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EDUCATION STRENGTHENING COMPONENT/ PRIMARY EDUCATION ASSISTANCE PROJECT II (MATHEMATICS)

JAMAICA

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EXECUTIVE SUMMARY

The Educational Strengthening Component of United States Agency for International Development (USAID)/Jamaica's Primary Education Assistance Project (ESC/PEAP) II was designed to support the Ministry of Education, Youth and Culture's (MOEYC's) plans to rapidly upgrade the delivery of primary school mathematics instruction by promoting better student performance. Although the component of PEAP II that began in October 1992 focused on mathematics, it was intended to lay the foundation for developing instructional materials, training, and assessment throughout the primary education curriculum.

Technical assistance specialists from AED, the prime contractor, and Juarez and Associates, the subcontractor, and their MOEYC counterparts planned and coordinated implementing the following activities:

- The mathematics curriculum was reviewed, and recommendations for its revision were approved and implemented.

- Mathematics textbooks were reviewed, and recommendations were made.

- Instructional materials were developed to support specific areas of the curriculum,.

- Preservice and in-service teacher training activities were designed to equip prospective and practicing teachers to use the ancillary teaching materials and to incorporate new mathematics teaching approaches and assessment strategies.

- The National Assessment Programme (NAP) was strengthened to help teachers more effectively track students' progress in mathematics.

Shortly after the consultants arrived, the PEAP II team proposed to modify the Management Information Systems (MIS) component within the ESC/PEAP project in anticipation of a pending USAID contract that was intended to carry out MIS activity in a more comprehensive fashion. This modification was approved during the first year of the project.

While the Educational Strengthening Component of PEAP II spearheaded primary mathematics curriculum development and instructional improvement, it also complemented the efforts of other international donor-assisted projects designed to improve the quality of Jamaican primary school education, particularly those that addressed mathematics education. The project also helped lead the way for comparable reform initiatives of curriculum, teaching, and assessment policies and practices in the other disciplines taught in the primary schools.

Constraints were identified at various stages of ESC/PEAP II planning and implementing. These and other factors in project development led to significant lessons learned and steps to be taken for enhancement and sustainability of the Jamaican primary mathematics education reform.

BACKGROUND

The Education Strengthening Component of the Primary Education Assistance Project) II was initialed in October 1992 to improve the quality of the delivery of mathematics instruction and, thereby, help students to achieve higher performance. Primary school mathematics education was also identified as an important issue in meeting Jamaica's economic and social development goals.

Inadequate mathematics skills are among the greatest shortcomings of primary school leavers as they enter the workforce. Such shortcomings result in both low productivity and high retraining costs.

By most valid indicators of achievement, Jamaica has done well in enrolling its primary-age children in school. However, ensuring that they learn efficiently and effectively, has been more problematic, especially in mathematics. For example, the sixth-grade Achievement Test was administered nationally for the first time in 1988. The results indicate that sixth graders were able to correctly answer only 36 percent of the questions in the mathematics section. This was the lowest average score of any subject. Other sources confirm this deficiency. Employers note that inadequate mathematics skills among school leavers constitute a glaring problem. Deficient training in practical real world mathematics contributes to the low productivity of Jamaica's workforce and the fragile state of the national economy.

Jamaica is a geographically and culturally complex island state with a rich tradition of adaptation to changing historical and economic conditions. With approximately two million citizens located on 4,500 square miles of mountainous land, Jamaica's population is primarily concentrated in a dozen major urban areas and smaller towns located around the periphery of the island. Access to postprimary schools and special social services is hindered by economic constraints and the geographical barriers created by the rugged terrain.

The educational system is a legacy of the British school model that emphasized early tracking and a high degree of selectivity. Over the past two decades the Jamaican government has initiated reforms to correct the inequities inherent in this system and to create a more egalitarian structure. The reform of the lower secondary education subsector is a manifestation of this commitment. The more recently initiated Reform of Secondary Education Project is another example. Although well established and well regarded by its citizens, the Jamaican primary education system is not without its problems. Real reductions in primary education budgets have resulted in substandard facilities, inadequate instructional materials, inexperienced teaching staff, and a shortage of support personnel. The demand for quality education increases annually. In 1994-95 over 300,000 children enrolled were in all types of primary level schools.

As in many other countries of the world, primary mathematics instruction in Jamaica is deficient in hand-on activities and applications to real-world problems. Prior to ESC/PEAP II, many teachers were trained to prepare students for examination success, not for the practical use of mathematics at home and at work. Students were taught largely through presentation, repetition, and rote drills in computational skills without learning the versatile problem-solving abilities and higher-order thinking skills needed for real-world applications. Teachers, students, and parents were too often unaware of the importance of mathematics to success in the upper grades and eventually to successful performance in management, scientific, and technical fields.

Texts and instructional materials have contributed to this orientation. British-based textbooks have lacked relevance to the Jamaican context and fail to impart the skills required for productive participation in the local economy. Texts have emphasized preparation for advanced learning rather than for the workplace and everyday life. Supplemental materials have often been poorly designed, pedagogically inadequate, and in short supply.

Another major need that was identified in primary-level mathematics was a reliable system to assess student performance. The lack of information on achievement by grades (1) constrains identification of schools, teachers, and students operating at substandard levels and (2) precludes changes in policy and practice to deal with identified weaknesses. Examinations have traditionally been used as selection mechanisms to determine access to further education and to place students in various types of schools. For example, in recent years, less than 25 percent of the students between the ages of 10 and 12 who take the Common Entrance Examination are awarded places in the secondary schools of their choice or the traditional high schools. This exam creates considerable pressure on the educational system. Far too often, teachers tend to emphasize preparation for the test rather than appropriate instructional practices.

While the MOEYC had taken initiatives to address these needs in primary mathematics instruction and assessment prior to the beginning of ESC/PEAP II, the following needs were evident:

- to support the recently (1988) established National Assessment Programme (NAP)
- to train teachers in the area of both mathematics content and teaching methodologies
- to analyze, develop, and refine instructional materials
- to review the math curriculum
- to improve teachers ability to develop and effectively use hands-on, learner-oriented ancillary materials.

Briefly, what was identified was the need for a new focus on active student learning opportunities and higher order problem-solving approaches that, in turn, place demands on curriculum developers, teacher trainers, teachers and students in terms of material resources, pedagogy, and assessment policies and practices.

To reach the project goal of assisting primary school children to meet grade-level performance standards in mathematics and, subsequently, to improve their prospects of completing secondary school and increasing their economic well being, both project implementers and stakeholders arrived at a consensus regarding the basic premises and assertions required for genuine success. Intent on avoiding failure and maximizing success, the project team stated the following in the ESC/PEAP II Project Implementation Plan (January 1993).

- Effective primary school mathematics education is critical to meeting Jamaica's development goals.

- Projects such as ESC/PEAP II are designed to support the improvement of the permanent system and, as such, serve to advise host country authorities and educators on the design and implementation aspects of improvement.

- An "islands of success" approach to development education applies to ESC/PEAP II in that the accomplishments in primary mathematics education can lay the foundation for success across the Jamaican primary curriculum and beyond.

- ESC/PEAP II will increase its success through well-founded, systematic collaboration with UNESCO, The World Bank, and other donor agency projects involved in Jamaica's Primary Education Assistance Program.

- Instructional delivery, broadly conceptualized, encompasses the whole of the teaching-learning processes, incorporating materials development, teaching methods, student assessment, and teacher education.

- Student assessment should address the stakeholders information needs within a framework of quality goals established by consensus.

- The NAP should be modern, efficient, effective, and sustainable while based on computerized data structures.

- Mathematics education is more than preparation for the workplace. It must also be emphasized in the curriculum for its intellectual and aesthetic worth.

- Indigenous materials and hands-on pedagogical approaches must accompany new technology and innovative practices in the teaching and assessment of primary school mathematics.

- Teachers are critical to successful math instruction and assessment and to the growth and development of learners and society.

- Teacher education required powerful collaboration among schools, teachers' colleges, universities, and the teaching profession.

- Preservice and in-service teacher training must be an integrated educational process.

- Education is a continuous, lifelong, process, and schools must be inclusive, not exclusive, from first to twelfth grade.

- All children can enjoy and learn primary school mathematics.

OBJECTIVES OF THE PROJECT

The Education Strengthening Component/Primary Education Assistance Project II (Mathematics) was intended to upgrade the delivery of mathematics to students in grades 1 to 6 through the training of Mathematics Resource Teachers (MRTs) and by improving instructional materials and the measurement of primary student achievement in mathematics under the already established NAP. This process required three years with a four-month no-cost extension phase (October 26, 1992, to February 1996). Two long-term advisors were needed: one in teacher training for 40 persons months and one in assessment for 20 persons months. The expertise of short-term consultants spans several areas: instructional materials development, cooperative learning, replacement units, continuous assessment, computer test systems, test results analysis and interpretation, preservice teacher education, and formative evaluation.

The expected results of the project spanned the major components of ESC/PEAP II:

- a field-tested approach to mathematics instruction at the primary school level
- 140 MRTs trained in selecting, preparing, and using effective mathematics materials and methods
- all MRTs being capable of training primary school teachers in improved approaches to the mathematics instruction
- items banks developed for grade 3 and grade 6 NAP math tests
- test data processing and timely reporting system implemented by NAP
- operational criteria-referenced, curriculum-driven test construction model
- linkages fostered among preservice teacher training institutions in primary school mathematics education
- mathematics achievement tests for grade 3 and grade 6 prepared
- materials distributed to MRT's to facilitate their teacher training efforts

The strategic objectives, selected end-of-project benchmarks, and impact targets are discussed below through the three project components: instructional delivery, assessment, and formative evaluation.

INSTRUCTIONAL DELIVERY

STRATEGIC OBJECTIVES

- to improve, in an integrated manner, the quality of mathematics instruction at the primary level
- to upgrade the delivery of mathematics by improving teacher training and instructional materials

SELECTED END-OF-PROJECT BENCHMARKS

- a field-tested and evaluated approach to mathematics instruction at the primary school level developed for the MOEYC
- at least 200 sets of indigenous materials to assist teachers in delivering active learning approaches in the classroom
- at least twelve low-cost instructional materials developed or adapted to support the teaching of mathematics in the areas perceived as difficult to teach
- all project-designated teacher trainers prepared to serve as effective MRTs to train primary school teachers in improved approaches to mathematics instruction
- mathematics educators at each of the seven teachers' colleges and University of the West Indies (UWI) oriented to model teacher training program and project-developed materials and methods
- 140 MRTs trained through a model teacher training program developed by project staff

IMPACT TARGETS

Curriculum and Educational Policy

- proposed curriculum changes approved by the MOEYC and incorporated within the new primary mathematics curriculum
- instructional materials recommendations adopted by MOEYC

- MOEYC demonstrating commitment to the materials and methods by allocating funds to purchase one complete set of replacement units and other resource materials for distribution in 800 primary schools, and 7 teachers' colleges and UWI after the life of the project.

