as an editor of the Entebbe primary materials. After completing this two-year assignment, he returned to the United States. Two years later he was hired by EDC and assigned to Accra to work for AMP. His responsibilities at Accra, which began in 1971, include editing manuscripts developed at the summer workshops, assisting in their production and distribution to the pilot schools for aiding in the feedback from the field test as a basis for revision, and preparing camera-ready copy of the WARMP texts.

13. Mr. John T. Norris  
Mathematics Educator  
West African Regional  
Mathematics Program  
(WARMP)  
Accra

The first association of Mr. Norris with AMP was in Liberia during 1965-1967 when he worked as a Peace Corps Volunteer. He is presently responsible for planning and conducting training workshops for tutors at teacher training colleges, and for supervisors of the public schools in most of Ghana. The workshops are supplemented with a correspondence course and follow-up visits by Mr. Norris to the participants' own institutions.

14. Mr. G.K. Nyinaku  
Mathematics Tutor  
Mount Mary Teacher  
Training College  
Ghana

Mr. Nyinaku has been at Mount Mary since 1951, after completing a year in Great Britain on a mathematics scholarship. He is one of the more senior mathematics tutors in Ghana, and has attended several AMP institutes. However, he is not in the current two-year program for mathematics tutors.

15. Dr. Robert A. Yawin  
Curriculum Research and  
Development Unit  
Ministry of Education  
Accra

As a Peace Corps Volunteer working with the CRDU, Dr. Yawin provides assistance in the preparation of mathematics curriculum materials and in the conduct of in-service training of CRDU personnel.

C. Kenya

16. Mr. John C. Fitzgerald  
Ministry of Education  
Inspector (Mathematics)  
Secondary Schools  
Nairobi

Mr. Fitzgerald is an experienced educator who is now responsible for conducting the in-service workshops for Kenyan primary school tutors and inspectors, supervising the correspondence course taken by workshop participants, and periodically visiting Kenyan school districts. He has also assisted in the development of the EARMP teacher training materials.

17. Mr. Isaac Hunja  
Ministry of Education,  
Inspectorate  
Acting Chief Education  
Officer for Education  
Nairobi

Mr. Hunja, in a key decision-making position at the Ministry of Education, is committed to both the philosophy and approach of the mathematics and science programs. In his current position, he works with KIE personnel to provide training for school inspectors through in-service workshops. He represents the Inspectorate on the mathematics panel at KIE. He participated in the development of the Entebbe Mathematics Series and currently serves on the Management Committee of EARMP, serving as Committee Chairman when meetings are held at Kenya.

18. Dr. Ed Jacobsen  
University of Nairobi  
Department of Education  
Nairobi

Dr. Jacobsen is a UNESCO appointee at the University of Nairobi who is responsible for training university students to be mathematics teachers in secondary schools. He has participated in the in-service training programs by lecturing the tutors and supervisors. He also serves on the mathematics panel at KIE.

19. Mr. Peter Jones  
Kenya Institute of  
Education (KIE)  
Secondary Maths Section  
Nairobi

Mr. Jones is revising the current secondary mathematics curriculum into the School Mathematics of East Africa program.

20. Mr. Joe Norris  
Ministry of Education  
Inspector (Mathematics)  
Secondary Schools  
Nairobi

As mathematics inspector of secondary schools, Mr. Norris supervises the mathematics activities in Kenyan schools and has an important policy determining role. He therefore is influential in the selection of curriculum materials used in the schools. He has made some recommendations regarding the EARMF teachers' training manual.

21. Mr. Dilbag S. Pfull  
Kenya Institute of  
Education (KIE)  
Primary Maths Section  
Nairobi

Currently responsible for the revision of the primary mathematics curriculum into KMP, Mr. Pfull's responsibilities also include the writing, proofing, preparation of graphics materials, and layout of all student and teacher curriculum materials.

D. Liberia

22. Mr. P.C. Agrawal  
UNESCO Expert  
Kakata Teacher Training  
Institute  
Kakata

Mr. Agrawal serves as technical advisor in mathematics education and consults the newly formed Committee for Elementary Schools in mathematics. He also prepared syllabus revisions for primary and secondary mathematics in Liberia.

23. Dr. Doris Banks-Henries  
Director of Higher Educa-  
tion & Textbook Research  
Coordinator of Social  
Studies & Mathematics  
Ministry of Education  
Monrovia

Dr. Banks-Henries is a key decision maker at the Ministry in many educational areas. She has participated in several AMP institutes and supports this approach to the teaching of mathematics.

