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Report of the Committee on International Cooperation in
Mathematics Education in the African Mathematics Program

September 16, 1969

CONTENTS

I.	Introduction	1
II.	Procedures of the Evaluation	4
III.	Evaluation Procedure 2 - Testing	8
IV.	Textbook Evaluations	12
V.	Field Observations	15
VI.	Summary of Conclusions and Recommendations	17
Appendix A:	Testing Results	A1
Appendix B:	Dr. Vogeli's Report on Visit to Mombasa, Dar es Salaam, and Nairobi	B1
Appendix C:	Dr. Springer's Report on the Trip to Ghana	C1
Appendix D:	Dr. Pollak's and Dr. Young's Summary Report ..	D1
Appendix E:	Dr. Pollak's and Dr. Young's Report on Kenya	E1
Appendix F:	Dr. Pollak's and Dr. Young's Report on Tanzania	F1
Appendix G:	Dr. Pollak's and Dr. Young's Report on Uganda	G1
Appendix H:	Dr. Pollak's and Dr. Young's Report on Ethiopia	H1

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TECHNICAL REFERENCE
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Report of the Committee on International Cooperation in
Mathematics Education in the African Mathematics Program.

September 16, 1969

I. Introduction

The Committee on International Cooperation in Mathematics Education of the Conference Board of the Mathematical Sciences consists of representatives of each of the societies of the Conference Board. These committee members, selected because of their involvement in international activities in mathematics education, were given the commission to determine the manpower supply and demand for projects in mathematics education both in the USA and abroad.

The members of the Committee are:

Dr. William F. Atchison, Director, Computer Science Center, University of Maryland, College Park, Maryland, representing the Association for Computing Machinery.

Dr. Edward G. Begle, Professor of Mathematics Education and Director, School Mathematics Study Group, Cedar Hall, Stanford University, Stanford, California, representing the Conference Board of Mathematical Sciences.

Dr. W. L. Duren, Jr., Professor of Mathematics, University of Virginia, Charlottesville, Virginia, representing the Mathematical Association of America.

Dr. Julius H. Hlavaty, President of the National Council of Teachers of Mathematics, 250 Coligni Avenue, New Rochelle, New York, representing the Conference Board of the Mathematical Sciences.

Dr. Burton W. Jones, Professor of Mathematics, University of Colorado, Boulder, Colorado, representing the National Council of Teachers of Mathematics.

Dr. Gottfried Noether, Professor of Statistics and Chairman of the Statistics Department, University of Connecticut, Storrs, Connecticut, representing the Institute of Mathematical Statistics.

- Dr. George Springer, Professor of Mathematics and Chairman of the Mathematics Department, Indiana University, Bloomington, Indiana, representing the American Mathematical Society. Chairman of the Committee.
- Dr. Donald Thomsen, Jr., I.B.M. Professional Activities, Armonk New York, representing the Society for Industrial and Applied Mathematics.
- Dr. Gail S. Young, Jr., Professor of Mathematics, Tulane University, New Orleans, Louisiana, representing the Conference Board of the Mathematical Sciences.
- Dr. Bruce Vogeli, Professor of Mathematics Education, Teachers College, Columbia University, New York, New York, executive secretary of the Committee.

The following people also assisted with the activities of the Committee:

- Dr. Truman A. Botts, Executive Director of the Conference Board of the Mathematical Sciences, 2100 Pennsylvania Avenue, N. W., Washington, D.C.
- Dr. Jay Davenport, National Science Foundation, Washington, D.C. 20550
- Dr. Henry O. Pollack, Bell Telephone Laboratories, Inc., Murray Hill, New Jersey

As part of its manpower study, the Committee decided that it would make a study in depth of one program that has involved a large number of mathematicians in work abroad. At the request of the Agency for International Development (AID) for an evaluation of its African Mathematics Program, the Committee agreed to use that project for its study and to provide AID with the requested evaluation.

On June 25, 1968, the Committee met with representatives from AID. These included Mr. Clifford H. Block, Mr. Myron Vent, Mr. Thomas MacDonough, and Mr. David Laird. The AID representatives suggested that the evaluation and study of the African Mathematics Program (AMP) include the following:

1. A determination of the mathematical quality of the materials developed by writing groups.
2. An assessment of the educational quality of the materials. (They may be "good" mathematics but can they be taught by the teachers available?)

3. An assessment of the educational effectiveness of the materials. (How do the new materials relate to other subjects taught in the African schools and how has the "new philosophy" embodied in the mathematics materials affected the process of change in other areas such as the social sciences, physical sciences, etc?)
4. A determination of the present status of the project in each of the ten countries involved in the AMP.
5. An assessment of the barriers to the use of the new materials. (For example, there may be great difficulty in producing the student texts and teachers' guides; there may be a shortage of qualified teachers so that system-wide adoption in a particular country is not feasible, etc.)
6. An appraisal of the trend toward local adaptation should be made. (Are the adaptations in the "spirit" of the original, have adaptations downgraded the quality of the mathematics, have adaptations made the materials more acceptable to the local teachers, etc?)
7. An assessment of the transfer potential of the method used in preparing the materials in Africa both to other subject matter areas and to other parts of the world.

The AID group requested that an interim report be submitted by December and that the final report be ready in June of 1969. Although this did not give enough time to make as thorough a study as a program of this magnitude requires, the Committee agreed to do as much as possible within the existing limitations and to meet the deadlines set by AID.

II. Procedures of the Evaluation

As a result of the June 25, 1968, conference with AID representatives, the Committee on International Cooperation in Mathematics Education explored various procedures for conducting a study and evaluation that would provide information in the seven areas of interest cited by AID officials.

As a result of these deliberations, three kinds of evaluation procedures were developed:

1. review and evaluation of textual materials of the African Mathematics Project by distinguished mathematicians and mathematics educators;
2. administration of especially prepared mathematics tests in elementary and secondary schools in selected African Mathematics Project countries;
3. field observations and discussions with teachers, administrators, and Ministry officials in countries participating in the mathematics project conducted by visitation teams of American mathematical personnel.

Although these procedures are interconnected (for example, the evidence obtained in 1 supports conclusions in No. 2 and No. 3) they are discussed separately in this report for clarity and emphasis.

The evaluation of the AMP^p textual materials by distinguished mathematicians was undertaken in an attempt to answer partially the following two questions raised by AID officials:

1. A determination of the mathematical quality of the materials developed by writing groups.
2. An assessment of the educational quality of the materials. (They may be "good" mathematics but can they be taught by the teachers available?)

In order to obtain unbiased and internationally acceptable criticisms of the AMP texts, the Committee on International Cooperation in Mathematics Education nominated five distinguished mathematicians and mathematics educators with European affiliations. Three Scandinavian mathematicians were invited to survey and report in detail on the mathematical and educational quality of select AMP texts. A Dutch mathematician residing in the United States was invited to participate in the analysis also. Finally, a member of the Committee on International Mathematics Education with special interests in the area of probability volunteered to

conduct an analysis of the AMP materials as they relate to this area. Personnel participating in this critical analysis were as follows:

1. Reviewers for primary AMP materials

Dr. Matts Håstad
Högstigen 16
18274 Stocksund
Sweden

2. Reviewers for the AMP secondary school materials

Dr. Goran Bjorck
Department of Mathematics
University of Stockholm
Box 6701
11385 Stockholm, Sweden

Dr. Eric Kristensen
Matematisk Institut,
Aarhus Universitet
Aarhus, Denmark

3. Reviewers for probability and statistical topics within AMP texts:

Dr. Gottfried Noether, Chairman
Statistics Department
University of Connecticut
Storrs, Connecticut

Dr. Lucas N. H. Bunt
Institute for the Training of
Secondary School Teachers
University of Utrecht
Lucas Bolwerk 11,
Utrecht, Netherlands.

The results of these critical reviews are summarized in Section IV of this report.

Testing procedures designed to give some insight into the

following two questions raised by the AID group were planned and implemented by the Committee:

2. An assessment of the educational quality of the materials. (They may be "good" mathematics but can they be taught by the teachers available?)
3. An assessment of the educational effectiveness of the materials. (How do the new materials relate to other subjects taught in the African schools and how has the "new philosophy" embodied in the mathematics materials affected the process of change in other areas such as the social sciences, physical sciences, etc.?)

Thus, question 2 above was investigated both from the point of view of a survey of materials by qualified mathematicians and mathematics educators and by actual testing procedures in classrooms where AMP materials are used.

The testing program planned as a part of the evaluation was necessarily abbreviated. Because of the size of the AMP student population and variations in AMP utilization among countries, a testing program was attempted in only two countries--in Ghana and in Tanzania. AMP elementary school children in Ghana were tested as were Ghanaian children enrolled in traditional classes. In Tanzania secondary school classes of three types were tested. AMP classes were compared with traditional classes and with E. African School Mathematics classes. Testing procedures and results are discussed and interpreted in Section III of this report.

(EASMP)

The third and final evaluation procedure implemented by the Committee was the field observation of AMP classes, personnel and training programs. These field observations were designed to provide data relating to the following questions raised by AID officials:

3. An assessment of the educational effectiveness of the materials. (How do the new materials relate to other subjects taught in the African schools and how has the "new philosophy" embodied in the mathematics materials affected the process of change in other areas such as the social sciences, physical sciences, etc.?)
4. A determination of the present status of the project in each of the ten countries involved in the AMP.
5. An assessment of the barriers to the use of the new materials. (For example, there may be great difficulty in producing the student texts and teachers' guides; there may be a shortage of qualified teachers so that system-wide adoption in a particular country is not feasible, etc.)

6. An appraisal of the trend toward local adaptation should be made. (Are the adaptations in the "spirit" of the original, have adaptations downgraded the quality of the mathematics, have adaptations made the materials more acceptable to the local teachers, etc.?)
7. An assessment of the transfer potential of the method used in preparing the materials in Africa both to other subject matter areas and to other parts of the world.

Thus, question 3 was viewed both from the viewpoint of testing and observation, while questions 4, 5, 6, and 7 were answered primarily on the basis of observations by qualified personnel.

Field observations were undertaken in 3 stages---a preliminary visitation designed to collect information regarding personnel and potential sources of evaluation data; a second visitation involving actual participation in AMP activities relating to teacher education; and finally a team visitation to selected AMP countries for the purpose of collecting information from students, teachers, and officials relating to the status of and the prognosis for the African Mathematics Project, the need for and quality of local adaptations of AMP texts, the relationship of AMP materials to the educational needs and goals of the country, and anecdotal comments concerning the method and spirit of AMP as a means of stimulating educational reform.

The preliminary visitation cited above was conducted by Professor Bruce R. Vogeli, Professor of Mathematics, Teachers College, Columbia University, during the period from July 23 to August 3, 1968. The second visitation involved the participation of Professor George Springer, Chairman of the Department of Mathematics, Indiana University, Bloomington, Indiana, in a teacher education program in Ghana for the period from August 22, 1968 to September 6, 1968. The final team visitation was conducted by Dr. H. O. Pollack, Director of Mathematical Research, Bell Telephone Laboratories, Inc., Murray Hill, New Jersey, and Professor Gail S. Young, Jr., Chairman of the Department of Mathematics, Tulane University, New Orleans, Louisiana, during the period of November 6 through December 6, 1968. Professor Vogeli visited Kenya and Tanzania and participated briefly in the AMP writing session in Mombasa. Professor Springer confined his survey to Accra and its surroundings, while Professors Pollack and Young made in-depth studies of AMP projects in Ethiopia, Tanzania, Kenya, Uganda, and Ghana. The countries visited by Pollack and Young were selected by the Committee as a representative sample of AMP programs. They include countries where AMP utilization has been strong and countries where it has been weak as well as countries with substantial geographic, economic, and political differences. Reports and interpretations of the three field observations are contained in Section V of this report and documented in Appendices B through F.

III. Evaluation Procedure 2 - Testing

In order to obtain data about the pedagogical effectiveness of the AMP programs at the elementary and secondary school levels, special mathematics tests were prepared under the direction and auspices of the Committee on International Cooperation in Mathematics Education. One test was administered to elementary school children in Ghana and another to secondary school children in Tanzania.

In Ghana, classes tested were selected by Mrs. Lucy Tagoe from among elementary classes in Accra nearing the end of their fourth year of study. Of the 315 children included in the sample, 160 were enrolled in conventional programs and 155 in AMP programs.

In Tanzania, testing arrangements were completed by Mr. Albert Beninati and included 290 students divided among AMP, EASMP, and traditional classes as follows:

AMP - 99 students

→ EASMP - 93 students

traditional - 93 students

*East African
school math
program*

*School Math
Study Group*

The test administered to elementary school children was comprised of three parts. Part 1 consisted of materials extracted from a 40 item test prepared by AMP writers. Part 2 consisted of "five dots" items as used in the SMSG longitudinal study and designed to ascertain the ability of students to deal effectively with an unfamiliar mathematical situation. The "five dots" test is of importance also because it is believed that it is relatively culture free and, hence, may serve as a substitute for I.Q. measures unavailable in an African culture. The third portion of the test consisted of items designed by the Committee testing consultant to supplement specific sub-scales in part I of the test. The entire test was printed in two booklets, CBMS1 and CBMS2.

Because no information was available concerning the relative mental ability or intelligence of pupils enrolled in AMP classes in comparison with those enrolled in traditional courses, the sub-scales of the test were partitioned in a way that may cast light on the relative intelligence of the two groups. The following four sub-scales of the test

1. A-Computation whole numbers
2. D-Computation rational numbers
3. G-applications
4. L-5 dots

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are unique in that they are either treated or not treated in both programs. The first three scales are emphasized in both programs, while scale L is designed to be new to all students. The remaining scales of the test measure topics to which AMP pays explicit attention but are neglected by the traditional program. Scale C, Numeration, is an exception since no information is available concerning emphasis given it in the traditional Ghana elementary school program.

The three scales A, D, and G include topics that, on the basis of hearsay evidence, are effectively taught in the traditional Ghanaian program. Assuming that AMP pupils also master these topics well, it is reasonable to assume that traditional and AMP classes of comparable intelligence would perform equally well on scales A, D, and G. Similarly, since scale L is new to all students, an acceptable hypothesis would be that classes of comparable ability would achieve comparable scores on scale L. Thus, scales A, D, G, and L possibly can be used to establish the comparability or lack of comparability of mental abilities of the AMP sample and traditional classes. The average ratio of AMP scores to traditional scores on scales A, D, G, and L is 1.47 rather than 1.00, suggesting, at least, that the mental ability of the AMP sample was higher than the mental ability of students selected for the traditional sample. The fact that the ratio of AMP to traditional scores on scale L alone, a scale including topics new to both groups, is 1.58 further substantiates the hypothesis that the AMP sample was more capable intellectually than the traditional group. In fact, the results of scale L seem to indicate that the performances of traditional pupils on traditional scales (A,D,G) were comparable, mental ability taken into account, with the AMP performance. If the preceding interpretation of the scores on scales A, D, G, and L is accepted, then the scores on the remaining seven scales are given added meaning. As indicated in table 3 of Appendix A, the average ratio of AMP scores to traditional scores for the six scales excluding scale C is 1.83, which is significantly greater than the ratio 1.47.

These results are consistent with, but, of course, do not prove the following interpretations:

1. Students in the AMP sample on the average are considerably above students in the traditional sample in mental ability.
2. Students in the traditional sample do as well as, but not significantly better than, AMP students, mental ability taken into account, on topics relating to computation and application that are stressed in the traditional program.

3. AMP students do significantly better, mental ability taken into account, on topics stressed in AMP tests, but not in the traditional program.

This pattern is consistent with data obtained when comparing modern and traditional curricula in the United States.

Because of a lack of a culture-free instrument that measures not only mental ability but also other abilities such as special visualization that may affect achievement in mathematics, the comparison of AMP and traditional programs in Ghanaian elementary schools is inconclusive. It is absolutely essential that such instruments be developed before it will be possible to know whether AMP efforts (or for that matter any curricular efforts in cultural settings different from those in the United States) have been successful.

Unfortunately, at the time this report is being written, the analysis of the Tanzanian tests has not been completed by Professor E. G. Begle. On the basis of preliminary studies, it appears as though the results on Tanzania are similar to those on Ghana but with less difference between the three groups. In items that were unfamiliar to all three groups, the three performed similarly. The test was originally made up by Professor Robert Dillworth of California Institute of Technology to test AMP secondary school students. Professor Begle modified the test with some questions to make it more appropriate for the three groups, but it was still basically an AMP test. As might have been suspected, the AMP students did better on this AMP test. This shows that at least the African Mathematics Program is doing what it was supposed to do. It might be pointed out that none of these 10th grade students in any of the three groups did well on the questions on solid geometry, indicating that none of the three programs had covered that material by the time of the test. Professor Begle has promised to write a supplement to this report in which he will give an analysis of the Tanzania tests.

Below is a list of schools in Ghana in which the tests were given:

<u>AMP classes:</u>	OSU Presbyterian Girl's Primary School
	La-Bonne Presbyterian Primary
	Mamprobi Ebenezer A.T.C.C. Primary
	Castle Road Methodist Primary

Traditional Classes: St. Paul's Anglican Primary
Accra Semepe Boys' (I) Primary School
Accra New Town (I) Experimental Primary
Independence Avenue (I) Girls' Primary

The Tanzanian tests were given in the following schools:

AMP Classes: Marian Sec. School, P.O. Box 40, Morogoro
Kibaha Sec. School, P.O. Kibaha,
Dar es Salaam
Kazima Sec. School, P.O. Box 369, Tabora

SMP Classes: Assumpta Sec. School, P.O. Box 3041,
Moshi
Minaki Sec. School, P.O. Kisarawe,
Dar es Salaam
Karimjee Sec. School, P.O. Box 330,
Tanga

Traditional Classes: Bwiru Girls Sec. School, P.O. Box 170,
Mwanza
Ilboru Sec. School, P.O. Box 3014,
Arusha
Academic and Modern Sec. School,
P.O. Box 710, Arusha

*East African
School Math
Pro form*

Section IV. Textbook Evaluations

The evaluation of the textbooks was carried out by a group of mathematicians and mathematics educators representing several countries selected because of their neutral attitude toward the curriculum.

The evaluators were asked to concentrate on the mathematical content of the Entebbe texts. They were to consider the pedagogical aspects and the appropriateness of the material only as an incidental assignment. The material was divided into three categories for the evaluations: (a) primary, (b) secondary, and (c) probability and statistics.

The overall impressions of the texts were in general favorable. As was to be expected, each critic, after commenting that the texts made a positive impression, listed some specific criticisms after reflecting the critic's own pedagogical ideas. Some of these criticisms should be incorporated in future revisions or adaptations of the Entebbe books to improve them. However, it is clear from their reactions that the texts are mathematically sound--- indeed that they were written by competent mathematicians. The reports of each critic will be summarized below to give an idea of their reactions. The actual detailed critiques will be sent to E.D.C. to be made available when revisions or adaptations are contemplated.

Primary IV: The educator liked the treatment of inequalities and order of the numbers. He commented favorably on the use of "operations" and "machines". The early introduction of variables is good and estimation and rough calculation is taught, but could be emphasized more. Symmetry, translations, reflections, and rotations are introduced in geometry. In general, the book stresses understanding and problem solving rather than drill and memorization.

The criticism included the comment that the problems were "stereotyped and mostly rather boring". Almost all problems are presented in a few lines and deal with traditional situations which often are rather uninteresting and do not show how mathematics is applied today nor make contact with the teaching of other subjects. Almost all problems are closed in that they have a unique solution, all data needed are given and no more, etc. It would be better to introduce more open problems where pupils collect data themselves and even formulate their own problems.

The terminology relating to fractions may be confusing. He suggests letting the numbers be called "rational numbers" and letting "fractions" be the names for rational numbers. Since fractions are difficult to handle, he advises doing less on multi-

plication of fractions and spending more time on the concept of fraction and on order of fractions. Finally, he suggests that the pupils' understanding would be better if they worked with laboratory material instead of only following demonstrations on the black board. There should also be more differentiation within each class, including special exercises and sections for gifted pupils and more repetition for slow pupils. Instead of including almost nothing but problems and exercises, the book could contain parts with an easy text to read where the mathematical content is explained. Diagnostic tests could also be included.

Secondary C4. Again the two reviewers found the content "acceptable and very well written". One reviewer felt that vectors should have been introduced earlier in the text and used more extensively in the coordinate geometry and in trigonometry. He objected to the treatment of linearity in Chapter IV, since its definition depends upon the coordinate system used. The difficulty apparently arises in the identification of points and vectors. Linearity is normally defined for transformations of vectors. What the textbook should define is an affine mapping expressed in terms of coordinates.