- project curriculum materials, support activities, assessment methods, and teaching practices integrated within the MOEYC curriculum revision and in-service training activities

- MOEYC regional offices, with the MOEYC Professional Development Unit (PDU), assisting with implementing MRT teacher training and with introducing, implementing, and monitoring of the curriculum guides and materials

Materials Development and Mathematics Resource Teacher Training

- MRTs demonstrating ability to select, prepare, and use the instructional materials in the primary classrooms; formative evaluators assess MRT ability through classroom visits

- MRTs incorporating the instruction of at least one replacement unit within the class syllabus and showing commitment to using materials and methods; regional officers and evaluators assure use

- MRTs favorably disposed to the pupil-centered, activity-based, problem-solving materials and to teaching and learning approaches; determined by satisfaction rating tools used by formative evaluators

- MRTs demonstrating understanding of the new goals for mathematics and mastery of the desired teaching practices involving lessons, assignments, manipulatives, grouping, and assessment

- students in MRT classroom demonstrating increased participation as evidenced by increased student-to-student and student-to-teacher interaction, on-task behavior, and involvement in activities requiring higher-order thinking

- students in MRT classrooms demonstrating increased motivation and positive attitudes towards mathematics

- as a result of MRT regional seminars planned by the Mathematics Section of the Core Curriculum Unit under the auspices of the project, teachers and principals demonstrating effectiveness in conveying the desired teaching practices, the content and methodology of the replacement units, the construction of resource materials, and classroom organization and management practices

- the PDU of the MOEYC incorporating primary mathematics instructional materials and teacher training model into the preservice training program through the Joint Board of Teacher Education, teachers' colleges, and UWI.

- teachers and principals demonstrating effectiveness in conveying the desired teaching practices, the content and methodology of the replacement units, the construction of resource materials, and classroom organization and management issues, resulting from MRT regional seminars planned by the math section of the CCU

ASSESSMENT COMPONENT

STRATEGIC OBJECTIVES

- to determine the adequacy of the NAP's mathematics testing efforts

- to enhance NAP's efforts to ensure a valid and effective system of assessment of student needs and performance

SELECTED END-OF PROJECT BENCHMARKS

- items linked to the curriculum activities through an existing blueprint that cross-classifies objectives by mathematics content and by level of cognitive learning

- curriculum objectives in the blueprint to test items connected by item specifications, enabling inferences to be made about the attainment of curriculum objectives; specifications set for item writing

- more than 700 grade 6 and grade 3 items written, edited, and validated by teachers, education officers, and principals; all items computer filed under their corresponding objectives at least two items for each objective); 400 of these items piloted on three different occasions

- final draft of the report for the 1994 NAP grade 6 mathematics test that examined effects of sex, parish, and grade completed; item difficulty and discrimination, sex bias, and Rasch ability estimate analyses completed

- grade 6 mathematics tests, administered in 1994 and 1995 in the national sample of 142 schools, represented primary, all-age, and private schools; regional and education officer coverage; high- and low-achievement levels; and large and small size of classrooms

- NAP test results sent to schools before the end of the school year; separate reports presented on performance averages for each school, for boys and girls, and for the entire grade-level samples; male, female, and overall performance averages listed; each school's rating as high, middle, and low in comparison to all schools at each grade level listed

- item analyses based upon data for all students with valid mathematics scores carried out

- a series of workshops trained and engaged education officers, principals, and teachers in the NAP operations involving stakeholders in test construction (item preparation), test administration (developing recommendations for standardized procedures), analyses (item validation and standard setting), and reporting (specifying formats that facilitate proper interpretation and use of test results)

- a prototype of specific assessment procedures for the PEAP II Instructional Delivery Component developed; assessment of pupil learning outcomes attributable to replacement units must fit within the framework of NAP's classroom assessment model

- grade 3 Mathematics Tests administered in 1994 and 1995 in 43 schools in Trelawny and South West St. Ann

IMPACT TARGETS

- item specification implemented in all item writing activities and linked with the blueprint and the test plan for grade 3 and grade 6 tests

- a core of teachers, education officers, and principals trained in writing items, preparing tests and other assessment procedures

- prototype item bank developed so at least two test forms can be selected

- NAP freed from outside dependance on computer scanning of answer sheets through installation of optical scanner

- data processing completed in-house by trained NAP staff

- school rosters of test results distributed to schools within two months after test administration and used for decision making

- analyses of Common Entrance Examination (CEE)/NAP relationship initiated to provide Ministry with information for effective policy planning

- item analyses routinely carried out as part of test data processing and item analyses fed into item bank files

- regular and formally scheduled participation of stakeholders in similar assessment-related workshop, and in policy review panels

- changes in the test reports that reflect judged passing scores conducted

- training programs in classroom assessment conducted by NAP staff to school based coordinators

- prototype of continuous assessment guidelines and procedures exist for assessing the effects of teaching the replacement units; MRTs trained to implement these procedures

FORMATIVE EVALUATION

STRATEGIC OBJECTIVES

- to implement within the project effective formative evaluation procedures to qualitatively assess the understanding, presence, use, and effectiveness of the instructional materials and methods developed under the program

- to foster the technical strengthening of personnel within the MOEYC through training in qualitative evaluation and formative evaluation methodologies

SELECTED END-OF-PROJECT BENCHMARKS

- timely and usable reports directed toward the implementation, adaptation, and evaluation of principal instructional delivery activities and components

- core of investigators trained in qualitative evaluation and formative evaluation methods

IMPACT TARGETS

- formative evaluation findings and recommendations reflected in project decision making and fine-tuning of instructional delivery activities, components, and products

- qualitative investigation and formative evaluation methodologies and procedures incorporated within the operational structures of the MOEYC

COMPONENTS AND APPROACHES

This section describes the approaches used by each of the three major components. Although each component is addressed separately, component plans and implementation activities are integrated whenever feasible. The Instructional Materials and Teacher Education Component is referred to as Instructional Delivery. In general, component activities are presented chronologically.

INSTRUCTIONAL DELIVERY

STAFF

Dr. Ernest O'Neil, ESC/PEAP II teacher training specialist and chief of party, was assigned to the project on October 26, 1992, and arrived in country within a month, staying through the final completion date, February 24, 1996, (40 months). Mrs. Lorna Jascinthe (Jas)Bourne, Dr. O'Neil's counterpart in the Ministry, served as mathematics specialist from the beginning of the project until her untimely death in October 1995 (three years). Beginning in February 1993, Dr. John McNeil served as instructional materials specialist for approximately four and one-half months each year of ESC/PEAP II, Mrs. Bourne, in the absence of a sufficient number of Jamaican mathematics specialists, also filled the role of counterpart to each of several other international consultants in all three components over the life of the project. The Instructional Delivery technical assistance advisors included Dr. Susie Hakasson (replacement units and Los Angeles County Schools tour coordinator) and Dr. George W. Smith and Dr. Ana Maria Rodriguez (cooperative learning specialists). These three short-term consultants assisted the MOEYC during the last two years of ESC/PEAP II in areas identified as a result of formative evaluation activities in the early months of the project: need for training specific to methods used in replacement units and need for training in cooperative learning, an internal teaching method for effective use of replacement units. Following the February 1995 USAID coordinated PEAP II Management Review, David Morgan (preservice teacher training) was contracted as a local hire on a short-term basis.

CURRICULUM REVIEW PROCESS: RECOMMENDATIONS FOR CONTENT, PURPOSE, AND METHODOLOGY

One of the first tasks initiated by ESC/PEAP II in March 1993 was reviewing the curriculum to recommend improvements. The Curriculum Review Committee was composed of representatives from the Jamaican mathematics community: teachers; principals,; Regional education officers; and members of the Core Curriculum Unit, Mathematics Association, Mathematics Board of Studies, Joint Board of Teacher Education, and the Jamaican Teachers Association. Technical assistance was provided by long- and short-term advisors from Assessment, Instructional Delivery, and

Formative Evaluation in collaboration with Jamaican counterparts. (Refer to Appendix A for list of committee members.)

The first curriculum review focused on forming goals and making decisions about content and methodology, by giving attention to assumptions about learning, social needs, and views of mathematics. Discrepancies between the present and ideal math curriculums were identified. Participants reviewed innovative guidelines and scope and sequence frameworks for the teaching of mathematics as promulgated by such organizations as the National Council for the Teaching of Mathematics. The seminar concluded with establishing teams whose function was to propose content and illustrative activities for new strands of content and teaching methodologies. During the intervening two months, each team completed a tentative mathematics curriculum for a given strand between grades 1 and 6. Subsequently, during the second curriculum review in May 1993, members of the team examined the subteam's draft of the scope and standards, and affirmed recommendations for a curriculum review report. The report, presented in July 1993 through the Core Curriculum Unit to the Permanent Secretary, was approved in August as a foundation for further primary mathematics education reform.

In evaluating the curriculum reviews, participants made the following observations: reviews were widely attended, opportunities existed for expressing viewpoints, model math curriculums that held promise for meeting the needs of Jamaica were available, and serious deficiencies were recognized in the existing math curriculum. This curriculum review and recommendations served as the basis for the project's activities related to selecting and developing the instructional materials and to training teachers. The review also led directly to the philosophy, content, and methodology as found in the Ministry's newly developed curriculum guide for primary mathematics curriculum. The guide and related teacher's manual will be piloted in 1996 by 140 project trained MRTs.

EVALUATION OF TEXTBOOKS

Initially ESC/PEAP II assumed that activities within the materials development component were to complement the selection by the Ministry of a new primary level mathematics textbook series—the Merill Mathematics Series, adapted to Jamaican needs. However, it became clear that the series had not been officially adopted, that competing textbooks should be reviewed, and that textbooks may not be the most appropriate delivery system for the new curriculum. Hence, the task of evaluating the Merill texts for their place within the overall education program, as stated in the RFP, was broadened to include review of other series.

The following approach was taken: (a) a review team of teachers from different grade levels and grade sites, representatives of the Core Curriculum Unit and Mathematics Section, the Ministry textbook committee composed of representatives from the Curriculum Review Committee, and the project technical staff was selected; (b) an evaluation instrument that would reflect the curriculum revision committee's recommendations for the teaching of mathematics, such as the

inclusion of new math topics and emphasis upon real life applications and greater use of students own ideas was developed; (c) textbooks for review, including texts that are innovative and traditional and that are presented by both local and international publishers, were procured; and (d) a review of the evaluation instrument was conducted. Each member of the committee first worked individually in reviewing a category (such as content, expectations, students activities, and teacher materials) for a given textbook and then conferred with another reviewer of the same book and category to establish consensus. All of the series were reviewed and assigned a final rating by the entire committee membership. High rating textbook were recommended for possible adoption, although it was recognized that the cost of these materials might be prohibitive. Therefore, the committee recommended that if the Ministry did not adopt a highly ranked series, replacement units and other teaching and learning resources should be provided.

A replacement unit (refer to Appendix B for more detail) is an instruction unit that guides the teacher in the replacement and expansion of what textbooks provide. It addresses content, methodology, and attitudinal factors and offers student experiences in solving real-world problems that are manageable within and outside the classroom context. The replacement units and other instructional materials proposed by the committee act as useful resources in the delivery of the Mathematics curriculum. They provide active learning elements that many textbooks lack. They also provide suitable suggestions for activities, model units for the different strands of the curriculum, and other resources that the teacher can use to construct meaningful learning opportunities for students. In so doing, they support not only the teaching of mathematics, but also the integration of mathematics with other subjects in the curriculum. In replacing textbooks, the units offer opportunities for students to make conjectures, explore ideas, generalize their findings, and express these findings in both oral and written forms.

REPLACEMENTS UNITS AND INDIGENOUS MATERIALS

Although developing so called "indigenous" (or Jamaicanized) instructional materials was always a central task for the project, selecting and adapting replacement units occurred in response to the need for materials that reflected the recommendations of the curriculum review committee, such as those calling for new topics (such as statistics), for different approaches to difficult-to-teach concepts (such as fractions), and for active learning methodologies. This approach was to be reaffirmed later by MRTs who piloted replacement units.

Replacement units feature a set of investigations, projects, problem solving in real life-situations, and other activities that together address a coherent body of mathematics. The units offer teachers illustrations of the way other teachers and students have responded to the activities as well as notes regarding the mathematical ideas and suggestions for grouping and assessing.