24. Dr. Romanus Ohuche  
Mathematics Educator,  
Teachers College  
University of Liberia  
Monrovia
- In Liberia, Dr. Ohuche serves as Chairman of the Secondary School Textbook Committee. He has participated in many AMP Institutes and teacher training workshops. Dr. Ohuche served on the WARMP Management Committee when he was a faculty member at Njala University in Sierra Leone.
25. Mr. Solomon Russell  
Mathematics Department  
University of Liberia  
Monrovia
- Mr. Russell attended two workshops sponsored by WARMP to revise the materials for secondary school mathematics. As a leading mathematician in Liberia he is a member of the Curriculum Committee for Elementary Schools. He also serves on the WARMP Management Committee.
26. Mr. T.B. Snoh  
Chairman, Mathematics  
Department  
Kakata Teacher Training  
College  
Kakata
- Mr. Snoh has participated in various AMP Institutes since 1962 and is participating in the WARMP training program for tutors at teacher-training institutions. He teaches about 50 percent of the teacher training candidates in Liberia and is Chairman of the Curriculum Committee for Elementary Schools.

E. Sierra Leone

27. Mrs. Olive Benjamin  
Headmistress  
Akibo Bette School  
Freetown
- Mrs. Benjamin participated in several Entebbe workshops and the ABC Institute Program. In addition to her current responsibility as headmistress, she is a participant in the WARMP curriculum development workshops. Her school has been selected for a field test of the new WARMP materials.
28. Mr. Julius Jonah  
Chief Science and  
Technical Officer  
Ministry of Education  
New England
- Mr. Jonah has participated in several Entebbe writing workshops. He represents the Ministry on the WARMP Management Committee.
29. Dr. J.E.M. Taylor-Pearce  
Acting Chief Education  
Officer  
Ministry of Education  
New England
- A participant in the Entebbe writing workshops, Dr. Taylor-Pearce supports the use of modern mathematics textbooks in the schools in Sierra Leone. He will serve on the recently-formed Curriculum Committee to select textbooks for Sierra Leone.
30. Dr. Awadagin Williams  
Professor of Mathematics  
Fourah Bay College  
Freetown
- Dr. Williams' association with AMP began in 1964, when he was a participant in the writing workshops. He continues to support the introduction of new mathematics in Sierra Leone by leading WARMP summer workshops and serving on the WARMP Management Committee.

## 2. Science

### A. Ghana

31. The Honorable Samuel Adu-Ampoma  
Ghanaian High Commissioner to Kenya  
Nairobi
- Mr. Adu-Ampoma formerly served as Principal Education Officer and Head of the Elementary Science Unit at Accra. During the time he held those positions, he compiled the science textbook series currently used in the middle schools in Ghana. He has consistently encouraged improvement of science teaching in Ghana through APSP and other programs.
32. Mr. E.O. Adu-Gyamfi  
Ministry of Education  
Science Educator  
Elementary Science Unit  
Accra
- Since 1961, Mr. Adu-Gyamfi was a member of the group who prepared science materials for the middle schools in Ghana. He currently works in the ESU to further develop curriculum materials for primary schools.
33. Mr. E.K. Appau  
Ministry of Education  
Science Organizer  
Elementary Science Unit  
Accra
- Mr. Appau regularly visits the elementary schools within Accra. His duties include holding follow-up meetings with the teachers who have been oriented in the use of APSP units, working in the schools to assist in the expanded use of APSP, and cooperating with other science organizers at the Elementary Science Unit to develop new units.
34. Dr. Hubert Dyasi  
Executive Secretary  
Science Education  
Programme for Africa  
(SEPA)  
Accra
- Dr. Dyasi is the chief administrative and executive officer of SEPA. He is responsible for preparing program activities, supplying personnel and materials requested by member countries which contribute to science education among the English-speaking African countries, and obtaining financial support to continue SEPA operations beyond termination of the current EDC funding.
35. Miss Edna Y. Opoku  
Science Educator  
Ministry of Education  
Elementary Science Unit  
Accra
- Miss Opoku serves as a liason between the Elementary Science Unit and the teachers in her school district. She works with the science organizers to conduct in-service training meetings for elementary science teachers.
36. Mr. Michael Savage  
Science Educator  
Science Education  
Programme for Africa  
(SEPA)  
Accra
- Mr. Savage participated in APSP from 1962, developing many APSP units and conducting both writing and training workshops throughout Africa. He currently works at SEPA headquarters with Dr. Dyasi, planning and directing SEPA's national and international conferences and workshops for science educators, teachers, and curriculum developers.