The second reviewer was more ambitious and took time to read all four volumes of the C-texts. He gave comments on each text relating to small changes that could be made to improve the texts. He comments that his impression of the work is favorable and that the "ideas of the new mathematics are well taken care of".

Probability and Statistics. One reviewer read the probability and statistics at both the primary and secondary levels. The primary part came from Volume IV of Basic Concepts of Mathematics. His comment is that "the statistics is purely descriptive: tabular representation, graphs, averages, typically the kind of material included in every elementary statistics text some 20 years ago, but being deemphasized nowadays more and more". The probability treatment is also very unimaginative being almost exclusively concerned with equally likely cases.

The secondary C4 text contains descriptive statistics that is well done. It represents "a very imaginatively done preparation for a possible discussion of random variable, approaching statistical concepts from the point of view of population functions. The advanced mathematics also contains material on probability which "is well written and is good mathematics".

The second reviewer only commented on the probability sections of the A-level manuscript. He made the general statement that "the contents are mathematically correct and in general the explanations are very good". In places the presentation is somewhat too condensed for high school students and he suggested some additional examples and a better format.

It seems apparent that the probability and statistics at the primary level was not written by an expert in statistics but rather by the team of general writers. The material would have been better had they brought in an authority to help with those sections. On the other hand, the secondary writing teams did have such expertise available and their product reflects this advantage.

On the whole, one can conclude that the texts are mathematically sound. Experience has shown that the material is not too difficult for the African student to master. It is apparently much more relevant to their situation than any previous mathematics text, so the Africans do feel that they are well suited to the educational situation in their schools.

V. Field Observations

Dr. Bruce R. Vogeli visited Kenya and Tanzania from July 23 to August 3, 1968 for the purpose of making preliminary contacts for the Committee and preparing for the later field trip by Professors Pollack and Young. A detailed report of his visit is included as Appendix B. A summary of his observations will be given here.

The visit was made at this time in order to attend part of the last African Mathematics Workshop in Mombasa. Interviews were held with all of the African participants and most of the American participants. He found the Africans very enthusiastic about the program; they were very loyal and dedicated to AMP. Since these same people were often in influential positions in their home countries, their impartiality must be difficult to maintain. Those working on the elementary writing team were critical of the quality of some of the local adaptations being made. They also felt that there were enough suitable applications in their program to make their program appropriate to the African schools. The secondary team felt their program was appropriate to prepare the African students to enter universities, but attributed their limited use to the preponderance of British expatriates teaching in African secondary schools who naturally favor the curricula based on British programs.

The groundwork was laid with Professor R. Dilworth for the testing program in Tanzania and Ghana, and the countries which seemed most suitable for visits by the Committee's observers were suggested. Suggestions were also made for the kinds of people to be visited in each country.

The report by Dr. Vogeli then summarizes his impressions after speaking to various groups such as the African participants in AMP, expatriates, AID personnel, African professors, and government officials. He ends his report with recommendations for procedures to be used in the subsequent evaluation.

Dr. George Springer spent the period from August 22 to September 6, 1968 in Ghana where he took part in an institute for primary teachers. He also used part of his time to make preparations for the later visit by Drs. Pollack and Young. Contact was made with Mr. Frederick Gilbert of AID in Accra, various representatives of the Ministry of Education, and teachers at the Universities and the primary schools. A report of his visit is given in Appendix C. It was apparent that the AID people in Ghana did not want involvement with education. They favored a broader regional approach leaving them to concentrate on product oriented missions. The Ministry of Education was committed to a local adaptation of the AMP (Entebbe) primary series of which the first

two years were finished. They were still experimenting with the AMP and JSP (an adaptation of the British SMP) at the secondary level, both on a rather small scale. The primary teachers using AMP materials are all very enthusiastic about it and want to see the program expanded but are held back by financial and other considerations connected with lack of adequately trained personnel.

Dr. H. O. Pollack of Bell Laboratories and Professor G. S. Young of Tulane University visited Ethiopia, Tanzania, Kenya, Uganda, and Ghana between November 6 and December 6, 1968. In Tanzania and Kenya, they visited primary and secondary schools, the ministries of education, teacher training colleges, and universities. Their overall impressions and experiences are given in their reports in Appendices E and F. Their analysis of the situation and recommendations are given in Appendix D.

These particular countries were selected for the field evaluation because they were each in some sense typical. Tanzania was selected as an East African country in which AMP materials were being used at the secondary level and where adaptations of the many materials had been made to Swahili and are widely used. Kenya was selected as a country where the British expatriate secondary school teachers have advanced an adaptation of the British SMP materials and the AMP materials have not been widely accepted. In Uganda, no progress has been made introducing AMP materials at any level. Ethiopia was selected because they have been using the AMP materials widely and have an ambitious program for the general adoption of the program and training teachers. Ghana was selected as a typical West African country in which the primary materials are being used experimentally and the secondary materials are in competition with a local adaptation of the British SMP. Drs. Pollack and Young felt that the detailed review of Tanzania and Kenya gives a fairly representative picture of the situations in countries where AMP is finding support and those where they are finding strong local opposition or competition. The observations of Drs. Pollack and Young can be best read in their report. We shall summarize some of their conclusions and recommendations in the next section.

VI. Summary of Conclusions and Recommendations

1. Evaluation of Textual Materials. The reviewers of the AMP (Entebbe) books all concluded that the materials were in general mathematically sound. They each found parts which they would have done differently but mostly agreed that these were matters of taste. One reviewer objected to the treatment of vectors and transformations in the secondary geometry, but this again was largely a matter of taste.

In Africa, an objection often raised is that the program is too abstract and does not have enough applications or materials related to their needs and experience. This has been one of the main objections leveled against the AMP materials by the supporters of other programs. However, there is evidence in Tanzania (reported by Pollack and Young) that the Tanzanian officials believe the AMP to be much more practical than the traditional one it is replacing!

The general question of the appropriateness of the AMP materials for Africans is one that the Committee was not able to resolve. It may be that materials should be aimed more at vocational training rather than preparation for study at a University, but there is no unanimity in this view (in fact, the Africans would have to be convinced of this, since they have always followed the British tradition of preparation for the University) and there are no such materials available. Perhaps another program should investigate the question of the educational goals in the developing countries. It may well turn out that two separate tracks will be necessary, one academically oriented and the other vocationally oriented. When the two tracks separate is a serious problem that has to be resolved. The Committee felt that this is a very important and large scale problem affecting many areas of the world and should probably be undertaken by an international body.

It is also apparent from the classroom visits by Pollack and Young that the African pupils, at each level, seem to be capable of handling the AMP materials. However, the teachers are not yet adequately trained in large enough numbers to teach these and then is grave doubt whether the teachers' guides will really help thereinadequatley prepared African teachers. The problem of teacher training in Africa as in the USA, is one of the major obstacles to the introduction of a new and improved program.

2. Testing the pupils. Unfortunately, the testing program was not as conclusive as had been hoped for. One of the difficulties seems to be the lack of an appropriate test to measure general intelligence or mental ability. An I.Q. test must be devised to measure the general level of intelligence of the pupils in order to make comparative studies between difficult mathematics programs. In both the Ghanaian and the Tanzanian testing programs, pupils in

different schools taking different programs were tested but there was no way of comparing the general intelligence levels of the different classes to enable one to interpret whether the differences in scores were due to the mathematics program or the general level of intelligence of the pupils. The Committee felt that it would be worthwhile to develop such tests, for they would be useful for many important evaluations which should be made, not only in this mathematics study, but for many other educational experiments and programs.

It seems apparent from the tests given in Ghana and Tanzania, that the students in the AMP program are learning the AMP mathematics, so in that sense the program is doing what it is supposed to do. What has not been possible, for the reasons given above, is to get a valid comparison between the different programs. From the Ghanaian tests, it could be concluded that the primary students in the traditional program may do as well as but not significantly better than students in the AMP program (mental ability taken into account) in the topics related to computation and applications that are stressed in the traditional program, whereas, AMP students do significantly better in topics stressed in the AMP but not in the traditional program. Likewise, the Tanzanian tests, which were modified AMP tests, showed that the AMP students did better on AMP *materially* materials.

3. General Observations. The Committee discussed the dual roles that the U.S. can assume in offering technical assistance abroad in the field of education. The first is to set up pilot programs aimed at training the local mathematicians and educators to carry on curriculum reforms, educational development, teacher training, etc. The other role is the actual development and implementation of a new curriculum for a country. Apparently, there has been confusion in the minds of many of the people involved in AMP as to which of these roles they were assuming.

The Committee felt that the proper role for projects supported by U.S. government funds is the first of the two. In the long run, we have performed a greater service to a country if we train their own personnel to carry on educational reforms and let these reforms emerge from within rather than be "imposed" from abroad. The problem of implementing a new curriculum is a tremendous one that requires great resources. We have not even come close to training our own elementary school teachers to handle their "new math" because of the enormous resources necessary. It would seem that the proper approach toward the problem of teacher training is to set up a pilot program in which some local educators can see how it is done and then they act as leaders in their countries to set up an expanded program of teacher training. The same philosophy applies to curriculum preparation and revision, testing procedure, etc.

The Committee felt that there was confusion by EDC and

probably by AID in the ultimate objective of the AMP. It was started as a research effort but the actions were such that the end product was the introduction of a new curriculum in Mathematics in English speaking areas in Africa. It was agreed by members of the Committee that the program, even assuming that the objective was merely to train Africans in the process of carrying out a curriculum development project, has been left incomplete. In particular, African colleagues of the U.S. mathematicians and educators have not had the experience of revising any of the materials which were developed. Experience in the U.S. and elsewhere indicates that a writing workshop to produce new materials is only one step in a curriculum development process. Equally important is the revision-testing-evaluation of the materials based upon classroom use. Since this step has not been done in the AMP, it is important that AID support some pilot revision projects in Africa as soon as possible.

It is interesting to note that Pollack and Young report that "the Africans looked on the Entebbe project as an educational experiment in which they were partners. Yet the decision to terminate was not made in consultation with them. It has been a blow to their pride". They apparently realize the need for further classroom testing of the materials, education, and revision. As Pollack and Young point out, some of the countries involved have already committed as much money to this reform as their limited resources allow. Termination of AID support of the research phase means for most of them that they will have to dig up still more money, or lose the momentum that has been generated. Pollack and Young urge AID to re-evaluate the decision to terminate the research phase of AMP. The Committee agrees with their assessment of the situation and support most of their suggestions for the next phase of the program. These are summarized below, and can be found in Section 16 of Appendix D.

1. The Africans must participate in revising an experimental curriculum to prepare them for future self-reliance and to complete their experience in curriculum reform. This can be done on a sample basis, with two elementary and one secondary grades. The project would involve classroom experimentation, evaluation, and subsequent revision. The revision can be carried out in a manner similar to the Entebbe workshop or it can be connected with the development of the autonomous examination systems discussed in Section 9 of Appendix D. Section 16 of Appendix D also details how the classroom experimentation-evaluation-revision can be carried out.

2. Several people from each country should be brought to the U.S. to do advanced study in the field of testing and evaluation not only at such places as ETS but also curriculum development centers such as SMSG. Africans trained in this way would then form the nucleus for the local development of groups in testing and

evaluation.

3. There should be continued U.S. support of experimentation with the books written last, in the same manner as there was of the earlier books. This includes the upper secondary, A-level, and additional mathematics texts.

4. One or more high level traveling consultants should be made available to groups of countries to help with local adaptations. He should be a mathematician (rather than primarily a mathematical educator) whose main function would be to insure the mathematical correctness of the adaptations. One man could be shared among three or four countries and would be available for an academic year.

The Committee questioned the adequacy of the supply of mathematicians in the U.S. to staff such a program of assistance with local adaptations. Consultants when used for massive developments of local materials lead more toward the objective of implementing a new curriculum in a country rather than the objective of local training to solve curriculum development problems.

5. The upgrading of pre-service primary teacher training is urgently needed. In addition to the kind of help offered now by Peace Corps teaching in the schools, there is a need for pilot programs in modernizing the training of the tutors for the teacher training institutes. This will need the services of mathematical educators to help set up one pilot program per country.

6. The need for additional institutes for in-service training of primary or secondary teachers is questionable since such models have been operated by EDC for several years. At most, American personnel may be needed only until local counterparts are prepared to take over the program. The limitations on the supply of such personnel in the U.S. may make this unfeasible.

7. A concerted effort should be made to develop simple gadgetry for use in mathematics education from locally available materials.

8. A study should be undertaken by an international organization such as UNESCO to reconsider the purposes and methods of primary mathematics education in developing countries. For most of the pupils, primary school is terminal. What kind of mathematical curriculum best prepares them for the life they are likely to lead? Should the curriculum be made up primarily of local practical examples of applications of mathematics to everyday life? It is hoped that the goals of primary education in developing countries will be given serious consideration before a "second round" of curriculum revision.

Finally, some remarks should be made about the transfer

This has been done in several Math

potential of the African Mathematics Program. It is evident that AMP has formed a model for similar curriculum reforms in other subjects in African countries. For example, the new geology and history text in Ethiopia, were directly stimulated by the experience with AMP. The AMP idea of using district supervisors to propagate ideas to primary teachers and of holding conferences for secondary teachers has also been used by other fields.

The Committee has also received inquiries from groups in other non-African countries about the success of the African Mathematics Program since they were considering adopting these materials. For example, such an inquiry recently came from the Marianas District of the U.S. Trust Territory of the Pacific Islands when they were considering the Entebbe materials for adoption. Thus what has been prepared for Africa may find potential users, in other countries who may eventually make their own local adaptations.

More important than use of AMP materials outside of Africa is the use of the AMP workshop technique for producing materials. There are many lessons to be learned from the AMP experience that should be useful in planning future ventures into curriculum revisions. These include such things as the involvement of truly representative groups to avoid bitterness and ultimate factionalization. The local participants must really be made full partners in the program rather than be relegated to insignificant tasks merely to make them feel as though they were contributing something. The goal should be to train the local participants to be able to carry on subsequent curriculum revisions on their own. A careful reading of the Appendices gives insight into still other things to consider in planning a similar program. On the whole, it was one of the possible ways to effectively produce materials for use in developing countries and as such can be used as a model for other similar projects in other disciplines or in other countries.

Appendix A
Testing Results

	Item Numbers	
	<u>CBMS-1</u>	<u>CBMS-2</u>
A. Computation - Whole Numbers	2, 23, 25, 37	21, 33
B. Structure - Whole Numbers	3, 8, 10, 12, 24, 26, 27, 31, 34, 36	25, 34
C. Numeration	1, 6, 19	20, 28, 30, 31, 32, 38, 42
D. Computation - Rational Numbers	18, 39	26, 27, 35, 41
E. Structure - Rational Numbers	7, 9, 11, 14, 17, 30	
F. Number Line	5, 28	
G. Applications	15, 16, 21, 29, 38, 40	22, 23, 36, 39
H. Geometry	4, 13, 32, 35	24, 29, 40
J. Measurement	20, 22, 23	37
K. Entebbe	1 - 40	
L. Five Dots		1 - 19

Table 1.

Subscales Contained in the CBMS Fourth Grade Test

	<u>Mean</u>	<u>Standard Deviation</u>	<u>Cronbach's Alpha</u>
A.	2.800	1.670	.608
B.	3.803	2.546	.673
C.	2.870	1.731	.413
D.	1.803	1.242	.421
E.	2.135	1.268	.266
F.	0.533	0.639	.087
G.	2.568	1.844	.538
H.	2.743	1.692	.547
J.	1.136	0.892	.188
K.	12.263	6.411	.834
L.	6.863	3.480	.715

Table 2.

Scale Statistics for Total Population

	<u>Traditional</u>			<u>Entebbe</u>			<u>Ratio of Entebbe to Traditional</u>
A.	2.475	1.581	.534	3.135	1.693	.653	1.26
B.	2.406	1.678	.371	5.245	2.484	.625	2.14
C.	2.125	1.391	.182	3.639	1.711	.368	1.71
D.	1.406	1.157	.362	2.194	1.136	.328	1.45
E.	1.671	1.131	.107	2.600	1.227	.260	1.56
F.	0.321	0.497	-.182	0.703	0.674	-.007	2.19
G.	1.987	1.569	.451	3.168	1.914	.514	1.60
H.	1.968	1.277	.200	3.529	1.639	.542	1.79
J.	0.893	0.762	.029	1.355	0.942	.191	1.52
K.	8.906	4.315	.670	15.703	6.431	.829	1.77
L.	5.335	2.672	.551	8.432	3.227	.673	1.58

Table 3.

Scale Statistics for Populations Separately

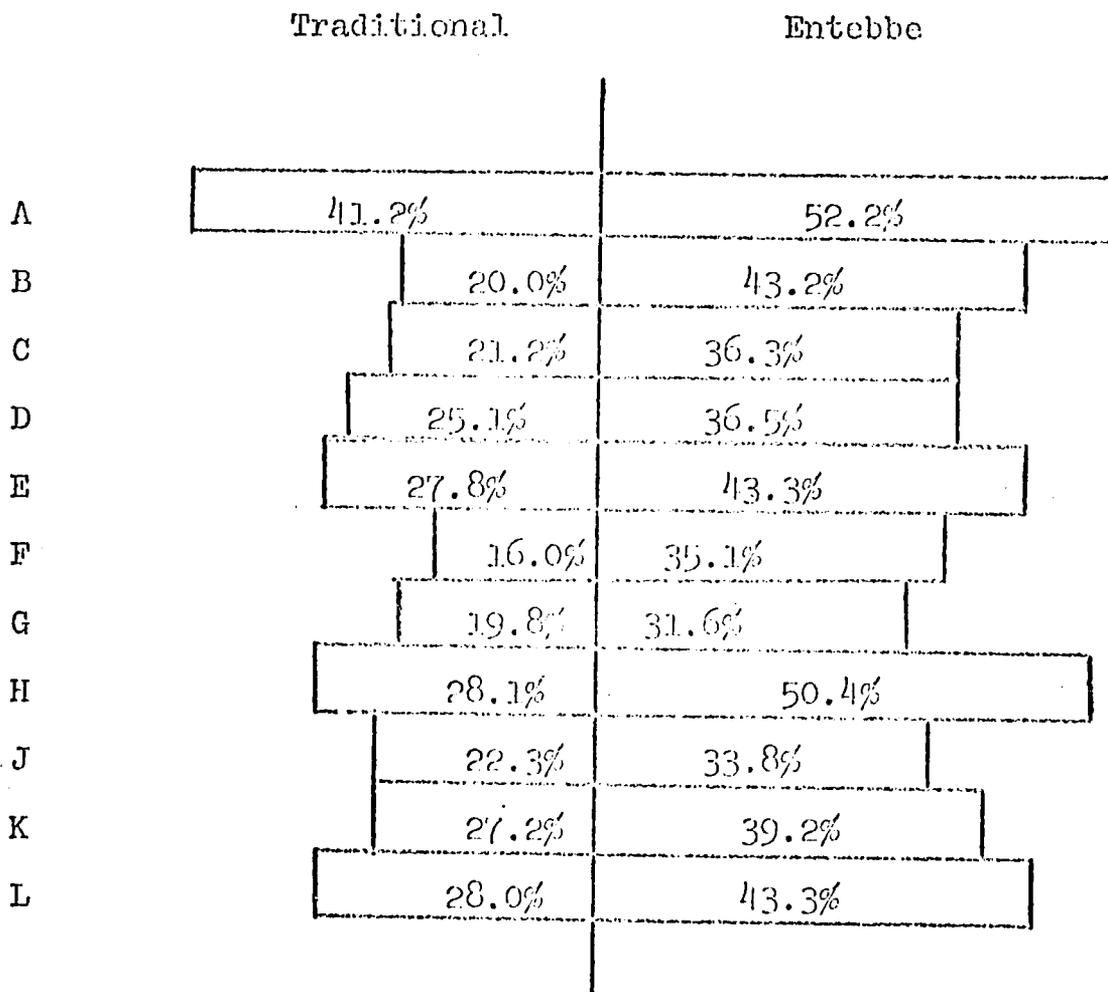


Figure 1.