Initially, there was concern whether replacement units developed and proven to be effective in the United States could be adapted to the Jamaican context because of cultural, language and other differences. Therefore, the units were piloted in representative schools and grade levels.

Candidates for the position of MRT participated in orientation sessions about the units and were asked both to use the units in their classrooms and to share and record their experiences. These teachers were visited by the members of the formative evaluation team during the piloting and attended the debriefing conference where they summarized their experiences with the units.

As a result of reports from the formative evaluators, positive student and teacher responses to the units, and evidence from teacher observation and interviews that teachers could adapt the units to their contexts, replacement units were adopted to serve as the following: (a) a primary instructional resource for the teaching of mathematics in Jamaica and (b) a vehicle for preparing MRTs by introducing them to important mathematical ideas and to practice consistent with constructivist views of learning—use of manipulatives, multiple representations of problems, and justification of solutions by students. Subsequently, extended use of replacement units by the MRTs verified the importance of these units in upgrading the teaching of mathematics. Currently, a set of twelve replacement units that match the recommended curriculum strands and curriculum guide is being distributed to all MRTs for use in their own schools. The MOEYC is committed to making replacement units available to all grade levels in 1996 and in accordance with Math Section plans, to most Jamaican primary schools by the 1997-98 school year if funds are available. This wider dissemination plan includes the cooperation of MRTs in assisting other teachers in the use of the units.

Indigenous instructional materials were developed in the form of a mathematics resource kit, two activities booklets, and a glossary of mathematical terms. The piloting of the kits resulted in a guide for use in grades 1 to 6.

The Mathematics Resource Kit, designed to meet teachers' need for hands-on learning contains geoboards, abacuses, rulers, trundle wheels, scales, spinners, and the like. The project staff gather examples of devices, games, manipulatives, and other instruments as found in the Jamaican teachers' colleges and primary schools. In addition, ideas for materials were collected from commercial catalogs and the ancillary materials found in text series.

To identify potentially useful resources, a few MRTs and ESC/PEAP II staff and Mathematics Section Officers constructed a prototype resource kit with over three dozen items. (Mathematics education research and practice support the use of hands-on, culturally relevant materials that can be manipulated by school children when exploring new concepts and solving higher-order problems.) The kits were pilot tested, revised and, on the basis of additional formative evaluation data and teachers' experiences, each item was described and presented in a math kit construction guide for teachers. These items were made with readily available materials, such as tin cans, bottle caps, straws, cartons, and plastic strips. All items had a purpose in the teaching of a math concept and were easy to construct. Ten kits were assembled and piloted by teachers throughout the island. (Monitoring of the field testing is described in the Formative Evaluation Component.) After evaluating additional suggestions from teachers, the project staff designed "Take It & Make It," a booklet detailing procedures for constructing a math resource kit. These procedures were

validated by teachers who attended a workshop where they followed the booklet instructions. Copies of the booklet have been distributed to MRTs and teachers' training colleges. Plans for wider production, distribution, and related training have been made and required resources through 1996-97 have been budgeted by the MOEYC.

A wide range of mathematics games, puzzles, story cards, manipulatives, and projects were collected to develop an activities booklet for teaching mathematics in grades 4 through 6. The activities in the booklets, which support the recommended curriculum, allow for individual and group participation. Draft versions were tried out in a sample of classrooms, and contributions from teachers were added in the final version. A similar booklet of over four dozen activities was developed for use in grades 1 through 3. Copies of both booklets have been made available to MRT schools, to the teacher training colleges, and to the regional offices. Similar to other project-designed instructional materials, these, too, will be provided to all Jamaican primary schools.

"The Glossary of Mathematical Terms," prepared by Mrs. Jas Bourne, mathematics specialist for the Ministry, as well as by other ESC/ PEAP II staff members, lists over 100 items. While enhancing children's learning, this extensive glossary supports the professional development of Jamaican primary teachers in mathematics.

MATHEMATICS RESOURCE TEACHERS

Selection. In the second quarter of the project, a document on the role and responsibilities of the MRTs was prepared and schools throughout the island were invited to submit the names of nominees for the MRT positions. Criteria for selection included the principal's recommendation and identification of outstanding teachers of mathematics; and self-assessment with respect to familiarity with specific mathematical topics, resources, planning of instruction, assessment, and teaching methodologies. Because responses to the invitation were predominantly from upper-grade teachers, strong lower-grade teachers had to be contacted directly. Education officers assisted in the selection process.

PILOTING OF MATERIALS. As indicated previously, replacement units and indigenous materials were piloted in classrooms. The teachers in these classrooms were generally from the MRT population, although sometimes they would involve colleagues in the piloting. While piloting materials, MRTs acquired knowledge of new methods and content, making them prime candidates for leading training workshops, their future roles as MRTs. Extensive monitoring by project staff and MOEYC math education officers along with formative evaluation activities supported this process.

MRTs Training Workshops

Seven three-day workshops (refer to Appendix C) were offered to prepare over 140 MRTs. These workshops emphasized helping participants gain the knowledge for enacting the curriculum reform in mathematics. This knowledge included an understanding of mathematical concepts to be taught (such as statistics), methodology (encouraging multiple correct solutions from students connecting math ideas to their subjects), and classroom organization (such as cooperative learning). In addition to these MRT training workshops directed by Instructional Delivery team members, MRTs were involved in other training activities conducted by the NAP and the Assessment Component technical assistance staff. This training is described in the assessment section of this paper.

MRT workshops were participant-led, hands-on introductions to the replacement unit. Participants acquired additional knowledge in difficult content areas and the found ways to increase student motivation and understanding of mathematics. MRTs who had piloted replacement units led small group sessions for other MRTs in activities using replacement units; participants were able to question (1) the rationale and the comprehensiveness of the innovation and (2) the experience learned from the perspective of students. Subsequently, participants developed and conducted their own activities as suggested in the replacement units. At a final plenary session of the workshop, all participants observed exemplary activities from each of the replacement units. Education officers from other disciplines and other Ministry observers were often present and participated in this and other final-day training activities.

The MRT workshops varied:

- Some included leadership issues to guide MRTs in their future work.
- Three workshops drew heavily upon the guidance of outside consultants.
- In one workshop a consultant not only introduced two replacement units, but also offered problem solving sessions aimed at strengthening the mathematical knowledge of MRTs.
- Other workshops had two other consultants leading presentations and activities that featured cooperative learning—its rationale and implementation.

Improving MRT planning, interpersonal communication, and presentation skills were emphasized in all training sessions and during follow-up in-school monitoring by staff members of all three project components.

All the workshops attempted to overcome prior experiences with the teaching of mathematics—experiences that were based principally on recall and memorization of rules of

operation and involved little higher-order thinking. A guiding principle was that participants should not be lectured to but should have opportunities to practice, to question, and to formulate mathematical meanings. As indicated in the formative evaluation component, all workshops for MRTs were evaluated.

ORIENTATION WORKSHOPS FOR PRINCIPALS AND REGIONAL OFFICERS

Parallel with introducing replacement units and other instructional materials, principals attended a one-day workshop where they were advised about the ESC/PEAP II intervention. They participated in MRT-directed activities drawn from replacement units and discussed the implications of the interventions for their roles.

A similar workshop was held for regional officers who experienced learning from constructivist viewpoints through replacement units taught by MRTs.

TEACHER PROFILES

Separating personal characteristics from technical skills is important as the latter can be enhanced through education and training. If the ESC/PEAP II was to be successful in achieving its goals and relating assessment, curriculum, instruction, and materials in a coherent way, a definition of teaching that is consistent with active-learning methodologies had to be the focus. Posing a rhetorical ideal that exceeds the resources of the project and is unsustainable in Jamaica beyond the life of PEAP II would lead to failure.

Throughout the project three profiles of primary mathematics teaching were presented: (a) the traditional, (b) the transitional, and (c) the desired. (Refer to Appendix D.) Each view delineated practices, not personal guidelines. Acceptance of transitional and desired practices would contribute to implementing the revised curriculum materials, to teaching methodology, and to assessment practices. Each of the three orientations was contrasted along a range of categories—lessons, assignments, computations, manipulatives, technology, student interaction, grouping, and assessment.

The profiles were presented to multiple stakeholders—education officers, principals, teachers' colleges lecturers, members of many professional groups, and teachers to clarify the intent of the ESC/PEAP II and the Math Section and to gain support for what was desired. The "Teacher Profile" was agreed upon, published, and disseminated among teacher educators, including all project-trained MRTs.

ORIENTATION SESSIONS FOR REPRESENTATIVES OF TEACHER TRAINING INSTITUTIONS

During the first year of the project, the staff developed a working knowledge of Jamaican teachers' colleges, particularly in mathematics teaching. A survey and visits to the colleges revealed training needs and resources, issues, and suggestions for improving both mathematics instruction at the primary level and programs for educating teachers.

Later, representatives from the teachers' colleges and the University of the West Indies attended an ESC/PEAP II orientation demonstration and review workshop where they discussed the project and participated in activities that illustrated the constructive approach to student learning of math.

Near the conclusion of the project, largely because of the recommendations at the USAID organized Management Review Seminar and through discussions at the ESC/PEAP II teacher education conference on primary mathematics, the linkage between teachers college curriculum gained noteworthy attention. Significant recommendations from the conference were that the teachers' college curriculum for preparing teachers to teach mathematics match the new curriculum guide of MOEYC, that materials such as replacement units be used in the college's mathematics program, and that MRTs participate, as appropriate, as resource persons in the college programs. Two successful regional follow-up seminars were held to address these recommendations. Representatives from all stakeholder groups, including MRTs, education officers, and teacher educators at the host colleges participated in these seminars.

PROFESSIONAL DEVELOPMENT

In April 1995, the project sponsored two Instructional Delivery staff members (Mrs. Jas Bourne, mathematics specialist, and Miss Beatrice Wilson, mathematics education officer) to participate in a Los Angeles, California, study tour on using mathematics replacement units and to attend the Annual Meeting of the American Educational Research Association in San Francisco.

ASSESSMENT

The NAP's institutionalization and maintenance of its examinations system was supported by the ESC/PEAP II Assessment Component by (1) carrying out item and test preparation procedures in line with NAP's test development strategy, (2) expanding NAP's in-house computer capabilities, (3) collaborating to develop the classroom assessment model, and (4) conducting staff and stakeholder development activities.

ESC/PEAP II supported NAP's (1) development of a curriculum-referenced basis for assessing student learning in mathematics, (2) acquisition of an in-house test paper optical mark reader (OMR, answer sheet scanner), (3) development of computer test scanning and data processing

capability, (4) use of stakeholders in test development activities, (5) development of a school-based classroom assessment model, and (6) establishment of prototype item banks.

STAFF

In June 1993, Dr. John Bowers, who replaced Dr. Carlos Mora as test and measurement specialist and Mrs. Sephlin Myers-Thomas, who assumed duties as the Ministry's project testing officer revised the PEAP Assessment Component's initial implementation plan. During the third and final year of the project, PEAP II assessment component tasks were carried out through short-term consultancies by Dr. Anthony Nitko (classroom assessment and training), Dr. Richard Johnson (test data processing), Dr. Carla Collins (data analysis and reporting to various stakeholders), and Dr. John Bowers (test preparation, data analysis, and reporting).