37. Mr. James Seawell  
Science Educator  
Ministry of Education  
Elementary Science Unit  
Accra

Mr. Seawell, an EDC employee, provides assistance in establishing the Elementary Curriculum Science Unit. He works with the science organizers to develop human resources through increased teacher training and the development of additional teacher units.

38. Miss Margaret Tawia  
Principal Education  
Officer  
Ministry of Education  
Elementary Science Unit  
Accra

A former teacher training college instructor, Miss Tawia participated in a number of EDC sponsored workshops. She developed APSP units and received training in their use. In her current position, she supervises 18 science organizers in the Elementary Science Unit who work directly with elementary school teachers in Ghana to assist them in using APSP units.

B. Kenya

39. Dr. Eugene Godfredsen  
EDC Science Educator  
Kenya Institute of  
Education (KIE)  
Nairobi

Teacher training is emphasized by Dr. Godfredsen in his work at KIE. He serves as a technical advisor to members of the science section in assisting them to organize and conduct in-service workshops. He is currently attempting to initiate a tutor training program to improve the existing capability of teacher trainers. Prior to his arrival in Nairobi in 1972, Dr. Godfredsen served for six years in the Institute of Education at Dar es Salaam, Tanzania, as a technical advisor to Tanzania in creating a curriculum development capability and in building a teacher training program.

40. Mrs. Lucy W. Ndegwa  
Head, Science Section  
Kenya Institute of  
Education (KIE)  
Nairobi

As head of the science section, Mrs. Ndegwa is responsible for curriculum development activities and in-service training in both the primary and secondary schools. She serves on the curriculum panels which select materials for classroom use, and she frequently leads in-service seminars and prepares guidelines to help teachers conduct classroom activities. Her work is closely coordinated with the Science Educator posted in Nairobi.

41. Dr. Doug B. Seegar  
Science Educator  
National Institute of  
Education  
Makerere University  
Uganda

During his two-year tour in Uganda, Dr. Seegar concentrated on securing the adoption of a science syllabus which focused heavily on APSP materials. He also organized and conducted teacher training workshops and institutes. At the conclusion of his tour, he was teaching at the Institute of Education, where tutors were trained.

42. Mr. John W. Steward  
Ministry of Education  
Science Inspector,  
Secondary Schools  
Nairobi

Mr. Steward's primary responsibility is in supervising secondary school activities related to science teaching. He supports the APSP approach but has little decision-making power in promoting curriculum reform in the primary schools.

43. Miss Grace Wokabi  
Primary Science Section  
Kenya Institute of  
Education (KIE)  
Nairobi

Miss Wokabi works closely with the supervisor of the science section in planning in-service institutes and workshops. Prior to joining the KIE staff, she was a tutor in a teacher training institution.

C. Liberia

44. Dr. Theodora Ward  
Jackson  
Director of the Science  
Center  
Professor of Physics  
University of Liberia  
Monrovia

In addition to participating in many APSP workshops, Dr. Jackson has been instrumental in the establishment of a science center at the University of Liberia. She is responsible for conducting training workshops for teachers of primary school science.

45. Mrs. Louise C. York  
Science Educator,  
Teachers College  
University of Liberia  
Monrovia

Mrs. York assisted in the establishment of the science center in Liberia and helps conduct the workshops held at the center. She also serves on the Executive Committee of SEPA.

D. Sierra Leone

46. Mrs. Innocent D. Gomes  
Inspector of Schools  
Ministry of Education  
New England

Mrs. Gomes attended a workshop at Njala University in 1967 where the APSP materials were demonstrated and distributed. As school inspector for the western sector of Sierra Leone, she supervises the implementation of APSP units in 20 pilot schools in the Freetown area.

47. Dr. Victor O.I. Johnson  
Deputy Director, Educa-  
tion Officer  
Peace Corps  
Freetown

Dr. Johnson was a Research Fellow and a member of the science center at Njala, where he worked closely with Dr. Dyasi. A strong advocate of the discovery/activity approach to teaching, he has been very influential in introducing this approach through his role as a Peace Corps consultant to in-service workshops. Since his recent appointment as Deputy Director of the Peace Corps, Dr. Johnson is responsible for planning Peace Corps activities in education, in cooperation with the Ministry of Education.