Scale Scores Expressed as Percent Correct

25

Appendix B

REPORT OF VISIT TO MOMBASA,
DAR ES SALAAM, AND NAIROBI
JULY 23 THROUGH AUGUST 3, 1968

Submitted by Bruce R. Vogeli
September, 1968

General Comments

The purposes of my visit to Africa were:

- a. To meet with EDC officials and American and African workshop participants in Mombasa to obtain information regarding program implementation in participating countries, desirable procedures for evaluation, and information regarding prospective resource persons, both African and expatriate in the countries involved.
- b. To select a tentative sample of three or four participating countries to be studied in depth by the evaluation team and to visit as many of these countries as possible to gather preliminary information and to arrange for subsequent visits by the evaluation team.
- c. To identify, if possible, an African institution capable of providing assistance to the committee in appraising the appropriateness of the African Mathematics Project materials for African education and to assist the committee in placing the African Mathematics Project in an African educational context.
- d. To gather information from African, American, and expatriate mathematicians and mathematics educators regarding problems, progress, and plans for mathematics teaching in Africa.

I arrived in Nairobi on the morning of July 25, 1968, and

spoke with Mr. Carroll S. Hinman, AID Mission Director for Kenya before proceeding on to Mombasa. Hinman welcomed the evaluation of the African Mathematics Project (AMP) and promised the cooperation of his office.

The Mombasa Workshop had been in session approximately four weeks when I arrived on the afternoon of July 25. Professor William T. Martin and Hugh Bradley had planned for my arrival by scheduling appointments with various African and American Workshop participants. During a four-day stay at the Workshop, I met with every African participant and most American participants either informally or formally in group conferences scheduled by Martin and Bradley. I found Workshop participants cordial, cooperative, apprehensive, and partisan. Many Africans (and some Americans) were unsure of the purpose of my visit and, despite my explanations, seemed to view me as an AID official in disguise. The recent AID decision to discontinue funding of the experimental aspects of the AMP and the move toward regionalization of AID programs created an atmosphere of moderate suspicion. African participants wrongly may have taken my presence as an opportunity to lobby for continuation of AID project funds. Nonetheless, my conferences with participants produced both valuable information (as described in later sections) and insights into African education.

From Mombasa I traveled to Dar es Salaam where I was met and accompanied by a newly appointed AID Education Officer in Tanzania. In Dar es Salaam I met with Ministry of Education Officials, members of the Institute of Education, and faculty at University College, as described later in this report.

I returned to Nairobi from Dar es Salaam for conferences with Ministry and Institute of Education officials as well as discussions with AID, Peace Corps, and TEWA personnel. Comments on these meetings also appear in the body of the report.

Because the visit was concerned with such diverse aspects of the AMP and with African education in general, this report's organization (if it can be called that) is rather loose. I've tried to include separate sections dealing with major points. These sections are not independent since often one supports or extends another.

In lieu of compiling a country-by-country AMP status report, I have included with this report copies of the "country reports" given by African representatives at the Mombasa Workshop. These should be taken not as analytic statements but rather as progress reports by local AMP partisans.

To summarize these reports, I have prepared an "AMP utilization table" that lists the number of AMP classes in operation at present in participating countries.

The report also includes copies of or excerpts from reports, speeches, and articles that are pertinent to AMP.

The Elementary Writing Team

The elementary school writing team comprised of Clarence Hardgrove, Vincent Haag, and Shirley Hill and their African counterparts completed work on the AMP Elementary School Program within the first four weeks of the workshop and departed on July 26. Fortunately, I arrived in time to interview all of the elementary school team, both African and American. The principal work of the elementary writing group this year was to adapt the six-year elementary program to countries operating on a seven- or an eight-year elementary school schedule. Professor Hardgrove and colleagues were optimistic about the applicability of AMP elementary materials in most participating countries. Elementary writing team members stressed the importance of the teachers' guides and emphasized that their goal was the preparation of a program that could be implemented by elementary school teachers on the basis of a 2-week workshop in modern mathematics and the use of the teachers' guides. The elementary writing team seemed unanimous in the opinion that they had achieved this goal.

Elementary writing group participants complained of the tendency to water down the elementary school program by means of local adaptations. Professor Hardgrove in particular was critical of the mathematically naive adaptations in progress in Ethiopia and Nigeria. She described some of these materials as plain "trash." Apparently, the elementary writing team does not subscribe to a "step ladder" implementation of AMP texts via successive local approximations currently being touted by Hugh Bradley et al.

I questioned elementary writing team members repeatedly concerning the "appropriateness" of a rather formal elementary mathematics program in an African setting. I was especially persistent with regard to the role of applications--agricultural, economic, industrial--in mathematics programs for developing countries, citing the practical bent of the Nuffield Project as an alternative to the SMSG AMP approach. American participants were firm in their support of the AMP approach, declaring that it includes many applications. African participants sensed a need for a more practical flavor but were not always familiar with the Nuffield program or other alternatives.

The Secondary Writing Team

The secondary mathematics writing team was faced with the task of completing the advanced mathematics "A level" course within the six-week workshop. The "A level" course requires approximately two years work in most secondary schools. The secondary school writing group seemed not to be as confident that

28

the materials they were preparing were appropriate for African schools as did elementary personnel, possibly due to the rather light use of AMP secondary texts throughout Africa. Like the elementary group, the secondary team has chosen more or less an SMSG emphasis with only minor attention to applications. Secondary writers were committed to producing mathematics programs at a level sufficient to prepare students to enter colleges and universities, both in Africa and abroad. Both Africans and Americans seemed to support this view of the role of secondary education in a developing country.

The competition of the British-backed EASMP and the JMP texts was mentioned frequently and appears to be something of an irritant to both American and African secondary writing group participants. Writing group participants tend to attribute the relatively narrow use of the AMP secondary school materials to the fact that so many secondary school teachers in Africa are British expatriates, while the expatriates themselves say that AMP texts are too theoretical. While some cooperation with EASMP has been attempted at the higher echelon, it is clear that the competition between AMP and EASMP and AMP and JMP in West Africa still causes considerable consternation and irritation.

The Testing Team

Professor Dilworth, Chairman of the testing group, provided information about testing programs that had been conducted and those that are planned. In Ghana a series of elementary school tests have been administered to children in the Entebbe stream. While this testing program was designed primarily to troubleshoot the tests that the Dilworth group was preparing, the data from this trial are available and could be used to evaluate achievement in the Entebbe stream. I suggested and Dilworth concurred that a series of tests of the same kind could be given to students in the traditional stream and that these data could be meaningfully compared with data from the Entebbe stream. Professor Springer will contact Ghanaian educational officials to inquire if a supplementary testing program could be conducted in Ghanaian schools not using AMP materials.

A testing program much like this has been conducted on a very small scale in Malawi. Students in Malawi who had used the AMP text and other students who had used the traditional materials were given the same tests prepared by the AMP team and the results compared. The Entebbe group performed comparably on test items of a computational nature. The performance of the AMP students exceeded the performance of the traditional group on items that might be considered "AMP bound."

A testing program at the secondary school level was conducted a few years ago in Tanzania. Students who had studied one year from AMP secondary school materials were compared with

students who had studied one year of the traditional program and with students who had studied the SMP text for one year. The results favored SMP, traditional, and AMP in that order, if I recall. Professor Dilworth promised me summaries of testing data in all three countries. A letter that I received from him said that he had enclosed the testing data, but unfortunately it was not in the envelope, probably due to a secretarial error. I am sure that I will be able to get accurate data from him upon his return to the United States.

One suggestion might be that we retest Tanzanian students now that they have completed three years of AMP secondary school study. The same comparison as before could be attempted with these more advanced students. I discussed this matter with Tanzanian educational officials while in Dar es Salaam and received tentative approval from them for the operation. Indeed, I received a letter from Professor Phythian at University College, Dar es Salaam, last week asking for large quantities of the test we plan to use, apparently with the understanding that he would be involved in the administration of the test.

The testing situation with regard to the AMP materials is further complicated by the probability that the Cambridge examination people soon will set an "AMP paper" for East and West African secondary schools. Mr. M. B. Jones was at the Mombasa Workshop representing the Cambridge examination group for the purpose of discussing the kinds of materials that might be included in an AMP-Cambridge paper.

As part of the appendices to this report, I am including a sample of Professor Dilworth's primary examinations. The examinations are divided into two sections, each of three parts. Professor Dilworth believes Section 1 Part 1 to be unrelated to the AMP. Indeed, he suggested that Section 1 Part 1 be taken as a substitute for an ability index such as I.Q., as it is used in American schools. Section 1 Part 2 deals with the number line and is related to the AMP. Section 1 Part 3 is not highly AMP oriented. Section 2 Part 1 is straight computation and could be applied equally well to traditional and modern streams. Section 2 Part 2 is moderately AMP oriented. Section 2 Part 3 again has more or less universal application. It is Dilworth's belief that this test could be given equally well to students in the traditional and the AMP streams. Section 1 Part 1 could be used as an ability base. Section 1 Part 3, Section 2 Part 1, and Section 2 Part 3 could be used to compare achievement in the two streams. Section 1 Part 2 and Section 2 Part 2 would give some information about AMP achievement alone.

If you will examine the test closely, I think you will recognize some possible difficulties. Section 1 Part 1 deals with pouring a liquid from one vessel to another. While Professor

Dilworth considers this to be relatively culture-free as well as AMP-free, I can see some difficulties in interpreting the illustrations. A tribal child unaccustomed to working with pictures and other semiconcrete representations would be at a disadvantage in completing this kind of item. I think it would be well to get some expert advice regarding these tests and others that have been prepared by the AMP testing group. I might comment that Professor Dilworth was extremely cooperative and anxious to work with the evaluation team in any way that he could be of service.

Sample Countries

Throughout my discussions in East Africa I repeatedly raised the question of an appropriate sample of participating countries for close scrutiny by the evaluation team. Tanzania would seem to be a necessary member of the sample since it is the only country that has effectively used both the primary and secondary materials on anything like a broad scale. The Tanzanian policy has been to encourage careful trial of the AMP and the SMP materials in selected secondary schools in the hopes that at some future date a choice can be made between them. The primary school materials are in relatively wide use and adaptations of the AMP primary texts have been made in Swahili through the fifth grade. Teacher education activities also have been extensive in Tanzania.

Ghana also seems to be a likely sample candidate. Ghana has made widespread use of the primary materials and is in the process of doing its own adaptations. In Ghana the teacher education problem is focusing upon the eighty (80) training colleges that prepare elementary school teachers. Because of the availability of testing data in both Tanzania and Ghana, these countries seem to me to be definite sample candidates. The secondary school Entebbe materials are used in Ghana, but on a very small scale. A British expatriate group has established a competing secondary school program, the Joint Mathematics Project, that seems to be pulling ahead of the AMP Secondary School Program in Ghana.

I suggested to a number of individuals that Uganda might be selected as a sample country in order to include in the sample a country where AMP movement has stalled. The response to this proposal from both Africans and Americans was at best luke warm. It appears that the Uganda situation is as much a product of personalities as it is of considered pedagogical judgments.

Kenya would seem a better choice since Kenya has done something with the AMP materials, but to date their use in Kenya is minimal. While AMP resistance in Kenya was rooted in personalities some years ago, there seems to have been a considered reluctance to involve Kenyan schools deeply with the AMP materials. It should be interesting and informative to explore the dynamics of Kenyan decisions to delay and then to go forward with AMP classes.

Handwritten notes:
Suggestion
Review of
Basic program
course to CREF
to BSMP
MB
M...

Handwritten note:
not
likely

Educators are now in the process of adapting AMP primary texts for use in Kenyan schools.

It had been recommended that Ethiopia be considered as a sample country. Inquiries of African and American educators in Mombasa and with AID officials in Dar es Salaam seem to indicate that initial reports from the AID Ethiopian office reflect future plans more than actual accomplishments. While AMP has had some application in Ethiopia, large scale implementation is in the future and, perhaps, at some distance.

While Tanzania, Kenya, and Ghana can be used to illustrate the various kinds of utilization of AMP materials in larger African nations, a sample country from among the smaller, less well endowed nations would be desirable. EDC officials at Mombasa strongly recommend that Malawi be chosen as a sample country because, in spite of its limited resources and rather feeble educational program, Malawi is in the early stages of a carefully controlled and coordinated AMP implementation program that EDC personnel believe will illustrate what can be done with modern mathematics under even rather adverse conditions.

Sierra Leone was suggested also as a small nation that has had some success with modern mathematics. On the basis of conversations I have had and with due consideration of size, cooperative attitude, and degree of AMP utilization, etc., I would recommend that the sample consist of Tanzania, Ghana, Kenya, and Malawi, with consultations with educators from Uganda, Sierra Leone, Nigeria, and Ethiopia, where practicable.

Whom to See in Sample Countries

The principal educational official in African countries generally is the Permanent or Principal Secretary for Education. While a protocol call upon this official would be in order for any high level visitation team, perhaps the first visit should be with the Chief Education Officer usually the second in command under the Principal or Permanent Secretary. The Chief Education Officer is in charge of the operation of schools throughout the country and in this capacity would be the one who could give permission for the American team to visit classes, to question school officials and teachers, and in general to operate within the country's educational establishment.

Each Chief Education Officer has associated with him a person with responsibilities in mathematics. This mathematics officer could serve the evaluation team in a liason capacity and could provide the necessary school and university contacts, etc.

In addition to these mathematical officers, the team also should contact the educational planning officer within each Ministry

of Education. The planning officer should be able to provide statistical data regarding past and projected enrollments and also would be the one with whom to discuss the relation between school programs and economic objectives.

In addition to the educational officials mentioned above, I would further recommend that the evaluation teams consult with AID educational officers, exchange educators such as TEEA tutors and with American and British professors in mathematics and in various professional areas serving in African colleges and universities. I am enclosing with this report a list of names of individuals in various countries who would seem to be knowledgeable in some aspects of mathematics and mathematics teaching.

As a matter of protocol, I would suggest that correspondence with the Chief Education Officers of sample nations be initiated well in advance of any team visit. I further suggest that carbons of the correspondence be mailed to one or more of the subordinate mathematical personnel serving under the Chief Education Officer. Communications are not what they should be in Africa and it would be desirable if the mathematics person actually responsible for carrying out plans relative to a team visit be informed of the negotiations with the Chief Education Officer directly rather than trusting that the Chief Education Officer will take the subordinate into his confidence immediately.

National Commitment

In my discussions with chief education officers in Dar es Salaam and Nairobi and in talks with subordinate officials from other countries who had gathered in Mombasa, I was impressed with the national commitments to modern mathematics that had been made by Ministry officials. It is not uncommon for a chief education officer to say frankly that modern mathematics will be implemented in the schools of his country by such and such a date. In some cases they will hedge slightly on the kind of mathematics, AMP or other that will be used in the schools; however, their commitment is clear.

In further questioning, I believe I found the motivation for this kind of strong commitment. Chief Education Officers for the most part are amathematical. They rely entirely upon subordinates for mathematical recommendations. All subordinate mathematics officers that I met were former AMP workshop participants. These AMP partisans have sold modern mathematics and in some cases AMP mathematics to uninformed Chief Education Officers. While this situation in the end may not produce bad results, it certainly casts doubt upon the decision process that has led to a commitment to modern mathematics at the national level.

Visiting Schools

It appears that the problem of visiting representative AMP and traditional schools in sample countries will be more difficult than had been anticipated. Not only is it unlikely that local African teams can collect useful information, it appears impractical for American educators to attempt to visit large numbers of classes. Furthermore, unless American visitors are well oriented in African education, the cultural, educational, and mathematical "shock" that they may experience possibly will lessen their perception of advances in mathematics teaching, if advances are present. An equally important consideration would be to determine in advance a representative sample of schools. If a sample could be found, it certainly would mean visiting schools of different types in urban and in rural tribal areas. The distances involved and the travel difficulties are substantial indeed.

In view of the many difficulties associated with classroom visitations, I would recommend that we reconsider our initial decision to conduct extensive visitations in sample countries and focus instead upon a small number of classes designated jointly by Ministry and EDC officials as being outstanding examples of either AMP teaching or traditional teaching of mathematics. If performance in the best AMP classes were not up to par, serious doubt would be cast upon their applicability in average and below average situations. On the other hand, if performance in these classes were good, we could demonstrate at least an "existence proof" that African teachers can use Entebbe materials given the right training and circumstances. Case studies of successful teachers, stressing their mathematical training and experience, could provide insights into teacher education problems associated with AMP.

Using Africans as Evaluation Team Members

In the course of my ten-day visit, I had conversations with, perhaps, sixty to seventy African educators. Of this number, perhaps fifty were definitely committed to the Entebbe materials at one or more levels, had worked with them in some capacity, or were involved in a supporting role that would seriously compromise objectivity. The remaining Africans were high educational officials with little first-hand knowledge of the materials who relied solely upon the judgments of partisan subordinates. While a number of Africans indicated a willingness to assist the evaluation team by serving as members of a visitation group, frankly I did not find one African whose judgment was sufficiently objective to encourage his active participation in the evaluation. Most were already so committed to AMP that visitation reports collected by them would be uniformly positive, superficial, or both. While I do believe that it would be well for any group of

American visitors inexperienced in African schools to be accompanied by an African host who would assist them in interpreting what they saw in the classroom in an African educational context, I cannot recommend that African judgment be used in lieu of evaluation by American visitors.

African Reactions

I was very positively impressed by the sincere partisan reactions of African workshop participants in Mombasa, Tanzania, and Kenya. The esprit de corps of these partisans is as high as one would find among partisans of, say UICSM or other charismatic programs in the United States. Clearly, AMP has benefited these partisans professionally and personally. In fact, an interesting and informative facet of the total evaluation could be comprised of case studies of selected African workshop participants. These studies could document the increased responsibility and competence of African personnel brought about through participation in AMP projects and workshops. The rise to mathematical prominence of a number of African partisans has been nothing less than spectacular. Surely, the elevation of African mathematics educators to positions of responsibility via AMP participation will have long term beneficial effects upon mathematics education in Africa.

While the great loyalty and dedication of partisans to AMP is symbolic of its impact and vitality, this same spirit may cloud the judgment of partisans and reduce the validity of the advice they give to education officers who depend upon them for guidance in mathematical education. In my opinion, the "AMP spirit" is simultaneously a commendable and dangerous biproduct of a series of comradely workshops and institutes.

Expatriate Reactions

I was surprised to learn that approximately 90% of secondary school teachers in the ten African countries participating in AMP are British expatriates. Someone mentioned that, three years ago, fewer than twenty secondary school teachers in East Africa were black Africans. While I cannot vouch for the accuracy of this estimate, it is certainly true that the British play a dominant role in secondary education in their former African colonies. The reaction, therefore, of British expatriates to secondary programs is absolutely critical. To date expatriate teachers have not, as a group, been favorably inclined toward AMP. Not only have they failed to implement AMP secondary materials but they have supported British-based alternatives in competition with the American-based AMP project. The East African School Mathematics Project and the Joint Mathematics Project in West Africa both owe their use to the allegiance of British expatriates. Expatriates' reactions to AMP secondary school materials are that they are too theoretical--"they try to make every boy a mathemati-

cian," while the EASMP and JMP materials are practically oriented--- "drawing mathematics out of experience." I am including some excerpts from the professional literature in Africa that illustrate the kind of "potshots" that British teachers continually take at AMP texts.

In one respect British resistance has been a boon to AMP. Many African educational officials, as might be expected, are rather anti-British. Some of the more radical profess to want to do away with every semblance of British rule including British educational programs. Because expatriate teachers are opposed to AMP, the AMP texts take on new allure to nationalist educators.

AID Reactions

I visited with AID personnel in Nairobi and Dar es Salaam. Dr. Whitten, the Assistant Education Officer in Dar es Salaam, though new to the position, was cooperative and informative. He viewed my visit as an opportunity to review the AMP program in Tanzania. His comments on the program, obviously gained through conversations with other American personnel in Dar es Salaam and with Africans involved in AMP, were relatively favorable. He has the impression that AMP is moving ahead satisfactorily in Tanzania.

In Nairobi I talked at length with Mr. Anselmo Bernal and Mr. Atjol Ellis, both of relatively long service in the Nairobi office. They too were cooperative and informative, but not uniformly positive in their appraisal of AMP. I sensed a definite irritation at the fact that the project has been more or less "Washington run." Both officials remarked that the program was conceived and operated from the Washington office with little or no consultation with field officers. They commented upon the AMP team that had visited the Nairobi office earlier touting AMP and decrying decisions to curtail and to regionalize AID project activities. I cite these incidents of field dissatisfaction to counterbalance the rather positive appraisals that were made by Washington-based AID officials to the evaluation team in June. I think it is important that we investigate further the reactions of AID field personnel who are in a position to know first hand the dynamics of AMP in the country they serve. I am including in this report copies of some replies from AID education officers to a cable circulated some time ago by AID in Washington. A careful reading of these replies also seems to substantiate my belief that field officers are not as enthusiastic about AMP as Washington-based officers seem to be.