NAP'S CURRICULUM-CENTERED ASSESSMENT MODEL

NAP's mathematics achievement test items are tied to explicitly stated learning objectives to connect assessment and instruction. The linkage of items and continuous assessment procedures to objectives is done by linking test blueprints, item specifications, and prescribed test plans. Item banking stores item content and usage data so that equivalent tests with predictable properties can be constructed. Standard setting procedures validated by the item response theory estimates lead to defensible minimum competence interpretations of student performance. Because stakeholders collaborate in NAP's test construction activities, they share ownership in the tests.

NAP's assessment program covers grade 1 through grade 6. In mathematics, tasks are (a) to set, administer, process, and report results for grade 1 readiness testing, grade 3 diagnostic testing, and grade 6 achievement testing and (b) to implement a classroom assessment model at all primary grade levels. A wider mandate is to implement procedures that will replace use of the Common Entrance Examination for grade 7 selection. NAP has extended its assessment program to include language arts, science, and social studies, with assistance sponsored by the Nordic Development Fund under the International Development Bank.

NAP ITEM AND TEST PREPARATION

Test Development Process. NAP mathematics testing is curriculum-driven and curriculum referenced. Test blueprints, test plans, and item specifications connect curriculum objectives to test items (and continuous assessment procedures) and allow valid inferences about attaining these objectives.

The test blueprint cross classifies instructional objectives by content topic (number, algebra, measurement, geometry, and statistics) and by level of learning (knowledge of facts and procedures, concept attainment and application, and problem solving). The test plan samples

objectives to be tested from the test blueprint, and specifies the number of items in each content learning level cell, the difficulty level of the test, test length, item types, scoring methods, reporting testing time, and administrative conditions. Item specifications set rules for item writing.

Item Development. In PEAP II's first year, grade 6 mathematics items were drafted by teachers, education officers, and principals, (some who represented the 43 schools in Trelawny and St. Ann and who have worked with NAP) at Moneague item-writing workshops during September and October 1993 and were edited and validated in a workshop in December in Moneague. One hundred newly written items were edited and divided into five forms of twenty items each. Preliminary pilot testing was carried out in December 1993 in eight schools in four parishes. Altogether 1,260 papers were completed, and item analysis was carried out.

Mrs. Myers-Thomas conducted an item-writing workshop in Moneague in July 1994. Participants were those who wrote grade 6 item specifications and produced 390 test items at the 1993 item-writing workshops at Moneague; 190 more items were final processed from the 1993 item-writing workshops. The July 1994 Moneague workshop produced 380 additional items. Mrs. Sephlin Myers-Thomas then organized a two-week session in August and December of 1994 that involved expert editing of these grade 6 mathematics items for computer entry and item banking. In late December 1995 and early January 1996, further item editing was completed by a team of mathematics specialists. All items for grades 3 and 6 have been extensively reviewed and edited.

In 1994 and 1995, NAP trial tested newly written grade 6 mathematics items by including them as part of the regular NAP grade 6 test. For each year, 150 newly written grade 6 mathematics items were assembled into 10 trial forms of 15 items each. These forms were evenly allocated among the schools in the national sample during the administration of the regular mathematics tests. Further pilot testing was done in September-October 1995; 100 grade 6 items and 75 grade 3 items were put in five booklets (20 grade 6 and 15 grade 3). The sample used for this pilot-testing task was drawn from various types of schools in Kingston, St. Andrew, and St. Catherine. As it was necessary to administer the tests to grade 7 students (for grade 6 test) and grade 4 students (for grade 3 test), some secondary and high schools were asked to participate. A representative sample of schools was randomly selected, (traditional high, upgraded secondary/comprehensive, junior high, secondary, all-age, primary, and Preparatory). The booklets were evenly distributed to the over 1,200 students who took the tests. Sephlin Myers-Thomas and NAP staff also prepared observation checklists for the 1994 and 1995 administration of the grade 6 NAP tests. This information is useful in deciding future changes in test administration procedures.

National Testing Sample. For the 1994 and 1995 administration, a national cluster sample of schools was drawn; 99 schools were sampled representing primary, all-age, and preparatory schools. The sample schools are in addition to the pilot sample of 43 schools in Trelawny and St. Ann, which have been working with NAP.

Analyses. Analyses were run in 1993 for the grade 3 diagnostic mathematics test, the grade 3 language arts test, and the grade 6 mathematics achievement test. Item analyses offered information for later test item development and test selection. Large differences based on sex were found in all tests and uniformly favored girls; 1991 NAP grade 6 test data in four subjects were also downloaded, and item analyses were carried out for the mathematics, social studies, and language arts tests.

Similar analyses were conducted for the results of NAP's 1994 and 1995 regular testing. A report for the 1994 NAP grade 6 mathematics test examined sex, parish, and grade effects; item difficulty and discrimination; sex bias; and Rasch ability estimates. Analyses are completed for the 1995 tests, and final draft reports are being edited.

NAP Computer Operations

Optical Mark Reader Scanner. NAP's acquisition of an OMR (answer sheet scanner) is essential to establish timely in-house processing of data entry, scoring, analysis, and reporting. In December 1993, consultant Dr. Richard Johnson assisted NAP in preparing OMR specifications sent to World Bank in January 1994. In March-April 1994, Dr. Johnson helped NAP to review and evaluate tenders submitted by various OMR suppliers and to conduct a short briefing session for NAP and CEE data processing staff as part of a two-day orientation and training workshop.

Test Data Processing. Dr. Johnson returned both in May-June 1994 and in May-June 1995 to oversee the processing of grade 6 test data and to document procedures for the overall NAP computer processing operation. Grade 6 test papers were scanned with the Opscan 10 machine at STATIN.

In 1994, grade 6 mathematics tests were completed by 12,307 students in the national sample of 142 schools that represented primary, all-age, and private schools; regional and education officer coverage; high- and low-achievement levels; and large and small student enrollment. The 43 Trelawny and St. Ann schools that have worked with NAP the past few years were also included. Fifth grade students in the sampled schools who took the 1994 CEE also took the NAP grade 6 mathematics test so the results of the two instruments could be compared. In 1995, grade 6 mathematics tests were completed by 12,765 students in the national sample.

Processing the test data for both years was successful and timely; score results were sent to schools in early July, before the end of each school year. Results for grade 6 and grade 5 students who took the tests were reported separately to each school. The following information was sent to the schools:

- a list of names of students whose papers were unscorable (forms incomplete or completed incorrectly)

- a list of names of students who registered but were absent were also noted
- alphabetical student roster, which included names of those who registered late and subscores and total scores for each pupil
- a list of averages for each school, for boys and girls, and for the entire grade-level sample.
- the school's rating as high, middle, and low in comparison to all tested schools at each grade level

Item analyses for each year's regular test results were carried out separately for boys and girls in Grades 5 and 6. Item response data were also analyzed for the ten 15-item tryout forms administered (one version in each school) at the same time as the regular 80-item mathematics test. Dr. John Bowers conducted the item analyses of the five booklets for both grades 3 and 6. Information gleaned from the results was used to edit pilot-tested items.

Grade 3 Mathematics Diagnostic Tests. NAP finished dBase entry of 1994 and 1995 grade 3 mathematics and language arts diagnostic item and total score data. Item analyses were completed and reported to workshops attended by grade 3 and grade 4 teachers in the pilot schools that administered the tests in Trelawny and St. Ann.

NAP Grade 6 Mathematics and Common Entrance Examination Scores Comparisons. NAP downloaded 1994 CEE data for matching with 1994 grade 6 mathematics scores. Dr. Johnson wrote the matching program, and Dr. Bowers ran comparison analyses in Minnesota. Test results for 54,941 students were in the CEE file with 10,415 in schools in the NAP sample. A total of 8,922 name matches were found, with some deleted who had been absent for NAP testing. The final output file contained 8,079 cases. When the analyses were completed, a research report was written.

Consultant Dr. Carla Collins completed a two-week consultancy to review data and write a report on NAP's two-year testing for 1994 and 1995. Her report was comprehensive, informative, and suitable for reporting to various stakeholder groups.

Macintosh Hardware and Software Acquisition. ESC/PEAP II acquired Macintosh hardware (Quadra 660 AV and a 16 inch monitor, a flatbed ScanMaker IIXE, and an HP LaserJet 4MP printer), which is operational with Word 5.1, Aldus PageMaker, ,Aldus Freehand, and other software programs.

STAFF DEVELOPMENT

A series of stakeholder workshops were instituted and continued throughout the project to actively train and engage education officers, principals, and teachers in NAP's testing operations. Activities involving stakeholders included test construction (item preparation), test administration (developing recommendations for standardized procedures), analyses (item validation and standard setting), and reporting (specifying formats that facilitate proper interpretation and use of test results).

Item Development Workshops. Item preparation workshops were conducted by Sephlin Myers-Thomas and NAP staff at Moneague and in Kingston in 1993, 1994, and 1995. Participants were principals, teachers, and education officers, who developed grade 6 mathematics item specifications and drafted and reviewed multiple choice test questions for the grade 6 mathematics test. New grade 3 diagnostic mathematics test items were developed at workshops conducted by Mrs. Myers-Thomas at Springburn House in 1994 and 1995.

Short orientation and review sessions were held in Clark's Town in 1994 and 1995 for third and fourth grade teachers in the 43 Trelawny and St. Ann schools who administered the mathematics and the language arts diagnostic tests to grade 3 pupils. These teachers reviewed item response data and offered suggestions on the kinds of test reporting wanted.

Orientation Workshops. Workshops were held both years for all primary education officers to inform them about the NAP agenda, to explain the national school sampling plan, and to involve them in registration procedures for all grade 6 students in the sampled schools and for the grade 5 students who took the CEE. Four similar workshops were conducted in Kingston, Brown's Town, Montego Bay, and Mandeville by NAP both years for principals in the national school sample to set standards (passing scores).

Standard Setting. A workshop in standard setting was conducted in November 1995 by ESC/PEAP II staff. The objective of the workshop was to set a passing score (using the Angoff method) on the 1994 grade 6 mathematics test administered in May 1994. The 30 participants were those teachers, principals, and education officers who participated in earlier NAP/PEAP workshops on item preparation. Participants were divided into five groups; each group estimated the proportion of "minimally achieving" students who would successfully pass each item on the 1994 grade 6 mathematics examination.

Participants learned that (a) a passing score reflects an interaction between examinees' ability and a test, (b) there is no absolute passing score, such as 60 percent, and (c) the setting of a passing score is best based on the judgments of experienced teachers and educators who are familiar with students, the test, and the curriculum. This group exemplifies these understandings.

University of Pittsburgh Study. Mrs. Sephlin Myers-Thomas enrolled for the winter term in January 1995 in the graduate school program in the Department of Psychology in Education at the University of Pittsburgh. (Much appreciation is owed to Mr. Danny Gordon of

USAID/Kingston, Dr. Anthony Nitko at the university, and Miss Isoline Reid and other MOEYC top administrative staff who expedited her study program.) Mrs. Myers-Thomas enrolled in four courses: Constructing Achievement and Ability Tests, Introduction to Program Evaluation, Statistical Methods II, and Independent Studies. In mid-April she attended the annual meetings of the American Educational Research Association and National Council on Measurement in Education in San Francisco, California.

CLASSROOM ASSESSMENT METHODS

NAP Classroom Assessment Model. For the past few years, NAP has been developing a school-based continuous assessment model. NAP's approach is to strengthen teacher assessment skills rather than create specific assessment procedures. An innovative feature of NAP's continuous assessment model is to place a school-based assessment coordinator who is trained in general assessment methods in every primary school site. Teachers trained by the coordinators learn various assessment skills, such as selecting appropriate and feasible continuous assessment methods and maintaining pupil progress records.