African Institutions

One goal of my visit was to try to identify an African institution that could serve in a supporting capacity to help the evaluation team place the Entebbe program in an African educational.

*Use as
attribution
never for
yet for
Mr. Ellis
mentioned*

context. Conversations with EDC and African personnel at Mombasa were not encouraging in this respect. Both Africans and Americans suggested that African "institutes of education" were not yet in a position to supply this kind of expert assistance. Indeed, both groups suggested that we rely upon American experts, some of whom had worked closely with African institutions in trying to establish budding educational research programs. I investigated the matter further at Dar es Salaam and again at the Institute of Education in Nairobi. In both cases it appears that the local African institutes are preoccupied with "bread and butter" educational matters--preparation of curricular materials, inservice education of teachers, organization of professional meetings, etc. Neither institute had as a member of its staff an educational sociologist or an economist. Statistics regarding teachers and pupils were unavailable at the institutes. Indeed, it is difficult to believe that these institutes will be able to play a significant role in the long-range planning of educational programs in their countries.

On the basis of this admittedly brief contact, I would say that it would not be possible to find an institution in Africa that could serve us in the manner we anticipated. It would seem a better policy to recruit qualified American personnel knowledgeable and experienced in African education who could supplement the knowledge of the evaluation team in the crucial areas of African educational sociology, economics, teacher supply and demand, etc. Professors Anderson at Chicago and Bigelow at Teachers College were mentioned as examples of the kind of people who could be helpful. I was unable to see Professor Coleman at University College in Nairobi since he was out of town during my stay in Nairobi. He may have some further ideas on this matter.

Teacher Training

The critical question throughout Africa with respect to AMP implementation is teacher education. In the final analysis, most Africans and many Americans would agree that AMP texts both at the primary and the secondary levels are beyond the present capabilities of the vast majority of black African teachers. The hope and intention is that these teachers can be restrained in brief but effective training programs so that through the use of teachers' manuals and related materials they can effectively implement AMP-type texts in their own classes. This minimum teacher education program combined with a thorough overhauling of the pre-service programs in teacher training colleges should produce (in theory) a climate where modern mathematics can be implemented within a relatively short period.

There are a number of circumstances that work against this plan, however. In many countries the language of instruction even in the primary grades is English. Primary school teachers themselves have little more than a primary education and consequently have only a rudimentary school knowledge of the language of instruction. The teachers' manuals are written in English and are themselves complicated and detailed. Textbooks also demand a relatively

high level of language competence. Many teachers are unable to pronounce words like "commutative" properly, let alone to understand them from their reading of the teachers' manual. Indeed, some African educators committed to Entebbe expressed concern to me that elementary school teachers could not read the teachers' manual or for that matter could not read any book in English. One important goal of the evaluation team should be to fully investigate the claim of AMP partisans that the typical African teacher can understand and can use AMP materials effectively after a minimum teacher education program and with maximum use of the associated teachers' manuals.

An even more difficult problem is the problem of preservice education. In some countries there are as many as eighty training colleges, all with weak faculties. Indeed, the faculties of such colleges in East Africa have been supplemented for years by approximately ninety American elementary and secondary school teachers supplied for two year periods by Teachers College, Columbia University, under a grant from USAID. What strength there is in mathematics in these colleges is due in no small part to the TEEA program. It will be important for the Committee to try to gauge the level of competence of teacher training college faculties and to try to determine the amount of work that will be required before these faculties can be brought to a level where the instruction that they offer will be adequate to prepare teachers to use AMP materials.

Some participating countries already have embarked upon plans for retraining college teachers. From my experience in the United States and in other countries, one of the most difficult jobs of all in the reform of mathematics teaching is to change the programs of training colleges. I doubt that it will be easier in Africa.

Economics

A Tanzanian educator raised an issue that I had not considered but may be of major importance. He proudly cited as an illustration of the dedication of Tanzania to modern mathematics that the Tanzania schools that used SMP texts last year had expended their entire materials budget to do so. No money would be available in these schools for purchase of texts or materials in other areas. I was greatly surprised at this comment and took it as a serious indictment rather than a point of pride. It seems to me that primary mathematics is the one area of the curriculum where effective instruction can be provided without textbooks. While this is an opinion that may be challenged by other educators, I doubt if even the most partisan educator in the United States would advocate expenditure of all materials money for one mathematics textbook. I would hope that the Committee could pursue

questions of this sort further with the goal of adding an economic dimension to the final evaluation.

Possible Meeting at EDC

I believe it would be wise to plan a joint meeting of EDC officials, American-Mombasa workshop participants, and evaluation team members before too much water is over the dam. AMP American partisans naturally are concerned and apprehensive about the evaluation in progress. They would like to have an opportunity to discuss their goals and their impressions of their achievements with evaluation team members. I would see this meeting as possibly productive with respect to the information to be gained from these African-experienced Americans and certainly therapeutic with respect to their apprehensions.

Evaluation Procedures

On the basis of the comments and reflections that I have included in previous paragraphs, I recommend that the evaluation team consider the following steps or procedures:

1. Scheduling of a meeting with EDC-AMP personnel.
2. Recruitment of Scandinavian mathematicians to serve as readers and mathematical critics of the AMP materials.
3. Selection of a sample consisting of Tanzania, Kenya, Malawi, and Ghana, with possible discussions with officials of other countries.
4. Operation of a supplementary testing program utilizing countries and classes where AMP tests already have been administered; that is, Ghana at the elementary level and Tanzania at the secondary level. In Ghana a series of tests would be given to children in the traditional stream and in Tanzania the AMP, the SMP, and traditional streams would be tested simultaneously.
5. Recruitment of one or two African-experienced American educators to work with and advise the evaluation team.
6. Organization of visitation teams comprised of one or two distinguished mathematicians or mathematics educators, possibly Committee members, and one American expert on African education. These teams would visit Ministries and educational officials in sample countries and would observe classes designated as outstanding examples of AMP and traditional teaching.

Appendix e

Report on the Trip to Ghana

August 22 - September 6, 1968

by George Springer

On my trip to Ghana, I was able to make contact with people in the AID mission and in the Ministry of Education. Those in the AID mission seemed very interested in the question of education since they have just received a proposal from the Ministry to support certain programs in the next five years. Gordon Evans, the AID program officer in Ghana, said that they are reluctant to put money into education in Ghana; they would rather support regional programs. They are interested in integrating the countries as much as possible. They would like to begin with airlines, power and the telephone systems and aim toward a common market. After this is achieved, they would perhaps go back to local programs.

The one most concerned with the question of education in Ghana was Mr. Frederick Gilbert who was assistant program officer at AID. He was the one who has been processing a proposal from the Ministry. He plans to forward it to Washington with a generally favorable opinion of progress so far and also in the reasonableness of the proposal. However, he also favors a regional program for all five West African countries. Furthermore, he does not feel that AID should get involved in educational programs in any field whether math, English, history and so forth. He believes that AID should concentrate on product oriented projects and plans to leave education and administration to the British. Apparently the British expatriates make up most of Ghana's trained secondary teacher corps and they naturally favor the JSP program which is an adaptation of British materials. He feels that it would be a mistake to alienate this group. I believe we will receive the utmost cooperation from Mr. Gilbert in our study of the situation in Ghana. He is very anxious for guidance in connection with the proposals that have been submitted to him. He requested that our committee stay in touch with him and let him know our thinking as we proceed.

Another member of the AID mission, Mr. G. Bettis, was also quite interested in the question of education and should be

consulted while we are in Ghana. I felt that we shall receive the utmost cooperation from both Mr. Gilbert and Mr. Bettis.

The person in the Ministry of Education most closely connected to the Entebbe Mathematics is Miss Lucy Addy. She has taken part in the workshops in both Entebbe and Mombasa since the beginning of the program. There she worked on the primary textbooks. She now holds a position with the ministry of Education as supervisor of the experimental program using the Entebbe materials. There are 20 primary schools in Accra in which these materials are being tried. Apparently, each of these schools has three classes in each grade level; they refer to these as three streams. In each of the schools, one stream is using Entebbe materials while the other two are using traditional materials. To prepare the teachers in these 20 primary schools to handle the Entebbe materials, special two week summer institutes have been held since the beginning of the program. To these institutes come the 20 head teachers in these schools who themselves will be teaching some grade level and 20 teachers, new each year, who will introduce the next grade level. In this way, the head teacher gets an overview of the whole program and is able to help the new teacher going to the program each year. The new teacher also has this two week exposure which usually is not quite adequate to handle the whole semester's work.

The only other use being made of Entebbe materials is in four of 82 teacher training colleges. Unfortunately, there are no Ghanaians teaching in these training colleges who are prepared to teach the future elementary school teachers Entebbe mathematics. They are relying entirely on American Peace Corps workers. So far, they are only able to have enough to teach one class in each of the four teacher training colleges. There are also approximately nine secondary schools using the Entebbe secondary materials on one stream of pupils each. These secondary schools are now going to graduate their first class and the Ministry is awaiting eagerly to see how these students do in comparisons with the other students on their final examinations.

Lucy Addy reports the program has been very successful at the elementary school level. They apparently have recently instituted a new program in which the primary school runs for eight years followed by either four or five years of secondary school. The last two years of primary school are called middle school. They are using the primary 1 - 6 materials of Entebbe mathematics for all eight years spreading out the material. The pupils who have taken Entebbe primary mathematics and those not taking it were given a test last year and those in the Entebbe program did significantly better. They claimed that the test was over material that both programs covered. This has convinced the Ministry that they should try to expand the Entebbe program. I asked Lucy Addy if she would be willing to give Bob Dilworth's test

to those students who had not taken Entebbe materials in order for us to try to evaluate the program. She said that if we send her the tests, she would give it to the number of students we request. We should inform Bob Dilworth of this and have him make suitable arrangements.

I spoke to Mr. J. S. Ocran who is principal education officer for primary and middle schools. He is most enthusiastic about the program and hopes to see it spread throughout Ghana at the elementary school level. He made the statement that he has instructed 50 per cent of the schools to begin using primary materials. Nobody else seems to know of this and I doubt whether it is true. They have already adapted primary 1 and 2 for the Ghanaian schools and have printed the necessary textbooks. He told me that in order to get them, all I had to do is ask Lucy Addy for copies and she will let me have them. This apparently was easier said than done and Lucy Addy made every effort to keep me from seeing these adaptations. I told her that I felt it was important for our committee to have one copy of each of the two books. She found one excuse after another to delay letting me see them and finally I had to leave without them. I asked Ted Martin about this when I returned and he said that she has never shown them to him and has also refused his requests to see them. I hope that the members of our committee who go to Ghana have better luck in getting access to this adaptation. I think it should play an important role in whether we support efforts of this type in each country. Apparently EDC is interested in having local adaptations made and the quality of these adaptations should play some role in deciding whether such efforts are supported and just how much help these countries need in making the adaptations. (Note added later: Pollack and Young did get copies and were favorably impressed by the adaptation. It did preserve the spirit of the original.)

I was able to speak with Mr. Ocran because he visited the institute in which I was lecturing at the University of Accra in Legon. I requested that Lucy set up an appointment for me with other members of the Ministry and arrange for me to get to Accra to speak with them. She managed to avoid doing this during the first week, so at the beginning of the second week of my stay I called the Ministry myself and made an appointment with Mr. J. W. L. Mills, the chief education officer in the Ministry. Mr. E. A. Brown, the permanent secretary of the Ministry of Education, was out of town during that week. Mr. Mills said that he would welcome the members of our committee who come to Ghana and he will cooperate with them in every way. He stressed that it is essential for Ghana to improve their mathematics teaching because there is a critical need for scientifically and technically trained people. At present the teaching of mathematics in the early grades is so poor that it discourages most of their students from going ahead in science and technology. Most of their students seem to go into the liberal arts and they have an excess of people

trained in humanities compared to those in the sciences. Therefore, he feels that the program to improve the teaching of mathematics should continue to have high priority in their future planning. He reported that 20 per cent of the national budget now goes to pre-university education and an additional 7 per cent for the university. He is in favor of using the Entebbe primary materials once they are adapted to Ghana. The situation at the secondary level is not so clear since the Joint School Project (JSP), which is an adaptation of British material, has widespread support from the British expatriates now teaching in Ghana. As I mentioned earlier, these people make up the majority of the secondary school mathematics teachers in the country. At present there are six schools using the JSP and nine using the Entebbe secondary materials. People have been spreading various rumors about these materials. Apparently, it is believed that the JSP materials approach mathematics from an applied point of view arriving at the abstract later where as the Entebbe materials begin with the abstract and do not have too many applications. Some people claim that the JSP materials are merely a series of recipes with no explanations; in other words, what we call a cookbook course. Mr. Mills gave me the names of some of the people involved in preparation of the JSP material. These are people mostly located at the University of Ghana in Legon. They are Dr. Hartley, Mr. Mitchell More, Mr. Reynor. Apparently, those involved in the JSP were making very little effort to train Ghanaian teachers to use the materials. Mr. Mills finally persuaded them to hold a two week institute for secondary teachers. This institute began during the first week of September and was held at the University of Ghana in Legon just a few buildings away from the Entebbe institute. Miss Harborn lectured in this institute. I intended to visit them later during the second week to discuss their program and perhaps get some of their written materials to study. Unfortunately, I came down with malaria on Wednesday of that week, and I was unable to make these contacts. I would suggest that our committee visit with some of these people and see to what extent cooperation between different groups can be arranged.

Mr. Service Adoo, the deputy chief education officer in charge of research and development came to the institute to deliver the closing speech. He was also very enthusiastic about the Entebbe primary materials. However, he did not give me any information to supplement that which I already learned from others.

Miss Deana Downs, a Peace Corps worker who is teaching at the Winneba Teacher Training College assisted in the teaching of the institute in which I lectured. She reported to me that the young girls and boys going into teaching seem to enjoy the Entebbe materials taught to them at the Teacher Training College. She is apparently having a great deal of trouble obtaining textbooks for her classes. She has 105 students in her class and she only has 50 textbooks. Apparently, a substantial supply of these textbooks

is available in Ghana, but Lucy Addy keeps them in her closet and does not distribute them to the training colleges where they are needed. I asked Lucy about this and she reported that these textbooks are no longer being supplied free by EDC and she wishes to keep a supply of them at her disposal. Apparently, the Ministry of Education cannot afford to buy the textbooks at the commercial prices asked by SRA who is distributing the books in Africa. I received the same complaint about textbooks from the head teachers who attended the institute. They claim that their students have been using the same textbooks for as many as five years now and that they are almost completely worn out, but that the Ministry is not supplying them with new copies of the books. Apparently, these books are selling for approximately \$1.50 each. Miss Addy reports that the Ministry cannot afford more than about 50¢ for each book, so they are unable to replenish their supply.

There are apparently two people connected with the Ministry of Education now with whom we should make some contact. One is Mr. Peter Williams from Britain who is working with the Ministry in trying to develop the JSP materials. Another is Mr. Steve Manning who is from EDC and is working on the elementary science program in the Ministry. They might be able to give some interesting sidelights about the development of these programs.

I met with the head teachers who attended the institute and asked them their impressions of the programs. They report that the students liked the courses and are learning math much better. The teachers enjoy teaching the material but find that it takes too much time to prepare. They apparently do not have any prepared apparatus or materials for the course and have to prepare everything themselves. They find that the teachers cannot use the teacher's guides without some preparation such as the institutes which are regularly held. They are worried because the Ministry has not indicated to them that the children who will complete the first six years of primary school in the Entebbe program will continue to be in special classes in the next two years of middle school. These pupils will only have completed about five years of the six year Entebbe program and they plan to do the last year in the middle school. However, if these students are scattered around through various maau schools which are not participating in the program, the experiment will have been in vain. I already mentioned their complaint about the need for replacement textbooks for those that have been worn out by many years of use. They are also worried that some of the teachers who have been trained to teach the Entebbe materials find that the additional work of preparing materials is too hard for them and they request a transfer. This leaves us with nobody to teach these materials. Some teachers are transferred due to promotion or to other reasons. They feel that once a teacher is trained, there should be some commitment that she will stay on the job and continue this experiment. They even feel that the teacher should get some bonus for the extra work they do in this new program. They report that there is a great deal of pressure from other schools that are not in the program to get into the program since they have heard of the success of the

students who are in this program. The children no longer seem to be afraid of mathematics. Finally, the head teachers feel that they could help train other teachers in the use of the Entebbe materials. They would like to hold some local training programs for other teachers in their areas. However, the Ministry does not seem to have funds for such a program and does not wish to pay them extra for doing it. I would say that their attitude is one of great enthusiasm dampened somewhat by various frustrations they are finding in administering the program.

In general, I found Lucy Addy most uncooperative in supplying information for our committee. I do not think we can expect much cooperation from her in the future either, although she obviously is the one that we shall have to go through in finding out about the Entebbe program in Ghana. I asked her to give me the details of the proposal she is presenting to AID but she was very vague about this. Fritz Gilbert did show me the proposal, and I shall try to summarize it below.

There are apparently 82 teacher training colleges in Ghana, only four of which are using Entebbe materials to train new teachers. Enrollments range from 120 - 500 students in each college. There are apparently 164 mathematics teachers in the 82 teacher training colleges. The four colleges using Entebbe materials will turn out 280 teachers yearly beginning September, 1970. They expect to double this number by 1972. The first proposal to AID wants a U.S. specialist to conduct training programs each for two weeks during vacations for the college teachers in the 82 teacher training colleges. They feel that they will need three institutes to reach the 164 teachers. These tutors can then help conduct two-week institutes for in-service primary teachers. They also want four more two-week institutes for teachers of primary grades VII and VIII. They then want the 164 tutors trained by the specialist from the U.S. to organize four institutes with 900 teachers each. These institutes are to last two weeks. They thus plan to train 3,600 primary teachers per year and in five years 18,000 teachers will each have had a two-week institute. Perhaps one should question at this point whether two weeks would be enough to cover one grade level for each teacher. The total budget for this five-year program is \$273,000. They are apparently asking approximately \$38,500 for the mathematics specialist from the U.S. for each year. The special institutes for the tutors in the teacher training colleges would cost about \$7,000 per year. The four in-service institutes for the teachers and head teachers for primary VII and VIII would cost about \$9,000. As I mentioned earlier, Fritz Gilbert is planning to forward this proposal to AID in Washington and leave the decision entirely to them. Presumably AID will wait for our committee to report before taking any action.

Three university people in Ghana who have been connected with the Entebbe program were very friendly and will probably be able to help our committee. These were Mr. Joseph Jackson in the

Mathematics Department of the University of Ghana in Legon,
his brother Dr. D. K. Abbiw-Jackson from the College of Science
and Technology in Kumasi, and Mr. Francis Allotey who is also
from the College of Science and Technology in Kumasi.

George Springer
September 23, 1968

Appendix D

Report of a trip to Ethiopia, Tanzania, Kenya, Uganda, Ghana
November 6 - December 6, 1968

by

H. O. Pollack and G. S. Young

CONTENTS

1. Sources of European effort
2. The present Mathematics teachers
3. Intelligence and competence
4. Language problems
5. Elementary
6. Secondary
7. The interface between elementary and secondary school mathematics
8. Teacher training
9. Universities
10. Examinations
11. Ministries
12. Propagation through the schools
13. Effect on other disciplines
14. Strength and weaknesses of the Entebbe program and operation
15. Termination of the research phase
16. What we think should happen next
17. Lessons for the USA - why are the kids not turned off?

Appendices

Tanzania

Kenya

1. Sources of European Effort

Africa is the recipient of much assistance in all fields, including mathematics education. Directly involved with the work of the Entebbe Project are three main American groups, the Peace Corps, the Columbia University TEEA, and AID itself. Peace Corps workers are used as classroom teachers in secondary schools, as tutors (so-called) in the TTI's, and as supervisors of teachers. They are often found in roles of much responsibility, for which their enthusiasm more than makes up for their inexperience and possible immaturity. The TEEA provides American specialists at the University level, whose work is primarily to influence the direction of teacher training in the country, by teaching, by working to modify curricula, by training prototypes, etc. In our limited trip, we only met three of these, one very briefly. They seem better than equal to their task and to have an effect wholly out of proportion to their cost.

The involvement and interest of AID in education in general, and in mathematics in particular, varies sharply from country to country. The local officials of AID almost uniformly seem to feel that education is of secondary importance as compared to the development of industry and agriculture. Faced with limited funds for local operations, they will need considerable Washington encouragement if they are going to spend any part of them on mathematics education. Of the nine AID officials whose work directly impinged on our mission, six seemed to us to be high quality representatives of the United States in every respect. AID personnel was uniformly helpful and cordial.

We need to make a few comments on the involvement of other countries. It is not surprising that the British are quite active in what are, for the most part, former colonies. They have an extensive system for recruiting contract personnel for secondary teaching. Many of their teachers have been in the countries for extended periods of time. The British Council sponsors many projects of cultural or educational value; we ran into its effect on mathematics education only in Ghana (q.v.).

The effect of Scandinavian effort on mathematics education in East Africa is quite unique. They seem to pick one very useful, reasonable-size job in each country, and quietly and efficiently go do it. They have built and staffed Kibaha Secondary School, with special agricultural interests, in Tanzania, and Kenya Science Teachers College in Nairobi. The Scandinavian faculty which they supplied are among the best we met, and they had neither a product to sell nor a history to live down.

2. The Present Mathematics Teachers

The bulk of secondary mathematics teachers are expatriates. Africans are, for the most part, too poorly trained to be used in anything but the two lowest forms, and are still rather few in number. Most of the countries have active programs to improve this situation. The comparatively small number of secondary teachers required makes the introduction of secondary school curricular which might, on the surface, seem too demanding on the teacher, actually quite realistic. Particularly in East Africa, very many secondary teachers are Indian. In general, their training has been highly traditional, and their background fits them admirably to non-resist innovation passively. In general, the training of the British expatriate mathematics teachers has been highly traditional, and their background fits them admirably to resist innovation actively. The Indians tend to remain for rather long periods of time, though not becoming citizens. The American secondary teachers, mostly Peace Corps, are well trained in mathematics, enthusiastic, but usually inexperienced at the beginning and without formal training in education. Their terms are typically short. The greatest variety of expatriates is in Tanzania, where a gang of well-trained Scandinavians, Canadians, East Germans and Lord-knows-what-else would, except, for their turnover, be no hindrance in any modern mathematics program.

The turnover problem, in fact, is in our view, the most serious obstacle to large-scale adoption of new programs on the secondary level. More secondary schools than not complain bitterly about shortages and losses of mathematics teachers, and cite this fact as the single greatest reason for difficulty with a new program. We feel that they are absolutely right and that in some cases the ministries are unaware of how great this problem is.

3. Intelligence and Competence

One of the features of the mathematics situation that seems to us most helpful was the high level of intelligence on the part of the Africans that we met in education at all levels. A school headmaster would have the sort of abilities that one associates in this country with the school superintendent, for example. Some of the ministry officials had the characteristics of the top level of American business. For example, Tanzania has about the same population as the State of New Jersey, but the quality of the people in the Ministry of Education seems almost uniformly higher than the quality of corresponding people in Trenton. Perhaps this is less true of the Africans in the universities and in the teacher training institutes, as compared to their American counterparts. Here, after all, the level of formal training which is by no means as high as that of the corresponding American faculty, begins to play an important part. In general, however, the level of intelligence is higher, position for position, than in the United States, and

the level of formal training is lower, by between one and two degrees.

It is interesting to speculate on the view of the world which might develop in the African, when for the most part the expatriates with whom he deals are people of somewhat lower to markedly lower intelligence. The African will never use a first-rate American businessman, or government official or British secondary teacher. But, everyone he sees will have many more degrees than the African. What impression will he form of the white man's abilities?

4. Language Problems

To dispose of the easy part of the problem first, all secondary education is in English. The difficulty is only how to get to this happy state from a great variety of native languages, and with a large majority of primary students not going on to secondary school.

The solutions to the primary language problem differ greatly from country to country. From the standpoint of mathematics education, the happiest solution is in Tanzania, where 90% of all elementary school children speak Swahili, all elementary instruction is in Swahili, and the full transition is made only by the 10% who go to secondary school. The next cleanest solution is in Ethiopia, which has taken the same approach but on a more tenuous base, since only 40% of the population speak Amharic, the language used. The multiplicity of native languages coupled with the lack of any dominant one has caused the other three countries to adopt a gradual transition to English as primary school policy. This policy is the effect of deliberate decision in Ghana, and is apparently satisfactory to everybody; it is coupled to what seems to us a deliberate lack of decision in Kenya (q.v.).

The English of the secondary mathematics teachers we saw was perfectly adequate to their job, with the expatriates, of course, in many cases native speakers. However, the same cannot be said of the primary teachers. Many of these actually tried to evade lecturing while we were there, or dropped into the vernacular. The mathematics lessons were uniformly used as English lessons as well. The contrast between the happy and comfortable Swahili-or Amharic-language teacher and the many nervous English-using teachers in the other countries was quite startling. However, if we may anticipate a little, the latter also seemed to get very good mathematics work from their students.

5. Elementary

The first thing to say about the elementary program is that the curriculum it is replacing is old-fashioned even in its home country, and irrelevant to the African situation. The most common

elementary books are a series "Highway Mathematics", where the original texts were designed for British schools and full of problems and examples of a so-called practical nature all laid in the background of British society. These comments do not apply to recent adaptations, possibly inspired by the competition of the Entebbe program, but were certainly true at the time that Entebbe began. We are not surprised to hear the people in the Entebbe group say that African demands forced them to write one book a year. We can certainly see that the African countries would be quite anxious to replace their older curriculum.

Perhaps we should say next that we found the Entebbe elementary program enjoying a universal success, and considerable acceptance. If the Entebbe primary program is allowed to succeed in a country it certainly will. It takes artificial restraints to keep it from spreading as rapidly as teachers can be prepared to teach it. We saw no one who wanted to go back to the former program. We found only one person who wanted a completely different type of new program, Father Franken in Tanzania. We have discussed his views in the report on Tanzania. This is not to say that in our view the Entebbe program is ideal, but in the countries we visited there were no comparable alternatives.

The African educators are enthusiastic about the program for three reasons:

1. As we have indicated, we believe, and they think, that it is much better mathematics than the program it replaced.
2. The children respond to it well and enjoy the work, which we understand is a change.
3. They regard the program as much more practical than the one it replaces. We agree that the program it replaces is not really practical, despite its superficial appearance. Our instinct is to question their conclusion about the practical nature of the Entebbe program, but they were not to be shaken.

It seems to us, that in countries where such a small percentage of students go on to secondary schools, a great deal of thought needs to be given to exactly what mathematics should be in the primary school program. Our impression of the Entebbe elementary program is that it is rather influenced by the American tradition that all children go on the secondary school. Now we are not saying that we think that a program designed specifically for students not going to secondary school would be different from the Entebbe program in any significant way. What we are saying is that we met almost no one who claimed specifically to have thought about the problem in these terms. Everyone says that the material was much better and much more practical than what they had before, and this is undoubtedly correct. There is, however, the possibility

that a further stage of development which took as its specific goal an elementary school program for the student not going to secondary school might end up with a different program in mathematics, or at least in the relation between mathematics and other subjects.

Our classroom visits in the primary school were undoubtedly the most enjoyable part of our trip. The high level of enthusiasm on the part of the teachers and the students was striking. Indeed, we were reminded of the best suburban schools in this country. These characteristics were most in evidence in classes of Africans taught by Africans. In classes which were predominantly Indian and taught by Indians, this was less evident, and in particular the African child in such a situation often seemed at a disadvantage.

6. Secondary

Unlike the comparatively simple situation we found for the elementary program, the on-site evaluation of the Entebbe secondary program is more complicated. There are competing materials from Britain, there are anti-American emotions, there are anti-British emotions, and we found nothing like a unanimous opinion on the scene.

We must first distinguish between the (earlier) Entebbe five-year program and the (later) four-year program. We did not see any classes using the five-year sequence. In East Africa this sequence does not fit their school pattern, and so is not used. Hence, the five-year version has had an effect on opinions concerning the Entebbe program both in East Africa and West Africa. We will leave discussion of the actual mathematics contents of the volumes to the special consultants. However, we found nobody in Africa who had a good word to say for the geometry. In addition, in East Africa, the fact that the five-year series was even prepared initially gave the East Africans the impression that nobody was listening to them. We were told also at one school in Ghana that the five-year program wasn't being used in West Africa either, because the pattern was to use the fifth year to prepare for the exams. This school was using the four-year program.

In our observation, the four-year program was perfectly successful with properly prepared teachers. There is no question that, with the right teachers, it is a much more satisfactory program than the traditional material it replaced. A great deal of the teaching of secondary mathematics, as we have said, is by British expatriate teachers. For the most part they are against the Entebbe material. Therefore, in those places where they have the power to determine the outcome, the Entebbe program is not going to succeed. However, very many of them are not competent to teach the program, even if they were for it. In order to discuss the effectiveness of the Entebbe material, therefore, one must distin-

guish the countries in which British teachers have effective control from those in which they do not.

In Kenya and Uganda we are certain, as a consequence of the above discussion, that the Entebbe program is not going to go. It is important to notice, however, that, even here, native-trained teachers who are trained specifically for secondary teaching can teach it effectively. For example, the training of secondary teachers at both Kenya Science Teachers College and at the University College in Nairobi would enable them to teach the best available kind of secondary mathematics program. There is, therefore, some point in keeping Entebbe secondary mathematics going in a few appropriately chosen schools in Kenya with native secondary teachers or expatriate secondary teachers other than British until a larger corps of native secondary teachers has become available.

In Tanzania, Ghana and Ethiopia, the situations are different. In Tanzania, the Entebbe material will be widely taught, and coexist with the British expatriate EASMP. What will happen ultimately, we cannot say, but the Entebbe secondary program is clearly a success. In Ethiopia the local adaptation, prepared for reasons discussed in the Ethiopian section, is now the basic curriculum and is going well. The situation in Ghana is complicated by the fact that each secondary school can determine its own courses. There are, however, enough secondary schools using the Entebbe material and enough non-British secondary school teachers to make us feel sure that the program will survive there also.

We have mentioned the existence also of British prepared materials. There are two versions of these, the West African Joint School Program, which we will call JSP, and the East African School Mathematics Program, or EASMP. Both of these are modifications by mostly local mathematicians of the British Southampton Mathematics Program. The first thing to say is that both the Entebbe and the British programs are better than the traditional courses that they are replacing. We had more opportunity to examine and discuss EASMP than JSP, and so will comment most fully about it in comparison with the Entebbe. Like the original SMP, EASMP was written mostly by good schoolmasters with the strengths and weaknesses that would result. All the authors of JSP and EASMP are British. The material is in some places too light, and takes up many topics for no other purpose than cream-skimming. The principal weakness, however, is that it is very difficult to go deeply into a topic when the mathematical content requires it. Many topics in school mathematics can be explained and taught best by finding a proper level of abstraction and explaining material at that level. This does not occur in EASMP, though parenthetically, this is not as true of the original SMP. On the good side, we note that much of EASMP is delightfully written, and looks quite

teachable,

It is our impression that JSP is less well done than EASMP, and is at a somewhat lower level of mathematical content, though from the educational history of the two sides of the continent, one might expect the reverse.

Whenever we were, we thought that the students were ready for good material. It sometimes killed us to have to watch very able students taught by uninspired teachers without a thorough command of the material. Whenever we found good teachers, we saw as good secondary classes as we have ever seen. We feel there is no problem whatever of the students being able to handle essentially any contemporary curriculum.

7. The Interface Between Elementary and Secondary School Mathematics

It has been almost universally the case that when secondary school and elementary school programs were prepared at about the same time, and the elementary school programs were widely adopted, then inevitably the secondary school programs became too elementary. It seems obvious that widespread adoption of Entebbe elementary school programs will have the same effect in Africa. Indeed, we heard comments that the first year of Entebbe secondary already contains material that some of the elementary school students are receiving now. In seven to ten years, the Entebbe program will have to be revised upward. There is, however, one factor in the situation which will tend to slow this process, and that is the language problem. Perhaps repetition, in English, in the first year of secondary, of material taught in another language in primary is time not entirely wasted.

8. Teacher Training

We will discuss the problems of training elementary teachers first. In general, one finds three basic patterns for the elementary teacher. There are a number of teachers whose background consists of primary school and two years of special training for teaching. It is the policy of most countries no longer to prepare this type of teacher but, particularly in the up-country regions, there are quite a number of them in teaching. The two types that are being prepared will have two years of secondary school followed by two years of teacher training, or four years of secondary school followed by two years of teacher training.

In general, the trend has been to establish a great number of quite small teacher training institutes, widely spread over the countries. Thus in Kenya there are presently 40 TTI's in Uganda 25, and in Ghana 82. One consequence of the large number of separate Institutes is that they can scarcely afford specialists, and in general have no "departments" providing opportunities for

discussion, research in mathematical education, etc. The Ministries are all aware of the problem, and all would like to change. In Kenya, for example, they are planning to drop back to sixteen larger Institutes, and in Uganda to only four! For political reasons, it seems doubtful that Ghana can reduce its very large numbers immediately. The facilities at TTI's in general do not seem good. Libraries are small, and there is a great deal of improvisation of educational materials.

It is hard for us to make an evaluation of the quality of the TTI's that produce only primary teachers, since we visited only one that was in session. The rest of our knowledge is hearsay, or extrapolation from institutes that also prepare some secondary teachers. From our very limited knowledge, it would appear that the Institutes have more of the characteristics of the old American normal school than of modern American colleges that emphasize teacher training.

The teacher training tutors (i.e. faculty), even in the strongest institutes, have more of the characteristics of secondary teachers who have been upgraded than of college or university faculty. The tutors are primarily expatriates, and we found very many Indians.

One of the problems with short-term expatriates in the TTI's is that they come with unrealistic expectations as to the level of students they will be teaching, expecting to deal with university freshmen rather than secondary school students. By the time they have adjusted to the real situation, it may be time to go home.

Besides the tendency to consolidate, there seems to be, at least in the Ministries, a recognition of the need to upgrade the training of the primary teacher. There is universal agreement that the primary school teacher should be trained to teach the new mathematics programs, for example.

Are the primary TTI students prepared to teach the Entebbe material when they graduate? We believe that the answer is certainly "yes" for those students who have used the Entebbe "Basic Concepts", which was designed for the purpose. This would include, according to our informants, all new primary teachers in Ethiopia, but teachers from only four of the colleges in Ghana. We found many quite able students attending the TTI's, for want of other opportunities for higher education, or for an assured route to advanced work which evades the university examinations. Our impression is that, for current graduates, not much additional assistance will be required to enable them to begin the Entebbe program.

The "Basic Concepts of Mathematics" text seems to be quite successful. We heard no criticisms from any users, even in

Uganda, and we found that it is widely used as a supplementary book or reference book in schools which do not use it as the text. We feel that, to judge by the customer's reaction, this was one of the most successful of the Entebbe products.

At first sight, one forms the impression that the African primary teacher receives more training in mathematics than his counterpart in this country. It is certainly true that the amount of mathematics taught in the primary TTT's in Africa is noticeably more than the traditional minima in the United States which we have been fighting for so long. The difficulty with the computation, however, is the difference of background in secondary school mathematics given the primary teachers before they get to the Institute or the college. Americans have had a minimum of ten years of mathematics before beginning advanced training, and so the total mathematics will perhaps only be equalled by a 7-2-2 primary program and exceeded only by 7-4-2. However, most of the latter probably become teachers of the first two years of secondary mathematics.

In general, the opportunities for further education for the primary teacher are less in Africa than they are in this country. The pattern of special summer school programs, of special master's degrees for teachers, of NSF Institutes, is present in Africa only in a most rudimentary way. After all, the primary teacher doesn't even have a bachelor's degree. With the exception of a special program at Dar-es-Salaam Teacher Training Institute, we saw no systematic activities designed to take able people at one level and upgrade them to a higher level. Individuals desiring such upgrading typically do it by self-study and presenting themselves for the examinations. However, in all countries, we saw evidence of a great deal of work to prepare teachers specifically for the Entebbe program. We will return to this a later section.

In discussing the training of the secondary teacher, we must differentiate between teachers for the first two years and teachers for the upper secondary. Many of the mathematics teachers for the first two years are now Africans, something that is still rather rare at higher levels. The teachers for the first two years are trained at a few selected TTT's in each country. The lower secondary teacher will have completed four years of secondary school, and had perhaps three years of further work in the TTT. He will have had work in several fields, including professional education courses. The upper level secondary mathematics teacher will have gone to a university college and received a bachelor's degree.

The curriculum for the upper-level teacher is patterned after the traditional British undergraduate program. There will be a great emphasis on mechanics, ordinary and partial differential

equations, complex variables, and concrete algebra. There will be rather few courses designed specifically to cover the content of secondary school mathematics at a higher level. Besides the university, each country has only one or two TTI's which train secondary teachers, and we judge these to be of rather good quality. The curriculum in these, although nowhere near as deep as in the universities, has more in common with the American idea of training the teachers specifically for his job. The sort of programs that we found at Kenyatta College (page 11 of Kenya report) and at Kenya Science Teachers Institute appear to be typical for the two levels of secondary teachers.

The number of people being trained for secondary teaching is small in each country. One must remember that these are small countries, that only a fraction of the age group goes to secondary school, so that there are few secondary schools to staff. If attained, an annual production of 50 secondary mathematics teachers makes a substantial impact.

One can ask again, are the teachers who are being prepared ready to teach Entebbe material? Our belief is that the answer is yes, at the level for which the teachers have been trained. The university graduates will have had much more total mathematics, of a more advanced level, than many of our secondary teachers. The graduates of Kenya Science Teachers College, for example, who are full secondary teachers, are prepared to teach any program anyone has yet devised. The graduates or institutes preparing teachers for the first two years, such as the Dar-es-Salaam TTI, are clearly prepared to teach the first two years of Entebbe. In fact, as part of their education they are likely to have done comparative work on the Entebbe, EASMP, and the traditional mathematics materials.

The great difficulty, therefore, in secondary teaching of mathematics, including Entebbe, is not the training of the teacher, but the lack of stability of the whole teaching corps. This has two aspects. There is a great turn-over of teachers. Some of this caused by government staffing policy, some by the shortness of expatriate teaching contracts, and some by such extraordinary factors as the expulsion of the Peace Corps from Tanzania. The other major aspect to instability is the rapid promotion of people with real training to administrative posts. For example, in Tanzania, of the eleven African university graduates in mathematics in the entire country, all of whom were secondary teachers at one time, seven of them are now headmasters and two are in the Ministry. The net effect of this instability is that the relatively permanent secondary mathematics teachers are for the most part Indians. These are not always active exponents of curriculum change in mathematics.

Many of the features of in-service training we commented on for the elementary teacher apply also to the secondary. However,

the small number of teachers involved makes it possible to assemble all the secondary teachers involved in a particular program in one place for a highly valuable period of specialized discussion. Such gatherings have been financed both by AID and by the countries themselves. We will return to this in a later section.

9. Universities

The university mathematics departments offer, in general, several choices of curricula. There is typically a classical pure mathematics curriculum, a very classical applied mathematics curriculum in the British tradition, and a teacher training curriculum. There are also the beginnings of work in computing, and some musings about modern applied mathematics. In the individual curricula, the level of course work appears to be quite high. The students, of course, are highly selected, having passed through two filters. The ability of the students may compensate for certain limitations of the staff. The faculties are almost all expatriate, sometimes from a surprisingly large variety of countries, though Africans are beginning to appear. In general, the faculties remind us more of the department of mathematics in Western X State College than of the faculty of a major university, which comes closer to being their level of responsibility. Teaching loads are not excessive. There seems to be very little interest in research, not that we feel that this is necessary. The faculties seem to take their teaching quite seriously, but, by and large, the attraction of the standard of living that is possible for an expatriate on contract seems to be a more compelling reason for being in the country than the desire to teach these particular students. The mathematics departments also have a service load for engineering and the sciences. These are accommodated usually in special courses while the mathematics majors are in separate courses generally restricted to themselves.

The interest of the faculties in curriculum reform is an individual matter. Such interest is not required and presumably not considered in the appointment. When it comes to the Entebbe program in particular, the greater mathematical training of the faculty, even if British, makes them better able to see what Entebbe is trying to do, and to appreciate it more than is typically the case with the British expatriate secondary teacher.

The Institute for Education in some countries is attached to the Ministry, and others to the University. The Institute has the primary responsibility in these countries for development, adaptation and propagation of curricular materials. Its ease of work depends on political influences. The Institutes appear to function best if attached to the university, since in this position the Institutes have direct access to all levels of the Ministry,

without concern over intra-Ministry protocol. It is less important for them to have direct access to various levels of the university, and presumably such access is easier in any case.

With the possible exception of Uganda, the Institutes of Education are trying to improve and modernize education in their countries. They think well of the Entebbe program and do what they can to push it.