During PEAP II's second year, the project began to assist NAP in further developing its classroom assessment program. Midway through the project, replacement unit intervention assessment procedures were being planned and developed by PEAP II's instructional delivery staff. It was important, therefore, to ensure that the assessment procedures specific to the replacement units would fit within the framework of NAP's classroom assessment model. Classroom assessment was the area where the two PEAP II components (instructional delivery and assessment) most productively collaborated.

PEAP II funded the attendance of Dr. Faulkner and Mrs. Bernetta Porter, the Deputy Coordinator of NAP who has been in charge of continuous assessment model-building, at the April 1994 meeting of the National Council on Measurement in Education in New Orleans, where they met with Dr. Anthony Nitko, a leading authority in testing and assessment, to outline terms of reference for his planned four-week consultancy. This consultancy in June-July 1994 assisted NAP in evaluating its prototype school-based classroom assessment model, in designing and conducting for NAP, PEAP II, and MOEYC staff a week-long residential workshop that focused on the knowledge and skill requirements of school-based assessment coordinators, and in developing future follow-up activities. Dr. Nitko prepared materials for the NAP who immediately conducted a second week-long residential workshop for currently posted school-based assessment coordinators.

Replacement Unit Assessments. Dr. Nitko addressed issues in preparing assessment specifications and procedures for PEAP II's mathematics replacement units when he returned for a two-week consultancy in mid-October 1994. He had two goals:

- to help NAP explain its curriculum-based testing approach and assessment perspective to higher-level MOEYC and professional educators

- to assist NAP and PEAP II staff to plan, develop, and conduct group training sessions for selected MRTs and school-based assessment coordinators.

Training topics included linking replacement unit learning targets with existing curriculum objectives, assessing higher-order replacement unit learning skills, and preparing guidelines for teachers to develop locally specific replacement unit-based lesson plans that include assessment procedures.

Dr. Nitko returned for a third consultancy in February/March 1995 in order to assist NAP in further redesign and revision of its continuous assessment model. The model at that time was being implemented in 43 schools in Trelawny and St. Ann. Dr. Nitko helped NAP to train school assessment coordinators.

School-Based Continuous Assessment Materials. Mrs. Bernetta Porter, worked closely with Dr. Nitko to develop material for school-based coordinators to use in upgrading the in-school assessment skills of their colleagues. Dr. Nitko assisted by evaluating and redesigning these materials.

Replacement Unit Assessment Materials. Assessment materials for the replacement units that were initially developed by MRTs were reviewed and refined by Dr. Nitko, who consulted on a short-term basis and assisted PEAP II in training MRTs. Procedures developed not only corresponded to the innovative teaching and learning activities of the replacement units but also were consistent with the core curriculum's mathematics objectives. Workshops were conducted to train teachers in applying continuous assessment methods that are locally feasible. Dr. Nitko assisted in training selected MRTs who were selected to implement the PEAP II replacement units in their schools.

FORMATIVE EVALUATION

The purpose of the Formative Evaluation, the third component integrated within the ESC/PEAP II design, was to provide continuous evaluative feedback to project staff on intervention use and to provide information about the project activities and accomplishments to interested stakeholders. (See the previous section for the two principal component objectives.)

Formative evaluation activities were implemented throughout the life of the project— the objectives-setting phase, the formative phase, the later usage phase, and the finalization phase of the project.

FORMATIVE EVALUATION COMPONENT STAFF

The ESC/PEAP II Formative Evaluation Component was lead by the short-term consultant Dr. Julia Richards, who initiated her work in January 1993. She dedicated approximately three months per year to the project over three years, working with Mr. Carlos Browne, assistant chief education officer, Program Monitoring and Evaluation Unit, her principal counterpart in the Ministry. Their field work was supported by six postgraduate students from UWI, Faculty of Education, especially Mrs. Deloris Royes-Graham and Mrs. Yasmeen Yusuf-Khalil, who were hired by the MOEYC.

BASELINE STUDY

During May-July 1993 (year one of the project), a baseline study of mathematics instructional practices was undertaken in a sample of primary and all-age schools. The investigation documented current instructional practices and oriented the staff about project interventions in instructional materials, teacher training, and continuous assessment.

The field study was carried out in thirty-six classrooms of selected inner city, urban, rural, and remote schools scattered throughout the island. The six postgraduate students were trained by Dr. Richards and Mr. Browne in qualitative field procedures. The team applied the instruments in the selected classrooms. Each classroom was observed on one school day. The observation instruments focused on the physical organization of the classroom, the use of time and space, material-based pedagogy, instructional and assessment strategies, classroom management, and teacher-student interaction. Before initiating project interventions, the evaluation team interviewed classroom teachers and the school principal to obtain their perceptions of mathematics instructional delivery.

The significant research questions addressed by the Baseline Study include the following:

- What mathematics instructional delivery practices are teachers using?
- What instructional materials do teachers use?
- What textbooks and other learning materials do students use?
- How do teachers organize their delivery of mathematics?
- What assessment and record-keeping procedures are employed?
- How much time do teachers dedicate during the week to mathematics instruction?

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- How do teachers rate their own professional preparation to teach mathematics?

Several key findings about current mathematics instructional practices, including the following, emerged from analysis of the data. The most salient findings are listed below:

- Mathematics classroom delivery tended to be teacher-directed, with the teacher functioning as the sole purveyor of mathematics knowledge in the classroom. Most of the interactional class time was spent on teacher presentation, teacher explanation, teacher interpretation and teacher direction giving.

- Mathematics instruction centered around the execution of short, one-correct-answer computational exercises according to predetermined and generalizable procedures that are intended to become automatic, given sufficient board-work and seat-work practice.

- Mathematics learning was an individual endeavor; communication, consultation, and collaborative learning among students was discouraged.

- Few mathematics learning tasks were provided for the students to talk, write, and engage in meaningful communication about mathematics. The mathematics questions teachers asked and the activities they generated generally require a lower level of thinking.

- The primary instructional materials in the classroom were chalk and the chalkboard. Some manipulatives, in indigenous materials such as bottle stoppers, were used in the lower grades, but their use was teacher prescribed.

- Mathematics lessons were organized in one-week units, centered around narrowly stated performance objectives. Daily 35-45 minute lessons taught or retaught all or part of the weekly lessons. Lessons consisted of an application example executed by the teacher with student intervention, further examples executed by students at the chalkboard to check for understanding, and practice seat-work exercises.

These findings were presented at a colloquium for MOEYC education officers, USAID officials, UWI lecturers and ESC/PEAP II consultants and specialists in November 1993 as well as workshops for principals and regional education officers and MRTs, in both March and May 1994.

PILOT TESTING OF INSTRUCTIONAL MATERIALS AND APPROACHES

Formative evaluation activities focused on monitoring the understanding, use, acceptance, and impact of the project-developed or selected instructional materials and teaching approaches as

they were field tested in the primary classrooms by MRTs. During the first two years of the project, twelve replacement units were pilot tested in three cycles:

- Cycle 1—October–November 1993: three mathematics replacement units (multiplication, measurement, and statistics) and the preliminary version of three locally developed instructional resources: "Glossary of Mathematics Terms," "Mathematics Activity Booklet-Grades 4-6," and a Mathematics Resource Kit by twenty-nine teachers in selected primary and all-age schools

- Cycle 2—February–March 1994: five replacement units (collections, excursions, geometry, fractions, and introductory statistics) by twenty teachers

- Cycle 3—October–November 1994: four replacement units (geometry grade 2, place value, decimals, and division)by thirteen teachers

Classroom observation and interview instruments were developed by the formative evaluation specialist and then applied in the classroom by the evaluation team consisting of Dr. Richards, the two investigators contracted by the project, Mrs. Royes-Graham and Mrs. Yusuf-Khalil, UWI postgraduate students, and lecturers from Mico Teachers College. Each pilot classroom was visited at least twice to observe teachers while they introduced the replacement unit lessons. Teachers were also interviewed about their pilot testing activities. On the basis of the formative evaluation observations, teaching evaluations, small group reports, and teacher questionnaires, workshops, feedback, and recommendations were provided for charting project direction.

The field testing activities focused on the following research questions:

- What replacement unit lessons did teachers introduce in their classrooms?

- What challenges or problems did the teachers and students encounter?

- What adaptations were made?

- Were continuous assessment activities incorporated into the lessons?

- How do the teachers judge the replacement units and the indigenous resource materials (mathematics kit, activity booklet, glossary) in terms of their time demands, ease of use, the availability of needed materials, the cultural appropriateness of the activities, and the effectiveness of the materials in generating student interest and learning outcomes?

- How do the students respond to the learning activities?

- Through the instruction of the replacement unit, do teachers approximate desired teaching practices?

The principal findings of the pilot study evaluations are listed below:

- The Cycle 1, 2, and 3 replacement units were enthusiastically received by both the pilot teachers and their students. Students were observed and reported to have enjoyed the hands-on, participatory, and student-centered activities.

- Although all of the teachers had introduced many of the replacement units in their classes, few had finished the entire unit during the five-week pilot testing periods. Teachers found the lessons difficult to instruct within the small blocks of the class timetables. Because of the many school obligations and activities (including revision work for the CEE), teachers felt restricted in the amount of time they could dedicate to piloting the replacement unit lessons.

- Teachers reported as their greatest problems the lack of space in their classrooms and the lack of materials needed to instruct the replacement unit activities. Because teachers had to locate or make most of the lesson materials and because they had to study the unit to implement the activities, they found lesson preparation to be very time consuming.

- Overall, teachers found the replacement units to be easy-to-use and flexible instructional models for introducing or reviewing mathematical concepts that are generally hard for students to comprehend. The units were followed closely; the few adaptations mostly involved the substituting certain indigenous materials or the changing of nomenclature to make the units more "Jamaicanized."

- Pilot teachers were observed to approximate many of the desired teaching practices outlined in the ESC/PEAP II "Teacher Profile," particularly in lessons, assignments, computational procedures, manipulatives, and review. Nevertheless, teachers demonstrated little familiarity with small group instruction, cooperative learning, and continuous assessment at this stage of the project.

EVALUATION OF TRAINING WORKSHOPS

A general objective of the ESC/PEAP II project was developing a model teacher training program to train at least 140 MRTs in selecting, preparing, and using effective mathematics instructional materials and teaching approaches. The Formative Evaluation Component participated in the evaluation and feedback processes involved in the numerous instructional delivery training workshops through the design, implementation, and analysis of workshop assessment questionnaires. The following workshops, conferences, and seminars were evaluated:

- Cycle 1 Orientation and Wrap-up Workshops (October-November 1993)
- Cycle 2 Orientation and Wrap-up Workshops (February-March 1994)
- Cycle 3 Orientation and Wrap-up Workshops (October-December 1994)
- Information Sharing Seminar for Principals (March 1994)
- Information Sharing Seminar for Regional Education Officers (March 1994)
- Mathematics Resource Teacher Training Workshop: Moneague College (March, May, June 1994)
- Mathematics Resource Teacher Orientation Conference: Ocho Rios (October 1994)
- Mathematics Materials Development Workshop (October 1994)
- Replacement Unit Learning Targets Workshop (March 1995)
- Cooperative Learning Workshop: Mandeville, Ocho Rios (November 1994)
- Advanced Cooperative Learning Workshop: Mandeville, Ocho Rios (May 1995)
- Teacher Education Conference on Primary Mathematics (October 1995)

Questionnaires were developed for participants to evaluate each of the workshops, seminars, and conferences listed above. Questions elicited both open-ended and ordered responses. During the training sessions, the evaluation team informally interviewed participants to obtain additional insights on the training experience. Participants were also asked to reflect back on their training during follow-up interviews.