The mathematical staffs of the Institutes are composed of the TERA group, more Africans than one would think, and expatriates. They appeared to us at a level with education school faculty in many American universities. If, however, a member of the staff is judged to have a personal financial interest in some aspect of curriculum reform, he possibly finds himself in a difficult position.

There is no definite pattern to answering the question whether the mathematics department in the university and the mathematicians in the Institute of Education talk to each other. This will vary from country to country with the personalities of the individuals involved. The situation here is therefore very much like the situation in the United States with the possible slight difference that the relative technical strength of the people in the Institute for Education is likely to be greater.

Aside from secondary teaching, what can a mathematics graduate do? A very few are able to leave the country and go to graduate school. For these, the probable goal is university teaching, either in the home country or in another African country. There are essentially no opportunities as mathematicians in industry, although this may come later. The best road to a goal of a position in the Ministry of Education seems to be through secondary teaching.

10. Examinations

To the American observer, the examinations system used throughout formerly British Africa has obvious defects. The entire future of a student is determined by three examinations; there are no alternate routes to the university or careers demanding education except through the examinations; although enough good people are provided for the needs of the countries, not every one is developed to the full of his potential. All this bothers Africans much less than it bothered us. In addition, there is essentially no way to eliminate students for academic reasons between examinations. They are allowed to progress from grade to grade essentially no matter how poorly they are doing. This is true even in the TTT's where there is little incentive to become good in the day-to-day work of preparing to become a teacher. After

all, a teaching job is waiting for you regardless of your performance in the TTT. Also, the necessity to meet common outside examinations stifles small-scale experimentation in the schools. Only a large enough experiment to have its own examinations can hope to make real changes. A minor sidelight of this is that teachers will sometime have difficulty to get students to pay attention to a particular presentation that is not part of the examination syllabus.

There is one other important point related to testing. In the course of curriculum work on Entebbe mathematics, the Africans themselves have had the opportunity of participating in the planning and the writing of experimental materials. They have, however, not participated in the experimental testing, evaluation and consequent rewriting of these materials, and this should be a necessary part of the experience. It would seem highly appropriate to combine this experience of experimental testing and evaluation of curriculum materials with the development of the Africans' own talents in making out examinations. We were pleased to discover that an East African Examination Council is being established with AID assistance. Perhaps some such enlarged view of this function can be incorporated into the initial design. There is, of course, a natural American reluctance to help to propagate an examinations system which is so foreign to our natural instincts. The situation in Africa, however, is that any attempt to get rid of the system would be quite premature. It is therefore excellent strategy to help them improve it and make it fit better their own situation. We should join them because, at this point, we can't lick them.

11. Ministries

The first thing to be said about the Ministries of Education is that the quality of the people at the higher levels is excellent, more comparable to better American industrial management than to the usual persons in education. In addition, they have had time to think about the problem of education in their country, and have thought deeply, without a stereotyped conclusions. They all are aware of the importance of education in the development of their countries, and know the local needs. They are also surprisingly well informed about mathematics curriculum reform, and have great interest in it. On second thought, this perhaps not quite so surprising; a fair number of people in the Ministries have come up through mathematics. There seem to be two kinds of reasons behind such promotions: We were told by one non-mathematician that they have "been trained to think." Also, the ones in high positions have all been involved in the Entebbe experiment, and the knowledge and status gained from this seem to have been

important in their elevation.

All the Ministries suffer from shortages of funds. They are all trying to supplement their countries' resources from outside agencies. However, we found a general inexperience in the art of proposal writing, which we believe hampers their efforts. We hope that American agencies considering African proposals competitively will make allowance for this inexperience. We believe it is a real handicap.

It appears to us from our discussions that cooperation between countries, except on very specialized problems, is virtually impossible. As an example, Kenya, Tanzania and Uganda have all switched to the metric system on the same day (soon after our visit). Yet it turned out to be impossible to arrange for cooperative development and printing of information booklets for the schools of the countries, despite the fact that everyone involved saw the necessity. Apparently the political forces for nationalistic effort are too great to be overcome by the Ministries of Education.

12. Propagation Through the Schools

What we mean by propagation of the materials is a good deal more than the mere use of the Entebbe material itself in the schools. We include the translations of the material and the various national adaptations, for example. We also consider the influence of the Entebbe materials on other mathematics texts. For example, it seems to us doubtful that EASMP and JSP would have been carried out if it had not been for the Entebbe program.

We will summarize the current status of propagation country by country.

Ethiopia

1. The P-1 commentary is being translated into Amharic. Next year all P-1's will be using the Entebbe material, and the adoption will proceed at one year per year thereafter.

2. At the secondary level, this year will grades 7, 9, and 10 are using the Entebbe material. Next year it will be grades 7 through 11. Grade 9 is using C-1 and grade 7 is using an adaptation from P-4 and P-5.

3. Plans are to push forward for universal use in all primaries, but it is expected that the P-1 - P-6 sequence will take eight years to complete comfortably.

4. There is a necessary slowdown in the secondary school, owing to the change from Amharic to English.

Tanzania

1. The first two years of the primary in all schools use the Entebbe material with the teacher's guide translated into Swahili. Translations of the remainder are under way, with separately minor alterations.

2. Though the pattern is not universal, secondary schools are not apt to have all three of a commercial arithmetic, an EASMP class and an Entebbe class. These are apt to be used as tracks in the American sense, with the Entebbe being the highest track.

Kenya

1. The Entebbe primary program is used in 25 out of 3,000 schools, with grades 1 and 2 using a local modification, and 3 and 4 using the original Entebbe material. The adaptation of P-3 is in the process of publication. No immediate large increase in usage seems likely.

2. Seven of the 500 secondary schools are using the C-1 book in the first year of secondary. The number will drop next year.

Uganda

An adaptation of a West African adaptation of Entebbe, by a man named Okello, is used in grades 1 through 3. They say there will be no more. Many schools are using the revision of Highway Mathematics in grades 1 through 6, a revision prepared presumably under the stimulus of the Entebbe competition. There is no direct use of Entebbe materials, and no prospects thereof.

Ghana

1. Twenty elementary schools are using Entebbe materials in a total of 145 classes. Two volumes of a local adaptation have just appeared. It is the intention of the Ministry to use these adaptations as rapidly and as widely as teacher training permits.

2. The secondary Entebbe is used in 9, and JSP in 20, of the 105 secondary schools in the country. Both programs will presumably have wider use, though the question is out of the hands of the Ministry.

In evaluating the forces for propagation, the first thing to be said is that the Ministries want to improve their programs in all subjects. However, in addition to Entebbe's development of

curriculum materials for both students and teachers, there was AID money available to provide classroom texts, in-service assistance, etc. There were also in each country a nucleus of people who had worked with the Entebbe writing groups, and who had had the necessary knowledge to help in implementing the program. Nevertheless we believe that, in every case, the initial force toward implementation was the Ministry, with the stimulus and assistance of AID funding. Where the further impetus for propagation came from depends a little on the individual country. In Tanzania, where the University College, the Institute, and the Ministry enjoy most cordial relations, it seems to us that the major role in propagation has been taken by the university and the Institute. In Ethiopia, on the other hand, the main role seems to have been taken on by the Ministry itself. In Kenya the decision to propagate the Entebbe material, and the decision not to propagate it very much, was the Ministry's with the Institute for Education assigned the task of the field work. The Ugandan decision to do nothing was the Ministry's. The activity in Ghana seems to have been entirely stimulated by the Ministry.

How are the teachers reached? The situation here is essentially different for the small numbers of secondary from the very large number of primary teachers. In the case of secondary teachers it is perfectly possible to bring together all the secondary teachers in the country who are currently involved in Entebbe materials into one place and to give them for one or more weeks intensive work connected with the adoption of Entebbe mathematics. Ethiopia, in addition, has found an ingenious system of what can best be described as roadrunners. These Peace Corps or Yale University students who make it their job to visit each secondary school in the country every few weeks to help the teachers, and then come together in Addis Ababa for a frantic week of comparing notes and preparing for the next round. These methods seem to us not only well suited for the present problem but to be easily adaptable and expandable for the larger scale adoptions of Entebbe-like materials to follow.

On the primary level it is of course not possible to reach all primary teachers in any of these countries at one time. The methods to be used therefore differ depending on the intention of universal adoption of Entebbe materials. In countries such as Kenya, where a limited experimental adoption is all is foreseen for the immediate future, the Institute for Education works directly with the teachers teaching in the experiment. In fact, weekly sessions with the teachers are scheduled, and attended by about half of the teachers involved. In countries such as Tanzania and Ethiopia, where universal adoption of Entebbe materials into the primary schools is contemplated, a different form of propagation must be found. In Ethiopia a very ingenious system of using the 107 district supervisors has been started. All of these were brought together, twice now, to Addis Ababa for training in the

Entebbe early primary material. They then go back to their own districts and use this knowledge to help the local primary teachers. In Tanzania, four institutes for district superintendents have been held. Each of these superintendents has then run classes for primary teachers in his own area. Again, the propagation can be expected to continue in this way. Incidentally, these efforts of primary propagation have been done entirely at the expense of the home country, and would seem to be one of the features of the present situation most worth supporting.

The original Entebbe textbooks were distributed free. With the stopping of this form of support, and with some of the countries in need of translations or revisions, we are obviously in a painful transition.

In Tanzania and Ethiopia the primary books are being printed in tens of thousands, at a total cost of what seems at first sight to be an outrageously large share of the total budget for educational materials. In Kenya also large numbers of copies have been printed, but, owing to a technical blunder, at such a high cost that it will be a long time before the books are all used. In connection with the cost, one must remember that in these countries the books are used to shreds and tatters, in a way that we can hardly appreciate in America, where, after all, we supply a new work book each year to the children.

Many of the adaptations seem to us to be clearly necessary. Universally, the teacher's guides need modification because the English is too difficult for many of the primary teachers. East Africa regards the original Entebbe student texts as spiced rather too liberally with the culture of West Africa, and believes more local seasoning is necessary. In countries such as Tanzania and Ethiopia, where teaching in English is begun at the level of the secondary school, simplification of the language, for the text at least, becomes a necessity. However, we are not quite sure that all the adaptations have valid reasons, over and above the desire to have a nationally produced book. In any case, the adaptations do not seem to be major changes from the Entebbe point of view.

The African seems to feel the need for making his mathematics concretè, and illustrating it with the use of actual objects even more than his American counterpart. It is therefore not surprising that we saw in every country a fair amount to locally and individually produced gadgetry to help with both primary and secondary mathematics education. The problem has been sufficiently important, in fact, for some of the Peace Corps people in Ethiopia to produce a "Scrounger's Guide to Mathematics," which suggests how people in the villages can use some of the few locally available materials to help with mathematics education. It would be very valuable if some central attention could in fact be paid to the problem of producing physical materials locally to be used in

connection with mathematics education.

The other, if one would want to call it, "teaching aid" which we found was the use of TV in connection with mathematics education in Ehtiopia and in Ghana. In Addis Ababa, we saw a twice-weekly TV program, about 20 minutes in length, which was used to supplement both the mathematics and the English in connection with the first year of secondary. This was telecast to the first-year secondary students in the nine secondary schools in Addis Ababa. The program was very good. In fact, we found it positively frightening to see on television in Addis Ababa a discussion of one of the points which had occupied a great deal of the time of the SMSG Ninth Grade Writing Team about ten years ago. TV is also used in connection with mathematics in Ghana but we did not have an opportunity to see one of the programs.

13. Effect on Other Disciplines

We attempted to find out whether the changes in the mathematics program had any influence on the other secondary school sciences by virtue of the different training of the students. Although we asked everyone we met concerning this, no one could give us any information. We suspect that it is too soon to see the results, rather than that the results do not exist, but this is only a suspicion.

There seems to be no question that one effect of the Entebbe program has been to lead to reform in other subjects. This influence was particularly strong in Ethiopia and Tanzania. We were told in Ethiopia, for example, that their new geology and history texts were directly stimulated by the experience with Entebbe. We saw these new texts, and they appeared to be excellent.

There has also been an impact on the methods of improvement in the other subjects. Other fields have been quick to catch on to the use of district supervisors for propagating ideas to elementary teachers, and to conferences for secondary teachers. In fact, in Tanzania we heard the complaint that mathematicians can no longer get the district supervisors together, because their time is being taken up by other subjects.

There is some EDC experimentation in elementary science in a number of individual countries. Unlike Entebbe, these small experimental centers are proceeding pretty independently. As a result of this and the Entebbe mathematics, we would expect to see forces developing which may lead toward another look at primary mathematics, and then ultimate integration of all of elementary school science and mathematics.

14. Strengths and Weaknesses of the Entebbe Program and Operation

We do not propose to discuss here the strictly mathematical merits of the Entebbe program. That is being done by others.

Instead, we want to comment on the program and its operation as seen on the trip.

First, there is one criticism that we met throughout Africa, and that seems to us to be completely valid. There is no question that the book distribution has been very poorly handled. Books are always arriving late, well after the time of need. In school after school, the headmaster would talk to us, or to the Ministry representative accompanying us, and complain that the books had not arrived. As nearly as we could determine, this is a long-standing problem, and cannot be blamed on any delays in the schools or in the Ministries. We can understand the difficulties of printing and shipping which may be at the bottom of this situation, but the result is simply unacceptable. If the distribution system could not perform, some other arrangements should have been made. We ran into no other logistical problems, but this one has had disproportionately bad effects.

We wish to proceed now to raise some deeper educational questions. We hesitate to call these questions "criticisms" without being surer of their validity than the limited scope of our study has permitted, but they are certainly critical in character.

One of these is the question as to whether there should have been more investigation of the nature of the schools before work started. We suspect, for example, that some of the difficulties of language might in this way have been prevented. Perhaps more attention would have been given to supplying directions for simple teaching aids. Perhaps some of the difficulties with the British would have been foreseen, and steps taken to dodge them. The difficulties with the five-year program might have been prevented. We conjecture a natural expectation that the extensive participation of Africans in the project would take care of such problems of information, but nevertheless such problems remained. The apparent fact that most Africans involved were not classroom teachers, but University, TTI, and Ministry personnel has a bearing on this. This is quite different from what has been done by such groups as SMSG in this country. Whether eight years ago any efficient personnel could have been found is, of course, most doubtful.

The fact that there is such a large drop-out during and at the end of the primary school may not have been sufficiently taken into account in the planning of the materials. We have commented on this in Section 5, and will not repeat the discussion here. This situation is perhaps related to our concerns in the previous paragraph. Closely allied is another question we have already asked, whether there was enough attention given to practical every-day applications.

We feel surer of one criticism which was touched briefly in Section 10. As we understand it, the principal job each summer was to prepare a new primary and a new secondary book, and there was essentially no manpower for revision of previously prepared materials. The very plausible ground for this, that the

materials were so much better than what was being taught before that the pressure for further material was irresistible, reinforces the immediate political as well as pedagogic priority for new writing over revision. In our opinion, nevertheless, only a quite limited view of the purposes of the project will preserve this decision from being adjudged a major mistake. If the main aim of the project was indeed merely to turn out rapidly a series of books better suited for the African schools than the existing ones, then the need for controlled classroom tryout, evaluation, and subsequent rewriting of the materials is not so important. It is true that, with revision, the books would have been better, and possibly many of the local adaptations would not have been undertaken, but a decision to forge ahead without looking back cannot really be questioned on the basis of such comparatively minor uneasiness.

In the broader view, however, the major goal of the project was really to provide a complete experience for Africans in the design and execution of a new curriculum. From this viewpoint, the omission of the revision process has been bad. A tendency of insufficiently trained educators everywhere is to regard the printed book as inviolable. One must learn to look at texts, at the topics in the curriculum always as only approximations, to be discarded or changed as soon as better ideas appear, or as soon as experiment shows defects. It is extremely valuable to see a good group work for a summer on a text, get reports back that the elegant ideas the group had do not work, and then see the group wipe out most of what had been done and start revising. This experience has been denied the African participants, and they have not been taught the methods for such revision if they feel the need from their own experience to revise. In fact, they have not been taught to recognize the need for revision.

It is easier to point out defects in what has been done than to discuss the successes of the Entebbe program. Many of these successes are not documentable in the same way as such faults as poor handling of text distribution. However, we are just as convinced of the reality of success.

Above all, material has been provided which is vastly better than the Africans had before. We can hardly overemphasize this point. We think, also, but cannot prove, that the competing modernized materials might not have appeared without the Entebbe challenge. Reform in the African mathematics curriculum stems from the Entebbe group.

At the beginning of the Entebbe program, the British had a monopoly and a stranglehold on the curriculum. This is now broken. The African educators realize that there are real alternatives, practical in their countries, and can now consider them. Even when Entebbe will have been forgotten, this will have

been a major contribution to African education, and not only in mathematics.

A truly international outlook has been provided for education in Africa in at least this one field, and the Africans now know that they can get ideas from the British, the Americans, the Scandinavians or others, and themselves judge and adapt these ideas.

The necessity for in-service training to prepare teachers for the Entebbe materials has provided a new climate for continued learning by the teachers, something that we judge was not there before Entebbe. The lesson has been learned not only for mathematics but for other fields.

In addition, in the schools of most of the countries, there is a new spirit of excitement, of progress, of enthusiasm. The country is going somewhere in mathematics: students are making more progress than their predecessors, routine has been broken, new career opportunities for teachers are opening up. Again, this is not being confined to mathematics. The *elan vitale* spreads rapidly.

A key part of this new spirit is a definite increase in national pride. All the countries are dying to be up-to-date on something. They are finding that they can be in mathematics. They are even providing their own books, in the adaptations and translation.

Probably the deepest effect has been to force the whole educational system to re-examine itself in every aspect. As a result of Entebbe mathematics there have been continuing ferment, questioning of aims, and motion. In every field, the people who want to argue that it should be the way it is because that's the way it is are now on the defensive instead of the offensive. While many interesting things remain to be done, this climate for change has clearly been established, and Entebbe mathematics deserves much of the credit.

15. Termination of the Research Phase

In the previous section we discussed the lack of classroom testing, evaluation and subsequent revision as a criticism of the approach taken by the Entebbe group. It was clear to us that in many of the countries (see the individual country reports) the Ministries themselves saw this need, and were prepared, as part of the experiment, to undertake such activity, by themselves or in conjunction with other countries. The decision to terminate AID support at this point was criticized, sometimes very frankly, sometimes more indirectly, almost everywhere. We met this particularly in Tanzania, and report the reaction at some length in the section.

on that country.

We think the criticisms are valid. As the Tanzanians said most forcefully, the Africans looked on the Entebbe project as an educational experiment in which they were partners. Yet the decision to terminate was not made in consultation with them. It has been a blow to their pride. Living in this country, and knowing the realities of our national politics, we can understand the forces which may have contributed to the decision. But we regard it as most unfortunate, and as an act which seriously damages the amount of good will generated by the project.

The decision has also caught many of the countries badly off-guard. We heard several times remarks like, "We would not have started so-and-so if we had known American aid would stop." Except for Kenya (and Uganda) the countries we visited have made quite extraordinary efforts to support the experiment. We cite, for example, their major investments of man-power, Tanzania's commitment of almost all of one year's total textbook money for all subjects for mathematics, the cost of local adaptations. Termination of support of the research phase means for most of them that they will have to dig up still more money from very limited national resources--or lose the momentum that has been generated.

We would urge re-evaluation of the decision. In the next section, we list some activities that should be carried on in a next phase, and that seem to us to be the most essential for the further development of African school mathematics.

16. What We Think Should Happen Next

We list activities that we think should be undertaken next by AID. Many of these are the direct result of talks with Ministry officials, that is, they reflect not only our own judgments but those of the Ministries.

1. In order to complete the Africans experience of curriculum reform and to prepare them for culture self-reliance, they have to have participated in revising an experimental curriculum. Given where they currently are in mathematics, this should probably be done on a sampled basis, with perhaps two elementary and one secondary grades. Such a project involves classroom experimentation, evaluation, and subsequent revision. As with the completed portions of the Entebbe effort, we expect this effort to have important consequences far beyond mathematics education itself. It would appear natural to us that this revision be carried out by an appropriate modification of the Entebbe group structure. However, if this is infeasible or somehow undesirable, there is an alternative mechanism. Since the revision process fundamentally begins

with measurement of classroom success, it could be connected with support for the development of the autonomous examination system (the East and West African Examinations Councils). This has been discussed in more detail in Section 9.

To make it possible to make estimates of the cost, we propose the following tentative scheme. The books to be revised should be taught in a number of schools. Probably a local person would have to visit the schools regularly, perhaps devoting one-half to two-thirds of his time. Each school will have extra duties keeping records, giving and grading special tests, as well as furnishing text books and students. The year's work would be followed by a conference at which the question of what revision needs to be made would be decided. Following that, a writing team of 8 or 9 people would be required for perhaps six to eight weeks to do the actual revision. This is close enough to work Entebbe has done so that estimates of cost should be available.

2. It would probably be very wise in the long run to bring several people from each country to the United States in order to do graduate work in the field of testing and evaluation. Such training should take place, both at such institutions as ETS, and in those curriculum development groups such as SIMSG that have had wide experience in evaluation. Africans trained in this way would then form the nucleus for the domestic development of groups in testing and evaluation.

3. There should be continued American support of experimentation with the books written last, in the same manner as there was of the earlier books. This includes the upper secondary, A-level, and additional mathematics texts. Presumably the cost of such experimentation can be determined easily from the Entebbe experience in the past, and we do not make any estimates.

4. One or more high-level traveling consultants should be made available to groups of countries to help with adaptations. Such a consultant should be primarily a mathematician with an interest in mathematics, rather than primarily a mathematics education specialist. His main function would be to insure the mathematical correctness of the adaptations. One man would be time-shared among three or four countries, and would be available for an academic year. We estimate that one could have three such mathematicians at any one time, over a two-year period. Each mathematician should spend at least a semester and hopefully a year. Such a mathematician would have an American academic year salary of around \$20,000, from which we are sure a rather accurate estimate of the actual cost of such a visitor can be made by AID.

5. The upgrading of local primary teacher training at the pre-service level is an urgent task. The TEMA workers we met were

performing a highly valuable function. But we believe that more effort is required. American mathematical educators are needed not only for direct teaching in the schools, a task which we found being done quite satisfactorily by Peace Corps workers for example, but for pilot programs in modernizing the training of the present teacher institute tutors. Perhaps one pilot program per country will be required. The Americans involved would be mathematical educators in the salary range of \$12,000 to \$16,000. Some additional support would be needed for textual materials for the tutors, but the overall amount should not be large.

6. It is not clear that pilot programs for in-service training of primary teachers are required, at least in the countries we visited. In-service programs connected with implementation of primary Entebbe materials are of course very useful and much desired by the individual countries, but questions of AID policy involved in their potential support are beyond our competence. Similar arguments apply to secondary implementation--with the exception of Recommendation 3 above. If such assistance were to be given on the primary level, in-service training would require providing American personnel for short-term courses as well as some contribution to extra costs of such courses. In addition to giving such courses, part of the tasks of the American personnel would be the training of African counterparts for such in-service work. As a rough estimate of the order of magnitude, we would estimate that a mathematical educator would be required for each country for perhaps a two-year period. The American salary for such a person would be in the \$12,000 to \$16,000 range for the academic year. Such a person could handle around 18 two-week institutes in the course of his tour each year. Perhaps each institute would be supported in the amount of \$2,000 each to cover cost of books, some of the support of participants, and some of the cost of the African counterparts. This is a very crude approximation and would need to be studied in conjunction with the countries concerned.

7. A concerted effort should be made to develop simple gadgetry for use in mathematics education from locally available materials. This sort of thing, which might perhaps be called a concealer's guide to mathematics, is very valuable for assuring an increasing understanding of the relationship between mathematics and the real world.

8. Throughout our visit to Africa, we found that the typical primary student is the terminal primary student. We have had occasion to raise the question whether the Entebbe project, or indeed any mathematics project with developing countries, has taken a sufficiently hard look at the needs of the terminal primary student. Just what should he have in the way of mathematics? One aspect of the job is clearly to collect local practical examples of applications of mathematics to everyday life. This sort of thing

can best be done by someone participating in the everyday life of the country who has an eye for the usefulness of mathematics in everything around him. These could be used in a "second round" of curriculum revision. The total job we have in mind, however, is more demanding and ambitious. It consists of nothing less than rethinking the purposes and methods of primary mathematics. Staffing such a project would be extremely difficult, and would demand a world-wide effort. It therefore sounds like an activity perhaps more for an organization like Unesco than for AID.

17. Lessons for the USA - Why Are the Kids Not Turned Off?

One of the current theories of elementary education in this country is that culture in the home is of primary importance in getting a good start in elementary school. In particular, it is argued that at the beginning of the elementary school the primary processes are those of abstraction. After all, we have to associate from objects to names for objects to symbols for names of objects to numbers to symbols to symbols for symbols, etc. It is argued that this process of successive abstraction is more difficult for a child from a home in which abstraction is never practiced. If there are no books, if no abstract discussion ever takes place, this child is at an obvious disadvantage. Many head-start programs have been founded in this spirit and they certainly seem to have been very successful.

In view of our brief experience in Africa, we are led to question this theory (although not the remedy) somewhat. The elementary school children whom we saw, for example in the countryside of Tanzania, most certainly came from under-cultured homes in the above sense. With high probability the parents are illiterate. Nevertheless, we found excellent facility for abstraction among these children. One of the things that we look for in this country, for example, is the ability to go back and forth between numbers and concrete objects. We are very happy if a first grader will take an addition problem, do it abstractly if he can, but go to the shelf to get some pebbles or cookies if he needs to count the thing out explicitly. The free interchange of these processes tends to show a real understanding of mathematics. This is just the kind of thing which first grade students in Tanzania did very well. They had no difficulty whatever going back and forth between objects and pictures and numbers.

What then happens to the explanation? We cannot prove it, but we have a feeling for the possible nature of the difference. One attribute of the elementary school children in Tanzania, which many of our children lack, is a complete feeling of self-confidence. These youngsters have never gotten, by any form of overt or subliminal advertising, the feeling that they might be in anyway inferior. The country belonged to them, the teachers were of their

own kind and the white man in the classroom was a rare curiosity but certainly no superior human being. The mathematics program itself was their own, adapted to their own culture and with familiar examples. We think this feeling of self-confidence and lack of fear may be at the heart of the good comprehension of mathematics which we saw.

One minor confirmation of this possible theory, even more tenuous than the theory itself, is the following: in some of the schools in the capitals, the African children were outnumbered by Indians. What we saw, particularly in the upper elementary grades, was a shyness and backwardness relative to the Indian youngsters which was all too reminiscent of some suburban American classrooms.

Kenya

General Situation in the Schools. We found the general situation in the schools and the forces at work much harder to understand than in the previous countries. Our impression is that this is a local reflection of the general political situation in the country rather than any special problem in the Ministry of Education. It is not even easy to get basic statistics, although this is probably due to the mushrooming of Harambee schools. There are apparently about 3000 primary and 500 secondary schools. 65% of the population begin primary school at ages between 5 and 8, and there is not much dropout during primary. (This varies from 95% in Nairobi to under 40% in the more outlying districts.) Perhaps 15% of primary leavers go on to secondary.

The major difficulty on the primary level is the use of English as the medium of instruction. We saw few primary classes with the enthusiasm and confidence we had seen in countries using the vernacular. (The only really excellent primary teaching we happened to see was by some Indian teachers in a school whose pupils were also primarily Indian.) The language problem is both practical and political. No single African language is spoken by anything close to a majority of the population, and it is impractical in terms of both finances and manpower to provide textual material in each of the 40 languages in use. Beyond this, however, there are political questions involved. There are forces working towards the adoption of Swahili, perhaps as an anti-colonial gesture, and such forces are strong enough to prevent the universal commitment to English which would make a real improvement in primary mathematics possible. We found primary teachers who preferred to give written work rather than talk in front of us - although they started talking as soon as we left. Much more of the written work was correct, however, than we might have expected. A massive program of instruction in English to improve the teaching by the primary teacher, which would appear to us to be a necessity, implies the unanimous commitment to English which at the moment seems politically impossible. The language situation is typical of many issues. We felt a general air of marking time and postponing of decisions. It appeared that, for every force that wanted to do something, there was a counterforce somewhere else that slowed it down.

The Entebbe Primary Program. There are about 25 primary schools using Entebbe, most of which are in or around Nairobi,

with a few around other teacher training centers. Grades 1 and 2 are using the revisions prepared by the Kenya Institute of Education, while grades 3 and 4 are using the original Entebbe texts. A revision of grade 3 has been prepared and will be available for next year. The revisions were mostly in the teachers' commentaries in the direction of simplifying the language and providing assistance with vocabulary. Many more copies of the revised Standard 1 and 2 Entebbe texts were printed than will probably find immediate usefulness. They cost more than twice as much per pupil book as the traditional Highway maths ($4\frac{1}{2}$ vs. 2 shillings), and the cost of the teacher's commentary is "astronomical." Part of the reason for the high cost of the pupil text, as we were told, is that someone at I for E (no longer there) insisted on a special style of 4's and 8's in the printing. These had to be designed especially for the project, and set into each page, by an artist, by hand. He was paid, we were told, on the order of £ 30 per page, and this doubled the cost of the books.

When the decision to begin the experiment was made, Sam Kagiri was brought into the Institute to supervise it. He is American-educated, and professionally competent. He has done his best with a very difficult situation. For example, as head of mathematics at the Institute, he made a projection of staff necessary to carry out its functions. The 1968 figure in that projection was 14; in fact he currently has 4. The reason given for lack of growth is financial. However, one or two specific peace corps mathematics people would be available to the Institute, immediately and for free, but permission to acquire them is lost somewhere between the Institute and the Ministry. Kagiri seems to suffer a good deal from the fact that the Institute is under the Ministry rather than associated with University College, so that he must work through channels instead of approaching the right man in the Ministry directly.

Kagiri runs a regular in-service course for the primary teachers in the Entebbe experiment. Unfortunately, they have to pay their own bus fare, and less than half of the sixty teachers attend a typical session. Regular visits to the primary schools in the experiment would be a tremendous help, but with the staff of only 4 people, the number of such visits is minimal. It is clear that no larger use of Entebbe materials at the primary level can be contemplated until the Institute has a mathematics staff large enough to prepare and implement such growth properly. It is perhaps not irrelevant to note our impression that the present assistant chief inspector, who was formerly Secretary of the Institute and incidentally a mathematician, may have been shifted because he got too much done. His present job appears to give him considerably less freedom of action. It does not seem likely that his successor will make the same mistake.

Everybody concerned with the Entebbe primary experiment, from the chief inspector on down, is a smart man and knows what needs to be done. The forces and counter-forces, however, seem to insure that the experiment will neither fail nor succeed sufficiently well to lead to immediate broader adoption.

The difficulties of the experiment on the primary level have been greatly increased by a local AID decision which led to the sudden and premature loss of Dr. Hollingshead from the faculty of education in University College. Dr. Hollingshead was a TEEA appointee, and by all reports a highly effective mathematics educator. Among his activities were helping the Institute with the in-service education of primary teachers, assisting KIE with evaluating books, chairman of the secondary mathematics panel, teaching of prospective secondary mathematics teachers, and running an in-service program for some. We have heard only one side of the story of Dr. Hollingshead's departure, and refrain from further comment.

The Entebbe Secondary Program. Dr. Hollingshead's departure apparently removed the only possible chance the secondary experiment might have had. There are currently seven secondary schools in Nairobi using the C1 books. They have finished a year, and four of the seven schools clearly want no more. Nobody knows as yet what they will do next year. Even those who have had at least partial success are hampered by the fact that no copies of C2 had arrived by the beginning of December although classes begin in January.

We do not believe that the failure of the secondary experiment can be laid to any inherent educational demerits of the Entebbe books in the Kenyan situation. The program had $2\frac{1}{2}$ strikes against it before it ever started. The major effect is clearly the presence of EASMP, which, as a matter of fact, has many more ramifications than one might expect. We will take them up shortly.

It is important to note that we saw at least one striking success of the Entebbe Secondary C1 in Kenya. This was at Starehe Boys School, which is both a primary and a secondary school for abandoned and orphaned African boys. The class we saw there, taught by a Peace Corps volunteer, was superb, and the students fully comprehended everything that was going on. We hope that his replacement will do as well.

The most common criticisms of the Entebbe program in Kenya should be noted. We were told that the books were too wordy and students were unaccustomed to reading mathematics anyway, that the mathematical approach was too formal, that the transformation geometry was inadequate and the other geometry too old-fashioned, that the books, especially the C1 geometry, began too slowly and repeated too much previous work, and that the original geometry had given the whole program a bad name. Furthermore, we were told, the African participants had been almost entirely West Africans with a resultant mismatch of the materials to East African schools. This was aggravated by the virtual absence of any secondary teachers, African or expatriate,

with African teaching experience.

Besides these relatively factual criticisms, there were a number of comments which reflected the strong emotions of the British expatriates towards the Entebbe program. We were told, for example, of the Penelope Effect: Each night, the work of the African participants during the day was rewritten by the Americans who furthermore pretended that they had made no changes. We were told of the extravagance of the operation, and that this appalled all but the American participants. We were told that ideas of experienced people were ignored just because they were British, and that early British participants had not been invited back and had been shut off from all further contact. One of the former participants quoted Africans as having said, on the last day, "Thank God we are free of the American yoke."

EASMP. The original SMP is an attractive series of texts prepared in England by a group of largely secondary school masters of mathematics. Three Kenyan expatriate teachers got early copies from friends in England and received permission from the Ministry to give it a try informally. We were told that it was not a success, but that the concurrent Entebbe activity provided the climate for the beginning of an effort to prepare an East African version. There was some thought at this stage of a combination of forces between EASMP and Entebbe Secondary, and stories differ as to why nothing came of it. By now, two years of EASMP are out, and the third year is expected to be out momentarily. Plans are to write materials for secondary 4, but it has not been decided whether to proceed beyond this. Schools experimenting all the way through A level are using the original English Version. There are also plans to write teachers' commentaries for the earlier volumes, since even the most ardent SMP advocates recognize the strength of Entebbe on this point. The books are commercially available at quite a reasonable price; for example, the complete secondary 1 course, in Kenya, costs 15 shillings as opposed to 33 for Entebbe. There is a considerable unexplained undercurrent of emotion of the question of royalties for EASMP, and we could not get to the bottom of it. Several writing participants asserted that they had not even received expenses.

The revision from SMP to EASMP consisted, first of all, of changing local references, names, and situations from England to East Africa, and, of deeper significance, lowering the level of abstraction and language. The books are an obvious improvement over the traditional program of Durell or Parr. They make sure to take up topics most important for the examinations early, so that the frequent complaint of inability to finish (which is common to EASMP and Entebbe) is not as damaging. Later chapters are more likely to be introductory, relatively shallow, surveys

of mathematical topics. It was reported to us that at least some students complain that they do not seem to lead anywhere.

It is not surprising that such a series written by local leaders, in the national tradition of almost all of the teachers, and energetically pushed, would gain wide acceptance. There has been deliberate effort to slow down the spread of SMP in Kenya; even so it is used in at least 20% of all secondary schools.

The East African leader of EASMP is David Morris, who has been given a post in the Institute for Education to supervise experimental use of the program. Next year he will be joined by another writer, Mr. Swift, who teaches at Alliance High School in Nairobi and is also president of the Kenyan Mathematical Society. Morris is a charming, urbane, and intelligent man, in the best British tradition of knowing exactly what he wants and being willing to take all the time necessary to get it. Swift is a perfectly reasonable secondary teacher of mathematics who seemed to us, in our brief encounter, to be out of his depth. Morris is a somewhat more controversial figure than one would at first believe. We were told of an attempt to expel him from Kenya which was personally squelched by the highest British representative in Kenya. The grounds were alleged to be connected with royalties from EASMP.

Entebbe vs. EASMP. The comparative situation is, on the surface, very easy to describe. SMP has nothing to offer as competition for Entebbe primary, and, in Kenya at least, has the battle clearly won for the secondary. Even David Morris can afford to be very generous in his comments on Entebbe.

None of this, however, settles the real problem of the relative merits of the two. We believe the Entebbe program has not had a fair try, and cannot possibly get one under present conditions. Furthermore, ESI has itself, in a secondary way, contributed to the negative milieu, by the failure, at various critical moments, to get books delivered on time.

The key facts in the situation are that perhaps 90% of the secondary teachers of mathematics are Asians or British expatriates who mathematical background and training condition them very well for SMP and very poorly for Entebbe. Additionally, they have a strong belief that the level of abstraction and rigor in Entebbe is simply not suitable for the African child. Our own observations in other countries of Africa as well as in the Starche School in Kenya itself are directly at variance with this belief. Furthermore, there is much, in at least the more advanced levels of SMP, which would be tremendously improved with more precise discussion. It was literally painful to sit through

a class of the best mathematics students in the best high school, taught by allegedly the best teacher, in Kenya, and see intelligent questions that require precise discussion to be treated as misunderstandings by the student. The teacher would repeat the same drivel and say: "Now do you see it?" We have formed a considerably higher opinion of the intelligence of the African secondary student. British expatriates might perhaps tell us that we just weren't here long enough, but we bet that isn't the answer. We are sure that the ministry is aware of these attitudes but the problem just cannot be attacked at present.

Teacher Training and Higher Education. Elementary teachers are prepared in one of several patterns. Most of the older teachers have had seven years of primary education, none of secondary as such, and 2 of teacher education. This is called level P1, and may be denoted by (7-0-2). Training now is being provided only for P2 (7-2-2) and P3 (7-4-2). There are 40 teacher training colleges, and it is the ministry's intention to reduce the number to 16 in the next two years. Each of these is intended to have an enrollment of at least 500. The Basic Concepts text is available in each of the present TTC's and is apparently well regarded; SMP 1 is used as a text in some of them. The mathematics curriculum is 2 periods in P3, and 3 or 4 in P1 and P2. Of the two-year training period, about 2/3 is spent on academic and 1/3 on professional training. The mathematics panel is said to be developing material to be used in the TTC's after it is approved by the Ministry. We were told of one teacher in a TTC who is using Etebbe and has asked for permission to continue to do so.

The Kenyatta College trains teachers for the first two years of secondary. There are two programs, a (7-4-3), with currently 187 students, and a (7-6-1), with 11. The first year's mathematics program contains a course in EASMP 1, a course in the development of mathematical concepts, and a course in the history of mathematics and number systems. The mathematics faculty had the characteristics of highly competent secondary teachers who have been moved up, and is mostly British. We believe that they are doing a good job, and that they are likely to produce enough African teachers to take over most of the mathematics teaching in the first two years of the secondary school.

We visited briefly the new Kenya Science Teaching Center, which is staffed and supported by Scandinavians. We have an impression of excellent facilities and faculty. We examined the syllabus and texts for mathematics, which compare favorably with the American Standard. In particular, teachers trained under this curriculum should be able to teach any of the new secondary school programs without additional study. The chairman, Mr. Andrejs Dunkels, who is departing, seemed to us an excellent man with strong mathematical training. The school is likely to produce the first large numbers of African teachers for the

higher forms, provided they are not promoted too quickly to other positions. These people may make the eventual introduction of better secondary mathematics possible.

University College has an excellent curriculum for the preparation of secondary teachers, but few students elect it. Once they get that far, they all want better jobs. Fears were expressed that the better jobs may not be forthcoming. In fact, at every level of education there are worries about overproduction. There is an excellent program for students with a concentration in pure mathematics and a very British one in applied mathematics. The mathematics department consists of two Americans (including the chairman), two Hungarians, three Africans, one Indian, and one British. They also have several African graduate students. There is concern about the small number of students going into teaching, and discussion of use of an indenture system. If, for one reason or another, more students go into teacher preparation, they will get very good training.

There is very little to indicate the presence of any extensive in-service training in mathematics in Kenya. We were told of 5 Canadian educators conducting in-service programs for primary teachers with minimum qualifications, and of a UNESCO program to provide primary school supervisory teams. The present assistant education officers spend their time on administrative duties; special mention was made to us of the collection of school fees in order to prevent possible misappropriation by the headmasters.

In Kenya, for the first time, we felt that we were serving not only as observers but also as communication channels. It is apparently as hard for local people to get to see people in the ministry as it is to get decisions. To be fair to the Ministry, they are overburdened; they have exactly the same numbers of staff now that there are 500 secondary schools as they had when there were 13.

Our trip was planned by Barry Vogeli and Sam Kagiri from KIE, who accompanied us on all our visits. They did an excellent job of planning and sequencing, and if the overall impression of Kenyan mathematics education is not as impressive as that in Tanzania, this is certainly not their fault.