The formative evaluation research questions about training activities were the following:

- How were the workshops organized? What were their objectives? Who attended the workshops? What was the level of participation and interest? What was the perceived quality of the presentations and working sessions?
- How were MRTs trained to use replacement units, other resource materials, and the targeted teaching practices and instructional strategies?

- Do the Mathematics Resource Teachers, principals, and education officers view the training efforts as effective and sufficient?

- What aspects of the training workshops did the participants consider most applicable?

- Do the teachers express more confidence and competence to use the instructional materials and methods as a result of their training?

- What kinds of additional training do they recommend?

The participants' assessment of the training activities yielded important insights on ways to improve the training model and indicated areas necessitating training or reinforcement. A summary of some of the findings that were instrumental in shaping future training are presented below.

- Many of the pilot teachers felt their one-day orientation training was insufficient. Most of the pilot teachers expressed familiarity with the unit only to the extent that they had piloted certain activities in their classes. Greater familiarity and understanding of the units was gained at later MRT training workshops. Some of the pilot teachers were unclear as to the objective or the mathematical ideas underlying the replacement unit activities, and many said they would have appreciated training in organizing and assessing the lessons.

- The MRTs who were trained at the Mathematics Resource Teacher Training Seminars held at Moneague College and the Orientation Conference held at Madge Saunders Center were enthusiastic about the training they had received. All applauded the training technique whereby they as participants were actively engaged in interpreting and implementing the replacement unit activities and gained working knowledge of the entire replacement unit.

- After their initial training, MRTs felt prepared to introduce the replacement unit lessons in their classes; however, they expressed the need for further training in some the teacher practices incorporated within the replacement units: continuous assessment methods, cooperative learning, the construction and use of manipulatives, problem solving and integrative learning.

- To be effective in their schools and clusters, all MRTs requested training in the use of other replacement units needed to address other problematic areas of the curriculum or to accommodate other grade levels.

- The Cooperative Learning Workshop and Advanced Cooperative Learning Workshop, developed in response to MRTs feedback, were rated by the MRTs as both beneficial and relevant training seminars. Many MRTs later indicated that they began to develop a sense of

being able to skillfully use the units and integrate the desired teaching practices after they implemented cooperative learning.

MONITORING OF PROJECT INTERVENTIONS

Throughout the second and third year of the project, the Formative Evaluation Component monitored the MRTs' project-related activities and changes in teachers' perceptions. The activities involved in the formative evaluation of the later usage phase of the project included observing classroom activities and interviewing teachers and principals.

In May and June 1994, a sample of fifty MRTs were interviewed about (1) their perceptions and use of the instructional and training materials, (2) the impact these materials have on teaching and student learning, and (3) their posttraining activities as related to the project expectations. Twelve additional teachers were randomly chosen to conform a longitudinal teacher profile sample. These teachers were observed teaching mathematics and interviewed before receiving their initial training. Ten of the teachers were subsequently observed at the beginning of the 1994-95 school year and eight were observed at the close of the school year. The MRT Activities Report was disseminated at the Orientation Conference. At the Advanced Cooperative Learning Workshop in May 1995, MRTs were asked to record their 1994-95 project-related activities. To systematize the classroom monitoring of MRTs, a classroom observation and interview guide was developed for use by the evaluation team from November 1994 to November 1995.

The research questions to monitor and evaluate activities included the following:

- What replacement unit lessons and other mathematics activities have the MRTs introduced in their classes?

- Which cooperative learning structures have they tried; which have been most effective; how have the students responded to small group learning?

- What problems have the MRTs and students encountered about the materials and teaching practices?

- What do the MRTs judge to be the cognitive and affective effects of the instructional materials and teaching strategies?

- What ideas emanating from the training sessions have been most applicable to the MRTs for their delivery of mathematics instruction?

- Have the MRTs introduced the replacement unit and other materials to the principal and teaching staff in their schools?

- Do the MRTs understand their role and responsibilities as Mathematics Resource Teachers?

The principal findings deriving from the ongoing monitoring of project interventions include the following:

- Few of the Cycle 1 and 2 pilot teachers interviewed during the May-June monitoring activity reported that they had continued to work with the replacement unit following the pilot study wrap-up workshop or MRT training workshop. In some cases, they had finished the unit or they felt they needed to cover other topics in the mathematics curriculum in the remaining school months.

- Most of the MRTs trained at the March and May Moneague training workshops had introduced one to three lessons in their classes by the close of the 1993-94 school year. The May and June participants said that the training had come at a difficult time in the school year because of revision, testing, and end-of-the-year activities.

- All but a very small percentage of the MRTs introduced replacement unit lessons in their classes during the 1994-95 school year; while the majority introduced up to seven lessons, few were able to complete all of the lessons in the unit. Many MRTs introduced the lessons during specific blocks of the grade syllabus, while others spread the lessons over the entire term or terms.

- Problems encountered by the MRTs in the use of the project instructional materials and teaching practices included the lack of materials, lack of space, and lack of time because of the tight timetable. Teachers reported the student problems as having to do with a lack of familiarity in working in groups and sharing resource materials.

- All MRTs reported increased confidence and ease teaching the replacement unit and incorporating the new ideas and teaching practices, especially after each training session and teaching the unit for the second and third time.

- During the ongoing classroom observations, MRTs were observed to adhere to the methodology of the replacement units, to show ingenuity with regard to the adaption of lessons and the substitution of locally available materials, and to successfully incorporate varied cooperative learning structures.

- At the close of the 1994-95 school year, MRTs reported that they had discussed the replacement unit and other materials with their principals and fellow teachers and had advised

teachers in their school with mathematics teaching problems or concerns; the majority had presented the materials to their schools during staff development sessions; approximately one third had conducted a workshop with their staff on the use of the materials and teaching methods or had directly trained another teacher or teachers in their use.

- Teachers reported that they had increasingly incorporated into their general teaching the teaching practices and assessment methods introduced in the replacement unit lessons and modeled at the training sessions. These included cooperative learning, subject matter integration, peer teaching, extended question-answering wait time, and more emphasis on writing.

EVALUATION OF IMPACT

At the close of the 1994-95 school year, the Formative Evaluation Component conducted a classroom-based study to examine the effectiveness of the activities, components, and products incorporated within the ESC/PEAP II evaluation structure. The focus of the final field study analysis was on providing a qualitative assessment of the attainment of the instructional delivery impact targets established by the project about teacher training and materials development. The data were gathered through the application of inventories, checklists, classroom observation forms, focused interviews, and questionnaires administered by Dr. Julia Richards, Mrs. Yasmeen Khalil, and Mrs. Deloris Royes Graham. Because multimethodological strategies were used to collect the data, different samples were chosen for applying the instruments of the study. For the classroom observations and the student attitude toward mathematics survey, comparison classrooms taught by teachers who have not been trained through project workshops were also randomly selected for participation in the study. Data analysis consisted of reducing the qualitative data, calculating frequencies of each indicator of impact and, where appropriate, making within-group and between-group contrasts between the MRT classrooms and the comparison classrooms. Where indicated, t-test and chi-square analyses were performed.

The significant questions orienting the impact evaluation included the following:

- What is the extent of the mathematics resource teachers' knowledge about the project materials and teaching approaches?

- How do the MRTs perceive the importance, adequacy, and use of the materials and the training they received?

- To what extent do the MRTs show mastery of the content and methods of the instructional materials and approaches?

- To what extent are the teachers committed to using the materials, the assessment methods, and the teaching approaches?

- Are the students favorably disposed to the materials and approaches?

- Does the use of the materials and methods stimulate increased student participation in the learning process?

- Do teachers indicate that through the use of the materials and methods, students' understanding of mathematic ideas and concepts is increased?

- Does the use of the materials and methods help improve students' motivation and attitudes toward mathematics?

In general, the numerous findings from the impact study (1) demonstrate that the end-of-project status about the Instructional Delivery Component's activities and products were attained and (2) suggest that ESC/PEAP II has been successful in addressing its central objectives of improving the quality of mathematics instruction at the primary level and upgrading the delivery of mathematics through improvements in instructional materials production and use and in teacher training. Among the significant findings of the study (Impact Study, 1995) are the following:

- All MRTs have received specific training in using at least one replacement unit and desired instructional practices and have at least one replacement unit and other project-developed resource materials appropriate for their teaching level.

- MRTs report that they have introduced in their classes the equivalent of at least four weeks of replacement unit lessons. They are able to articulate their understanding of the objectives, teaching methodology, and learning targets of the replacement units and can articulate reasons for their decisions about the syllabus, timetable, classroom organization, substitution of materials, student assessment techniques, and other classroom processes required for implementing the replacement unit.

- MRTs are(1)positive about the replacement units and instructional approaches and express the desire to continue to use these instructional materials,(2)report their own sense of being able to teach replacement unit lessons successfully and integrate the materials and methods into their teaching, and(3)are able to demonstrate adherence to the methodology of replacement units.

- MRTs trained at project-designed workshops show greater frequency of use and closer approximation to targeted instructional practices and cooperative learning methods than teachers who have not received ESC/PEAP II training. They also show frequency of use and

closer approximation to targeted instructional practices and behaviors than they did before receiving ESC/PEAP II training.

- MRTS more frequently ask student questions and engage students in mathematics activities requiring higher orders of thinking than teachers who have not been trained in project-designed workshops.

- MRTs report high/increased student participation and mathematics concept acquisition attributed to replacement unit introduction. They also report high/increased student participation and collaboration attributed to the implementing of cooperative learning.

- Students in MRT classrooms demonstrate the following: (1) positive attitude about the replacement unit lessons and cooperative learning and express the desire to continue participating in these types of learning activities, (2) greater frequency of instructional interaction with their teacher and peers than students in control classrooms, and (3) a more positive attitude toward mathematics than students in control classrooms.

ASSISTING MOEYC IN FORMATIVE EVALUATION

To foster the technical strengthening of personnel within the MOEYC through training in qualitative evaluation and formative evaluation methodologies and to ensure institutionalizing formative evaluation within the Ministry, the formative evaluation specialist worked closely with the principal counterpart, Mr. Carlos Browne, throughout the many phases of ESC/PEAP II. Dr. Richards and Mr. Browne together conceived all investigations and research evaluations that took place throughout the life of the project.

Because of staffing shortages, it was necessary for the Ministry to contract formative evaluation investigators at designated periods of the project. Mr. Browne was responsible for contracting the investigators and securing the participation of two research assistants who participated the in Baseline Study, the Pilot Studies, the Monitoring and Evaluation, and the Impact Study. Mrs. Khalil and Mrs. Graham were carefully trained in qualitative evaluation and directly participated in designing and developing the numerous classroom observation and interview schedules. They gained direct experience in evaluation by applying the instruments and analyzing the data; they also helped with writing several formative evaluation documents.

The instruments that were used in the many formative evaluation activities undertaken throughout the three years of the project have served as prototypes for several other investigations and project evaluations carried out by the MOEYC evaluation unit. It had been intended that a seminar in qualitative evaluation and formative evaluation methods was to have been given by the Formative Evaluation Specialist in May 1995 for twenty education officers and investigators. Because of budget restrictions and a reprioritization of project needs, the seminar was canceled;

nevertheless, through the guidance of Mr. Browne, formative evaluation procedures have been instituted in the Ministry and will be employed to continue the monitoring and evaluation of the activities and products initiated under ESC/PEAP II. The institution of formative evaluation strategies has set the foundation for comparable evaluation in similar MOEYC projects.