Some of our Contacts:

Hosts and Guides: Mr. Sam Kagiri, Kenya Institute of Education
Mr. Barry Vogeli, Kenya Institute of Education

Ministry: Mr. Kanina, CEO
Mr. Olwoch, Assistant CEO
Mr. Hunja, Inspector for Mathematics

NIE: Mr. Lijembe, Secretary
David Morris, Mathematics Section

Nairobi City Education Department:
Mr. Machane, Chief School Advisor
Miss Khama
Mr. Nzioka

Loretta Convent Pri. School:
Miss Sheehan

Dr. Aggrey Pri. School:
Mr. Gichuru (HM)

Starehe Boys School: Mr. Griffin (HM)
Mr. Bill Montfort

University College, Education: Professor Cammaerts
Mathematics: Professor Weinstein

Kenyatta College: Mr. Mehta
Mr. Douglas Field

Nairobi School: Mrs. Nancy Roach

Aga Khan School: Mr. Corkery (HM)
Mr. Mohammed
Mr. Montiro

Alliance High School: Mr. Swift

City Primary School: Mr. Ratan Singh (HM)

Kenya Science Teachers Institute:
Mr. Andrejs Dunkels

Appendix F

TANZANIA

Primary Schools. Our visits to primary schools ranged from long-established missionary schools in the capital to rural towns (up-country schools). We were very impressed with what we saw. There was much enthusiasm for the Entebbe program. At this time, two years of the Entebbe program have been translated into Swahili and are being used in all schools. In addition, experimental work in the higher standards is being carried out. The Ministry plan is to introduce one new grade level per year. The Tanzanians are enthusiastic about the program for three reasons: (1) They believe, and we agree, that it is much better mathematics than the program it replaces. (2) The children respond to it well, and enjoy the work, which we understand is a change. (3) The Tanzanians regard the program as much more practical than the one it replaces. We doubted this instinctively, but they weren't to be shaken.

We thought the level of primary teaching was quite good, most of the primary teaching being done by Africans.

The country has made the decision to use Swahili for all primary teaching. Assuming that extensive instruction in English is given throughout the primary school, we think the decision was wise. The teachers assert that the students do much better in Swahili, which is the native tongue for the great majority of the population. We would like to recommend that the instruction in English in the last year of primary should include the necessary background for secondary mathematics in English.

We saw no evidence of any difficulty with abstractions. The students made the transition from objects to pictures to words to symbols with ease. Considering the extreme poverty and lack of education of most of the parents, this is in striking contrast to the "culturally deprived" segments of the American school population.

By American standards, schools, especially those whose support has historically been only by the government, are quite poorly equipped. Nevertheless, we saw many ingenious examples of improvisation of teaching aids.

The single exception to the general enthusiasm for the new primary mathematics was Father Franklin, head of the Morogoro (primary) Teacher Training College, and a man of much experience and influence in the country. He asserted that the experimental programs funded from outside, and not only in mathematics, were "neo-colonial", and did not face the realities of Tanzanian life. He had had the standard tour of North Korea and Red China, and was much impressed by their education but not, according to him, by anything else. The primary school program, in his opinion,

should consist entirely of studies immediately applicable to village and rural life, at the expense of preparing for the secondary school. In mathematics, he wants only elementary arithmetic and some ill-defined "mental training". His views are well-known to the people concerned with mathematics in the country. In our opinion, Father Frankin does not know much about the actual mathematics program, and greatly underestimates the actual and potential usefulness of the total material.

We believe, however, that quite possibly a third round of curricular revision could incorporate many more examples showing the usefulness of the material to Tanzanian life, without altering the basic mathematical structure. This appears to us a difficult task, demanding the help of high-level mathematical consultants.

Secondary Schools. The government has made the decision to keep the secondary schools highly selective, at about 10% of the primary school leavers. There are about 100 secondary schools in the country. The curriculum situation is rather complicated. Accompanying the traditional mathematics program, there is a program in commercial arithmetic, and schools using one of the two experimental programs, Entebbe and SMP, will typically have all three. We found evidence that the three programs are used as "tracks" in the American sense, with students selected by ability. This has some effect on the validity of results from the experiments.

We believe that the entire problem is made extraordinarily more complicated by the difficulties of the supply of secondary teachers. Most secondary teachers are expatriates, from a vast variety of countries. We met Americans, British, Scandinavians, Australians, Canadians, East Germans, lots of Indians, and even an African from Lesotho. Typically, the expatriate stays for only a few years, and Peace Corps Americans disappeared quite abruptly. Expatriates bring with them the curriculum prejudices and methods of their national backgrounds. This rapid turnover of secondary teachers keeps a force of national consensus on the future development of secondary mathematics from developing. For example, two of the current leaders of thinking, Mr. Bergsonne from Kihaba and Mr. Beere from , are about to leave. The African secondary teachers of mathematics are almost all grade A teachers, which means that they are really prepared only for primary and often are restricted to the first two forms. As an interesting sidelight on this, we were told that there are precisely 11 African mathematics teachers with degrees in the country. Of these, 7 are headmasters, and 2 more are in the ministry. Thus only two are teaching mathematics.

The denial of opportunity for consensus is, however, not the worst effect of the secondary teacher turnover. In Dodoma

Secondary school, for example, (a straight government-supported school), the students in the experimental Entebbe program felt demoralized by the rapid turnover of their mathematics teachers and the resultant poor instruction. They felt that their preparation for examinations and their science learning were both suffering, and wished they were back in traditional. However, when one of us took over a class, we found that the spirit of understanding of the "new math" had nevertheless caught on and was easily transferred to a new problem.

In all schools, we found that the enthusiasm for new mathematics, either Entebbe or SMP, in both teachers and students, was strongly correlated with continuity of experience.

Our impression is that the secondary school mathematics students themselves are really excellent. We believe it would be possible to start producing research Ph.D.'s within six years if the necessary type of faculty were made available, and if the country were to make the decision that this was an item of high priority. We are by no means saying that it should be: We are only saying this as a measure of quality of secondary students that will be meaningful to mathematicians.

We attempted to ascertain the effect of the examination system on secondary mathematics education. The system worries many people, particularly of American background. The entire future of the student is determined by 3 examinations, and this is a system which Americans instinctively dislike. In addition, all tests are about twice as long for a given amount of time as we would normally give. We found it difficult, however, to arrive, ourselves, at firm conclusions. Teacher attitude about examinations tends to be a self-fulfilling prophecy. However, even the SMP students of an excellent British teacher received what looked to us like a horribly low distribution of raw test scores.

A second point about the examination system which is contrary to American instincts is that there is absolutely no alternate routing. The examination system apparently is successful in finding sufficiently many competent students for each successive level, but there is obviously no hope, for example, for an instinctively brilliant mathematics student who is weak in other areas or frightened by examinations. American worries about this only seem to amuse Africans. The thought of using, for example, high standing in the national mathematics competition sponsored by the Mathematical Association of Tanzania seemed naive to our hosts.

A second effect of the examination system which bothers some British expatriates, at any rate, more, is that there appears to be essentially no way to eliminate unsatisfactory secondary students once they have been admitted.

A third effect is the stifling of experimentation. For

example, several of the secondary schools have special goals, such as preparing students for work in agriculture. It is quite conceivable that the mathematics curriculum in these schools should be quite different. However, experimentation can take place only with the restriction that the students must be prepared for the standard examinations.

At this point we must remind the reader, as well as ourselves, that we have been speaking with limited experience and American prejudice. One of the best ways to continue to help Tanzanian mathematics may well be to work within the examinations system and to help bring the examinations more under local control.

In order to prepare for the examination, a common syllabus has been worked out by a Mathematics Panel established by the Ministry. No decision has been reached as to whether the giant task of writing a single program, as opposed to several programs covering a single syllabus, should be undertaken.

There was much discussion of mathematical details of the Entebbe and some of the SMP program. We see little point in reproducing comments which were as highly correlated to country of origin as these. Our own impression, and that of almost all secondary teachers and officials to whom we spoke, is that both Entebbe and SMP are clearly superior to the traditional mathematics. The influence of persons trained in, and favorable to, Entebbe, is such that it would probably win a direct confrontation. It has already won the primary, at any rate.

The most serious problem in mathematics confronting the country is one to which we have already alluded, and that is the supply of relatively permanent secondary teachers. We are not sure that the Ministry appreciates just how crucial this problem is. Well-trained secondary mathematics teachers receive pre-service preparation from only two places, the Dar-es-Salaam Teacher Training Institute and University College. In TTI, the students preparing for mathematics spend very close to one-third of their time on each subject. The numbers of students preparing in mathematics during the last 3 years has gone up from 9 to 11 to 26. This is a tribute particularly to the head of mathematics, Mr. C. E. Springer from Oklahoma University, and Mrs. Peera, a native of Zanzibar who has worked her way up from primary teaching. Unfortunately, we did not obtain details of the curriculum at TTI. At University College, the number of graduates prepared for secondary teaching is now quite small, but is expected to grow sharply. Here the curriculum is, by American standards, quite exacting, and also quite British. There is a great deal of analysis, going up to the level of Buck's Advanced Calculus and Churchill's Complex Variables. There is a good deal of statistics and probability. There is work in numerical analysis and computing, including actual use of the computer. However, there

is virtually no geometry, and only 20 classroom periods of abstract algebra. There is work in classical mechanics and in partial differential equations. We find we are not sure as to how much of the student's time is given to mathematics.

In-Service Training. We were impressed with the amount of in-service training being carried out for both primary and secondary teachers, despite limited resources, both of money and personnel. There is an annual December institute for secondary teachers, which is partly supported by US funds and for which there is a tremendous demand. There have been four Conferences for primary school inspectors, district education officers, and teachers college tutors. Each of these, in turn, is expected to run several programs a year in his own area for primary teachers, and this has been a major technique for getting Entebbe adaptations going in the primary schools. These latter conferences have been supported entirely by Tanzanian funds, teachers paying their own fares to the district meetings, for example. There is some danger that lack of funds will force discontinuance of this program vital to the spread of new mathematics in the primary schools. Anything that could be done to help would be very useful.

Quality. One of the most encouraging things we found was the high level of ability (possibly opposed to training) of the Africans with whom we talked. In almost every case, at each level the people impressed us as being better material than their counterparts in the United States. We found a great amount of deep and original thought to the problems of instruction everywhere we went. On several occasions, we received profound answers to the questions we should have asked rather than the one we asked. This particularly applied to headmasters and ministry officials. We were impressed also with their sheer energy and hard work. For example, the headmaster of Dodoma Alliance School, Mr. Juma, runs a boarding school of some 500 students and still teaches 20 hours a week himself. We believe this is typical. In our case, we were given a very detailed, very full program of visits covering a dozen schools and a wide variety of experiences that showed real understanding of our mission---and assumed an energy equal to theirs. We could not have used our time more profitably.

Chief of School
by [unclear] In our final discussion with the Ministry, we had the complete attention of the CEO, his chiefs of teacher training and of planning, for 1½ hours. They used the opportunity also for a frank discussion of what they consider the unilateral abrupt termination of a bilateral experiment. Before reporting this discussion, however, we would like to mention that the Chief Inspector of Mathematics, Mr. Alfred Newa, was taken from other assignments and spent his full time with us for the full week. We found his assistance invaluable.

The Tanzanian officials are understandably upset about the end of the experimental phase of AID support on December 31, 1968.

First of all, they feel that as partners in the experiment they should have been consulted. They do not agree the experimental phase is finished, since none has as yet seen the first products, made an assessment of their quality, and considered what revisions should follow. All these things are, to them, logically part of the experiment. We must say that we find their arguments convincing. Furthermore, there has been no experimentation as yet with the additional and A-level materials which Entebbe has produced, and thus even the first round, never mind the assessment and revision, is incomplete.

The Tanzanians understand the push towards regional effort, but cannot agree that regionalism makes any sense in this case. Even if Kenya and Uganda were to agree immediately to a full adaptation of Entebbe, and even if they were to solve the language problem in the same way, Tanzania would be at least three years ahead. The corresponding problems of teacher training and further curriculum experimentation and development are clearly unique. A plan for proceeding with a minimum program without US help has been drawn up, but much more could be done with continued assistance.

There is another point to this. Africans have participated as full partners in the seven years of summer workshops, and have learned very much about the first creation of a curriculum. However, we have been told that the pressure of students who had begun the program precluded any significant amount of revision based on classroom experience. This has always been a key part of curriculum experiments in the United States. For the future self-reliance of Tanzanian mathematicians, it is essential that they participate in the full cycle of curriculum development, which definitely includes the obtaining of experimental information in the classroom and resultant revision. Without this, their experience has been incomplete. Furthermore, the devising of methods for evaluation and feedback will be a very useful and indeed necessary first step in maturing an ability for educational testing which must ultimately become a native talent in East Africa.

48

Some of our Contacts

Regional Education Officer in Dodoma: Mr. Nyeme

Alliance High School in Dodoma: Mr. Juma (HM), David Martin

Dodoma Secondary School: Mr. Mwanukuzi (HM), Mr. Khaki,
Mr. Lisase

Mpwapwa: Mr. Mumbray (tutor helping primary school);
Mr. Mbale (primary teacher), Mr. Lema (HM), Mr. Cardwell

Morogoro: Mr. Mohuwi (primary head teacher)

Marian Secondary School: Sr. Julia Kubista

Mzumba Secondary School: Mr. Ambangile (HM)

Dar-es-Salaam TG: Mr. Mawowe (HM), Mrs. Peera, Mr. Springer

Aga Khan Secondary: Mr. Lila (HM), Mr. Kabir

Kibaba Secondary: Mr. Bergsonne

Ministry: Mr. Alfred Nawa, Mathematics
Mr. Meena, Assistant to CEO for Teacher Training
Mr. Michael Kinunda, CEO

Appendix G

Uganda

Our overnight visit to Uganda was to see if we could find out why they were not involved at all in the Entebbe program. Thus we are dependent for our information as to the actual state of the schools and the ability of the teachers to our informants. We talked primarily with four people, Mr. Alex Smith, Assistant Chief Inspector for Mathematics, his African assistant, Sam Muwonge, Mrs. Harbottle, who is the math education specialist at Makerere University, and Mr. Jacob Feldman, the new TEEA man in mathematics at Makerere.

Uganda has the same language problem that Kenya has, many tribal languages, no one used by any large part of the population. Much instruction in the primary school is in tribal languages, and many of the elementary teachers have little command of English. We are not able to judge what percentage of the primary students receive their instruction in English. English is used in the secondary schools universally. Apparently more elementary teachers have the minimal training of two years of secondary school followed by two years at a TTI than in the other East African countries. Since the chief inspector for mathematics is acting CEO, we were not able to meet with him. He is an African and apparently quite able. His picture might have been different. Mr. Smith's assistant, who is highly intelligent, gives a more optimistic picture. Mr. Smith himself is one of the nicest, friendliest people that we met in Africa, but his training is that of a London country secondary school master.

Mrs. Harbottle is an extremely forceful, energetic, strong-minded woman. As nearly as we can judge, without asking too many personal questions, her competence is also that of a secondary teacher. In the United States, she would be something like a mathematics supervisor in a secondary school system, where she would undoubtedly be a great success. As it is, she is probably in a job too much for her basic training, but where her personality lets her dominate the country's mathematical program. She had kind words to say for SMSG (possibly influenced by her knowledge that one of us had been involved). But she had very little to say in favor of the Entebbe program. She repeated the same comments that we had gotten in Kenya, both as to subject matter and to methods of operation. In particular, she feels that experience of the British expatriates was ignored, and that they were frozen out of the writing groups. She says that Uganda had entered the experiment, but was forced to drop out, because the books did not arrive on time. She regards EASMP as much better suited for secondary schools than the Entebbe. She reports this as the consensus of the secondary school teachers of mathematics, almost all of whom are British expatriates.

A major difficulty in change at the primary level is that a Mr. Okello jumped in quickly with a series of texts for the first three primary grades based, we understand, on an adaptation of an adaptation from West Africa. Both Miss Harbottle and Mr. Smith say it is quite poor. We were able to buy the texts and the teacher's guide and believe they should be examined by an expert. It is Ugandan policy to use texts by Ugandan authors wherever available, and higher levels in the Ministry imposed their use. We gather that efforts are being made to turn Mr. Okello off at just three grades. It is conceivable that this effort may lead to use of the Entebbe material at the primary level.

There are entirely too many TTI's, apparently staffed mainly by Indians. None of them were in session, but we were able to meet with the principal of one of them, an intelligent, energetic Goan. In his school at least there is a modern program for teacher training in mathematics, which he would like to strengthen. There is a move to reduce the number of TTI's, which he is firmly against, calling attention to the depersonalization of the student in large institutes of 500 to 1000 students. One of us (Henry) was unable to avoid mentioning Ohio State and the University of Illinois at this point, perhaps somewhat unkindly.

The Ministry has been for some time without a CEO. With such problems in the Ministry, on top of the problems of poverty in the country, it seems to us doubtful that much progress will take place for some time.

91

Appendix H

Ethiopia

1. History of Ethiopia's Involvement with Entebbe

- 1962 - Participation in the project begins.
- 1965 - Experimental courses begin at Tafari Makonnen School and the Laboratory School.
- 1967 - The decision is made for gradual but universal adoption of Entebbe.
- 1967 to 1968 - All ninth grades and all Teacher Training Institutes begin using C-1.
- 1968 to 1969 - All seventh, ninth and tenth grades use Entebbe materials. Grade seven uses a local adaptation of P-4 and P-5.
- 1969 to 1970 - All grades one, and seven to eleven use Entebbe materials.

2. Statistics (1967-8)

There are 43 secondary schools in Ethiopia of which 9 are in Addis Ababa. About 150,000 children, or 20% of the age group attend first grade. About 11% of the age group attends elementary school, about 3% of the age group attends secondary school. The number of grade one classes is about 2500. The official documents say that about 300 junior secondary mathematics teachers are required but it is not clear that that many in fact exist. Elementary teachers are Ethiopian, junior secondary teachers are 80% Ethiopian, while senior secondary teachers are only 25% Ethiopian. Only 5% of the university graduates teaching in secondary school are Ethiopian. The bulk of the expatriate mathematics teachers are Indian and Peace Corps volunteers. Ethiopian teachers are frequently on university service - an assignment as part of their university education.

3. Preparation for Adopting Entebbe Materials

In August of 1968 all 107 District Supervisors in the country attended a three week seminar to teach them modern mathematics and pedagogy and prepare them to work with the first of the seventh grade teachers in their district.

They then held workshops for elementary teachers. Eighteen professional courses for junior secondary faculty were held in October 1968. Plans included a two-week course in 1969 for 200 junior secondary teachers, 18 professional two-week courses for elementary teachers in the summer and a series of one-week courses throughout the year for tutors in Teacher Training Institutes.

Our impression was that the scheme of working through the District Supervisors was ingenious and highly successful.

4. "Road Runners"

Since 1967 Ethiopia has had a small group (3 or 4) of Peace Corps volunteers and Yale undergraduates who have served to work with all the secondary mathematics teachers in the country in the process of implementing the new curriculum. They divided up the schools among them, go on four or five week tours and then return to the capital for comparing notes and preparing additional useful materials. In 67-68 they concentrated on the implementation of the C-1 materials in ninth grade. All teachers were visited three or four times during the year, classes were observed, suggestions given, demonstration classes were taught, supplementary materials were written, and examinations given to all students. This small, enthusiastic and highly competent group contributes a tremendous amount to the success of the innovation.

5. Adaptations

The teacher's commentary to P-1 has been translated into Amharic which is the required language in all elementary schools. Four thousand teacher's guides and 28,000 textbooks have been printed locally for the combination of P-4 and P-5 which is used in grade seven. These are available at \$1.65 and \$1.00 Ethiopian money, respectively. All adaptations are watched by special language and mathematics guardians in the Ministry.

6. In the Capital of Addis Ababa, the seventh grade mathematics course, which is also their first year of instruction in English, is supplemented by television. A program is presented twice each week and the session we saw along with several hundred students was excellent in both mathematics and language. In fact, it was eerie to see an argument at SMSG 10 years earlier

repeated on television in the middle of Africa. At the time we visited, a total of 12 20-minute programs had been prepared.

7. Some People

The mathematics specialist in the Ministry of Education is Mr. John Fitzgerald, a very knowledgeable, active and forward looking Englishman. The chief expert of the Curriculum and Teaching Materials Division is Ato Tilaye Kassaie. The Assistant Minister of Programs Planning and Research is Ato Tadesse Terrefe. The man in the Mathematics Department of the University most concerned with mathematics curriculum reform is Ato Bisrat Dilnesahu. The person we met who was most concerned with training of the mathematics staffs at the Teacher Training Institutes was Miss Powell. Special mention should be made of Mr. Saunders in AID who was extraordinarily helpful.

94