ACHIEVEMENT OF PROJECT OBJECTIVES

This section highlights the accomplishments of the ESC/PEAP II team and the host of Jamaican educators and other stakeholders who collaborated with the 40-month project from the time of its initiation to its closure in February of 1996. (A list of deliverables appears in the Appendix E.)

As identified elsewhere in this report, project integration and cooperative efforts were believed to be essential to overcoming constraints and obtaining genuine success. It was always the intent of ESC/PEAP II planners and implementors to both internally and externally integrate any and all appropriate aspects of the project to meet project objectives in the most efficient and effective manner. The Secondary School Textbook Project sponsored by the Overseas Development Agency is one of the many related projects to which ESC/PEAP II made linkages. Specifically, ESC/PEAP II staff consulted with desktop publishing specialists and computer processing support personnel before purchasing hardware and software and before designing and producing project prototype instructional materials.

Among the other agencies with whom constructive, collaborative linkages were sought to establish an integrated approach to Jamaica primary education improvements were the United Nations Development Program, the International Development Bank, the World Bank, the Organization of American States, and the Canadian International Development Agency. To further illustrate, the Ministry's World Bank-sponsored Social Sector Development Project considered and approved a small (U.S.$6,200) grant to ESC/PEAP II to purchase replacement units midway through the project when MRTs requested additional units. Fruitful relationships were established with each organization through representatives of ongoing projects.

To further assure success, a reality-based, responsive and effective project management structure was installed at the outset of the project. Key personnel who constituted the ESC/PEAP II team were housed at the Caenwood Center close to the Mathematics Section of the MOEYC's Core Curriculum Unit, the Caribbean Examination Council, and other educators associated with assessment and instruction. The Chief of Party (COP) provided leadership, guidance, and oversight of all project activities in Jamaica. Reporting to and communicating through the COP proved to be essential to the effective coordination of the simultaneously implemented activities. A collaborative, participatory decision-making approach among technical assistance team members was fostered by working with and through all counterparts.

The project was guided by the Joint Monitoring Committee (JMC) composed of representatives of USAID/Jamaica, the Ministry of Education Youth and Culture, Teachers' Colleges, University of the West Indies, Jamaica Teachers' Association, Joint Board of Teacher Education, and other educators. The JMC met quarterly to discuss the status of the project and to monitor progress toward the overall goals of the project.

Project reporting was purposeful and efficient. Monthly team member reports and evaluations fed into the quarterly reporting process. Quarterly reports that were presented to the JMC before the quarterly meeting were complemented by appropriate memoranda throughout the life of the project and through weekly team meetings. Formative evaluation and systems management activities helped to assess team performance at the consultant, component, and total project levels. (Refer to Appendix F for the latest financial information.)

In addition to the above efforts to maximize success, the baseline study (cited earlier) was undertaken early in the project to fine tune the needs of Jamaican primary mathematics education and guide the project team in its work in instruction, materials development, and other areas.

INSTRUCTIONAL DELIVERY ACHIEVEMENTS

To reach the materials development and teacher training objectives of ESC/PEAP II, a participatory, integrative, and collaborative approach as noted above was employed by the project team. That is, the component specialists made a concerted effort to involve all stakeholders in the planning, implementation, and review of the project. This not only involved regular meetings and reporting from team members from each component, but also frequent contacts with representatives from other disciplines within the educational system, including the UWI, teachers' colleges, schools, professional organizations, and education officers.

Selected achievements attributed principally to the collective membership of the Instructional Delivery team and a host of collaborating stakeholders include the following:

INSTRUCTIONAL MATERIALS DEVELOPMENT

Indigenous materials were developed, pilot tested and revised:

- A handbook for making a mathematics kit, containing over 36 hands-on materials and manipulatives, includes an activity booklet for grades 1 through 3, an activity booklet for grades 4 through 6, and a glossary of mathematical terms. These materials were distributed to 140 MRT schools, regional offices, and teacher training institutions.

- The primary mathematics curriculum review document was approved and expanded by the MOEYC.

- Cycle 1, 2, and 3 resource materials pilot studies were undertaken and evaluated.

— Cycle 1: three replacement units (statistics, multiplication, and fractions) were piloted by twenty-nine teachers.

— Cycle 2: five replacement units (measurement, geometry, statistics, collection, and excursions) were piloted by twenty teachers.

— Cycle 3: four replacement units (place value, geometry grade 2, decimals, and division) were piloted by thirteen teachers.

- MOEYC approved the adoption of replacement units.

- At least two of the replacement units were distributed to each of the 140 trained MRTs and shared among an additional 100 teachers, reaching over 10,000 children.

- A total of 360 replacement units (sixty copies of six units) were purchased by World Bank and distributed in grade-appropriate MRT classrooms.

- An additional 285 sets of twelve replacement units were purchased by PEAP II and MOEYC budgeted 100 sets for 1996-97.

- Replacement unit learning targets were identified for at least two replacement units for use in alternative assessment approaches.

TEACHER TRAINING

- Providing the framework for the approach for mathematics instruction at the primary school level, *Profile of a Teacher* was developed and widely distributed. (Refer to Appendix D.)

- At one of three, two-day Mathematics Resource Teachers workshops 141 MRTs trained in the use of one of seven replacement units and methods.

- At the Orientation Conference held in October 1994 82 MRTs were trained in replacement units, problem-solving, and leadership issues.

- At one of two November 1994 workshops 146 MRTs were trained in cooperative learning.

- At workshops in May 1995 and follow-through classroom training in September 1995, 140 MRTs further trained in cooperative learning.

- Fifty educators participated in materials development and review seminars for regional education officers and school principals in spring 1994.

- Several education officers and school principals were included in MRT training workshops.

- Networks and regional clusters were identified by the Mathematics Section for training.

- Schedule for regional seminars and plans for replacement unit materials distribution were developed by the Mathematics Section.

PRESERVICE

- Seven teachers' colleges and UWI oriented to "Profile of a Teacher," replacement units, and other project-developed materials and methods at workshops in December 1994.

- One mathematics teacher education specialist was to be appointed by MOEYC Professional Development Unit (PDU) based on advice of ESC/PEAP II.

- Two site-based preservice teacher educators seminars were held for regional representatives of pre- and in-service education institutions and MRTs and school principals.

- Eight complete sets of indigenous materials and replacement units were distributed to teacher training colleges and UWI.

PROFESSIONAL DEVELOPMENT

- Five MOEYC project staff attended joint the AERA/NCME convention in April 1994 and in April 1995.

- Two MOEYC staff participated in the Study Tour of mathematics programs in Los Angeles County Schools and the University of California at Los Angeles in April 1995.

- Over 100 educators, including teacher trainers in the mathematics education specialization, participated in the October 1995 National Teacher Education Conference on primary school mathematics education.

ASSESSMENT ACHIEVEMENTS

The following achievements may validly be attributable to the joint efforts of the project assessment team members working with the NAP and its stakeholders. A set of major component deliverables is part of the Appendix. (Appendix E)

A summary of assessment achievements follows:

- Test construction and continuous assessment procedures are matched to curriculum objectives.

- PEAP II's work facilitated sustainability, largely because it made every effort to mesh with NAP staff and strengthened NAP's testing operations by purchasing equipment and assisting with specifications, prototypes, and technical assistance on equipment test construction procedures and training of assessment person.

- Sustainability is further enhanced by NAP's use of education officers, teachers, and principals in its test development activities—item writing, item review, post-testing critique, and standard setting. Ownership of the model was extended to practitioners.

- PEAP II assisted NAP in producing a far more timely system for test data processing. Test registration may be essentially the same, but once test administration is completed each year, scoring and computer processing of test results is under NAP control through new software program tailored to NAP's needs. NAP can now send results to schools quickly.

- Objective-test item matching is completed, 400 items have been piloted, and some prototype databases are in place. Further specific consultation in this area would be useful as item banking is not complete. The item-banking system used by the Caribbean Examinations Council should be examined.

- Two test forms were developed and administered: NAP's grade 3 diagnostic testing and grade 6 certification testing. Future changes in the system, if any, should be easily adaptable.

- The NAP school-based classroom assessment model serves as the umbrella for the continuous assessment of learning effects resulting from implementing replacement units by the MRTs. Furthermore, NAP's assessment model will undoubtedly guide further curriculum development and assessment by the Ministry.

- A total of 150 principals were trained in test administration and the use of test results for planning.

FORMATIVE EVALUATION ACHIEVEMENTS

The achievements of the Formative Evaluation Component far exceed the large quantity of studies, evaluation, and reports completed. (Refer to the extensive list of selected deliverables Appendix E.) From the beginning to the end of the project, the Formative Evaluation team provided an immeasurable service in that it obtained, analyzed, and reported information valuable to the entire technical assistance team in project planning, implementation, and development.

The following measurable indicators of achievement can be incorporated:

- Formative evaluation studies involving systematic classroom observations, qualitative teacher and student interviews, and questionnaires were conducted, and reports were submitted:

  — ESC/PEAP II Baseline Study
  — Cycle 1 Pilot Study
  — Cycle 2 Pilot Study
  — Cycle 3 Pilot Study
  — MRT Post-Training Report
  — MRT Teacher Training Workshop
  — MRT Orientation Conference Workshop
  — MRT Cooperative Learning Workshop
  — MRT Activities Report
  — MRT Extended Practice Report

- Six investigators were trained in qualitative methods in the May 1993 Baseline Study Training Workshop.

- Two investigators were trained in qualitative methods for evaluating the Cycle 2 and 3 pilot studies, the training workshops, and the monitoring of MRT extended practices.

- Two investigators were trained in qualitative methods for classroom impact study.

- An end-of-project field study was undertaken in April-June and September-October 1995, and a relevant impact evaluation report was completed and widely disseminated.

RECOMMENDATIONS

At the close of ESC/PEAP II the technical assistance team with input from representatives of various stakeholder groups assembled a set of recommendations addressing unfinished work, continuation of selected elements of the project, and steps that might be taken for further enhancement of the reform of primary mathematics education and the improvement of school-aged children's mathematics achievement. Several major and significant recommendations are presented below. These should be analyzed by the Ministry in view of the constraints and driving forces noted elsewhere in this and other key project reports. This list of recommendations is intended to help further assure proper institutionalization and sustainability.

- Further refine and implement a plan for extending the training of the corps of Mathematics Resource Teachers.

  This plan should consider ways of continuously "rejuvenating" the MRT corps to assure reasonable, modest, controlled growth and account for problems related to attrition, school transfers, and geographical/logistical factors. Special concern should be given to needs assessment; strategies for training other teachers on site and in cluster settings; and content, methodology, and resources required of MRTs to effectively serve as pivotal agents in the reform of primary school mathematics. Alternative and continuous assessment strategies should be a part of the MRT short- and long-term training program and could allow MRTs to earn master teacher status. MRTs have expressed interest in forming an association or linking to the Mathematical Association of Jamaica. To enhance the MRT corps' effectiveness, these and similar considerations should receive serious attention.

- Design and implement a comprehensive plan for the continuous, immediate, and long-term production of locally designed ("indigenous") instructional materials; for the acquisition of appropriate commercial resources; and for the timely distribution of both types of materials.

  The plan should reflect the requirements of each school served by an MRT and all remaining primary schools. The EMIS resources of the Ministry should prove invaluable given the improvements made through the Policy Analysis or PAMIS component of PEAP II. Once needs have been verified, a detailed reproduction and distribution plan, and budgetary resources must be specified and approved. The role of local publishers in this process should be clarified and encouraged. Without adequate and timely provision of at least instructional material in support of all teachers, not only MRTs, sustainability will dwindle and impact will not be long term as intended.

- Fully support and closely monitor the current piloting of the trial version of the new Mathematics Curriculum for Primary Schools.

Such support and monitoring will necessitate thorough orientation and evaluation. MRT classrooms should focus on materials, structural changes resulting from project-initiated and curriculum-supported innovations, and prescribed pedagogical considerations, including alternative assessment techniques.

- Design and implement a plan for the alignment of pre- and in-service teacher education.

  Preservice short courses that feature new curriculum and materials should be developed and followed by field-based experiences. The "cascade" approach, whereby MRTs sensitize principals and train teachers, and teachers train student teachers (preservice), should be incorporated. Other approaches in support of collaborative models of pre- and in-service teacher education and ways of jointly enhancing the reform of primary school mathematics instruction and learning should be identified and pursued. Importantly, Teachers' College curriculum must be closely linked to the revised primary school mathematics curriculum, instructional resources, and assessment approaches.

- To further enhance NAP's goals, use the benefits from collaborating with ESC/PEAP II assessment specialists.

  Among the various specific recommendations are three that exemplify the range of concerns that can be addressed: (1) the successful approach used by the project assessment consultants and testing officer/specialist should be considered as a model for other technical assistance efforts, (2) the foundation laid by Dr. Anthony Nitko in continuous assessment should be incorporated into the short-term plans for MRT training, and (3) NAP mathematics achievement test results should be analyzed and used each year to assist in determining project /reform impact over time.

- Adjust tests items to reflect the new curriculum.

  The NAP tests items were developed based on the curriculum at the beginning of the project. With sufficient lead-time, test plans should be adjusted to the piloted curriculum.

- Provide training for staff in areas determined to be essential to the sustainability of the mathematics education reform efforts.

  In addition to MRT training, areas that enhance the efforts required at regional and national levels in the Ministry units and other institutions involved with teacher education must be emphasized. Topics for training should include orientation to the reform of mathematics education, new curriculum guides, instructional materials development, alternative assessment approaches, qualitative research methodology, and formative evaluation. Additional staffing is required at the Ministry in the math section and in the professional development unit.

- Consider a regional focus during the early postproject plan of mathematics education reform.

  Because both human and material resources in the reform of Jamaica mathematics education, as well as the number of sponsored projects and other development activities being undertaken by the MOEYC, are scarce, the Professional Development Unit, Core Curriculum, and others should consider accelerating the reform efforts in one or two regions while maintaining essential support efforts islandwide. Clearly, there is a shortage of mathematics education officers to adequately cover the country in any one-, or even two-, year period. Furthermore, expectations regarding roles, responsibilities, and purposed/desired outcomes would be more realistic within one or two "pilot regions." Outcomes may be improved at the school and regional levels not only through more effective use of resources but also through monitoring and evaluating the effects of activities. This would provide feedback to improve implementing similar activities elsewhere. Linkages to components of other projects and the successes of the School Community Outreach Programme for Education and the Policy Analysis projects of PEAP II should be pursued.

CONSTRAINTS

The best plans have no guarantee for success even if unlimited resources are available. To help maximize attaining project objectives, the technical assistance team delineated those constraints that were of interest to stakeholders. In the ESC/PEAP II Implementation Plan both the constrains and strategies designed to avoid, or overcome them were identified. New constraints also emerged during the three-year implementation. Early and later constraints are summarized below:

EARLY CONSTRAINTS

Several project constraints were considered in January 1993 during the planning phase:

- the aura surrounding the Common Entrance Examination vis-a-vis the NAP testing
- the understaffing of the National Assessment Programme
- the shortage of MOEYC Mathematics Education Officers
- the limited relevant baseline data available at the early stage of the project
- the lack of innovative educational technology and low-cost instructional materials in Jamaica
- the existence of a substantial number of pre-trained (underqualified) teachers in primary school classrooms
- the overcrowded conditions in some Jamaican primary schools
- the limited financial resources available for the purchase of instructional resources
- the change of teachers' residence from one geographical region to another
- the low rate of teacher retention
- the inaccessibility of remote rural schools

- the lack of adequate transportation for many students and teachers

- the negative attitudes about mathematics that prevail among many teachers and students

LATER CONSTRAINTS

Several constraints evolved at different stages of the project:

- the shortage of counterparts or their limited availability in instructional material development and formative evaluation

- the substantial amount of time required for project administration and reporting

- the reliance of the Ministry and other projects on the services of a significant number of project MRTs, resulting in either their excessive absence from school or absence from essential training activities

- the high incidence of transfers by MRTs between schools and especially between school years

- in a number of institutions, the limited classroom teaching experience of teachers' college mathematics education lecturers

- the decreased use of the project vehicle because of custom delays and excessive maintenance

- the unfavorable (hot, humid, and unhealthy) office conditions from June 1993 to the end of the project and limited clerical assistance from MOEYC, especially during high activity and reporting periods

LESSONS LEARNED

No matter how successfully a project appears to have met its goals, at completion there is always a tendency to wish that more had been achieved. In part, this happens because in retrospect we now fully understand the project, its constraints and its potential. Any long-term technical assistance project in a developing country is subject to constraints, such as limited resources, understaffing and overassigning counterpart staff, insufficient data bases, and political exigencies. This said, there is usually an enormous reservoir of professional good will and commitment to the project, and the Jamaica PEAP ES/C was no exception. From the Ministerial level down on through the Joint Coordinating Committee, to USAID, a concerted effort provided the resources and thinking to make the project successful. A number of lessons, which may serve useful for similar development efforts, emerged through this project.

Sustainability of results must be introduced at the outset and be a constant theme through all aspects of the project. The progress made in training 140 Master Resource Teachers, introducing new pedagogical approaches through replacement units, and refining the National Assessment Program should be viewed not as ends, but as a beginning foundation on which to continue to build. This will require the MOEYC to constantly renew and refine its commitment to professional development to improve the quality of mathematics instruction for primary school children throughout Jamaica.

Donor coordination has become increasingly important, not only because of the need to use resources efficiently, but to reduce the programmatic demands being placed on Ministry staff as they work with donors. If donors coordinate their efforts they may be able to reduce the demands and maximize the time and efforts of staff who are assigned to their projects.

Where possible opportunities for participatory decision making can reinforce individual commitment to the overall goals of a project at every level.

The role and importance of a Joint Coordinating Committee to program effectiveness and sustain ability cannot be overstated.

APPENDIX A

CURRICULUM REVIEW TEAM FOR PRIMARY MATHEMATICS

Dr. John McNeil	Consultant, Instructional Materials Development, PEAP II
Dr. Ernest O'Neil	Consultant, Teacher Training, PEAP II
Mrs. Lorna J. Bourne	Mathematics Specialist, PEAP II
Dr. Claude Packer	Joint Board of Teacher Education, University of the West Indies
Sis. Mary Peter Ngui	Mathematics Board of Studies
Mrs. June Playfair	Mathematics Association of Jamaica
Mrs. Dorothy Raymond	Jamaica Teachers' Association
Mrs. Hyacinth Bennett	Independent School Association
Mrs. Carol Pinnock	Grade 1 Teacher, Port Antonio Primary School
Mrs. Dorothy Bramwell	Grade 2 Teacher, St. Richards Primary School
Mrs. Helen Reid	Grade 3 Teacher, May Pen Primary School
Mrs. Alleen Bethune	Grade 4 Teacher, Red Hills All Age School
Miss Ester Powell	Grade 5 Teacher, Drews Ave. Primary School
Mrs. Pauline Power	Grade 6 Teacher, St. Aloysius Primary School
Mrs. Ivette Russell	Grade 7 Teacher, Morant Bay All Age School
Dr. Doreen Faulkner	Coordinator, National Assessment Programme
Mr. Hugh Monroe	Ministry of Education, Youth, & Culture, Primary Unit
Mrs. Evadne Small	Ministry of Education, Youth, & Culture, Primary Unit
Rev. Stephen Jackson	Ministry of Education, Youth, & Culture, Core Curriculum Unit, Mathematics
Miss Beatrice Wilson	Ministry of Education, Youth, & Culture, Core Curriculum Unit, Mathematics
Miss Ohan Clarke	Ministry of Education, Youth, & Culture, Core Curriculum Unit, Science
Miss Cora Cox	Ministry of Education, Youth, & Culture, Core Curriculum Unit, Language Arts
Miss Cherry Davis	Ministry of Education, Youth, & Culture, Core Curriculum Unit, Social Studies
Mrs. Jennivie Tracey	Ministry of Education, Youth, & Culture, Core Curriculum Unit, Functional Education (Primary)

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APPENDIX B

The **Replacement Unit** replaces what textbooks provide. It offers students experiences in solving real-world problems that are manageable in the classroom and lead to the learning of essential mathematics.

The Replacement Unit has three elements:

1. Through problem-solving investigations in broad contexts, the unit integrates both ideas from mathematical strands (such as number, geometry, and probability) and the processes of using mathematics (such as recognizing the variety of situations that call for mathematical operations, identifying appropriate procedures for pursuing an inquiry, and evaluating and the reasonableness of solution.
2. The unit encourages students to create their own understanding of mathematical topics. In dealing with problems in context, students create their own theories, investigate strategies, ad justify solutions. Group work and discussion are part of the unit so that the individual's meaning is enlarged upon by the views of others.
3. The unit offers detailed instructions for the teacher, yet these instructions are modified in the local situation and in response to the reactions of students.

The Replacement Unit is structured so that it can be taught independently of other materials. Its goal is for teachers and students to experience a new kind of mathematics education, which, through activities and exploration, will lead to a greater depth of understanding and appreciation of mathematics.

Replacement Units usually build upon a specific theme such as fractions or statistics; many of the units include projects that extend over considerable periods of time. However, the teacher can use replacement units in a flexible manner, scheduling the typical five- to six-week unit for two to three sessions per week or for a longer block of time during the year's work.

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APPENDIX C

GOALS OF PRIMARY MATHEMATICS

The following goals of primary mathematics were discussed by the Primary Mathematics Curriculum Review Team at a seminar held on March 16, 1993. (These are not listed in order of priority.)

1. Prepare students for secondary-level education
2. Enable students to develop competence, a positive attitude, and confidence in dealing with day-to-day experiences
3. Establish equality and opportunity for all by teaching mathematics as a tool for improvement
4. Enable students to develop problem-solving skills to deal with real-life problem situations
5. Help prepare students to make rational decisions
6. Help students become mathematically literate
7. Enable students to value mathematics, explore and enjoy patterns and relationships
8. Help students learn how to reason and think logically

HOW STUDENTS LEARN MATHEMATICS

At the March 16, 1993 Curriculum Review Seminar, how learning takes place was also discussed. Students learn mathematics when

1. they are **motivated**, interested, and curious, or when they have a purpose.
2. the teacher is **exciting** and **enthusiastic**.
3. they are **successful** and have **control** over how they address problems.
4. they are **ready**. (Chronological age has little to do with readiness. Physical maturity, past experiences, mental age, and mastery of pre-requisite concepts should be considered.)
5. something make **sense**.
6. they can **relate** mathematics to their real-life experiences.
7. the work is **challenging** and causes them to want to "stick to it."
8. they **participate** actively in learning activities.
9. they **explore** alternative ways to learn concepts.
10. their individual differences are **recognized** and **accommodated**.
11. the "atmosphere" of the classroom encourages them to **try**.
12. they have **specific goals** in sight.
13. learning is **reinforced**.
14. **parents** show interest in their work and **interact** with them.
15. they use a variety of ways to determine **how well** they are doing.
16. there is **more emphasis on learning** from a situation than from immediate correctness of the answer (such as learning from mistakes).

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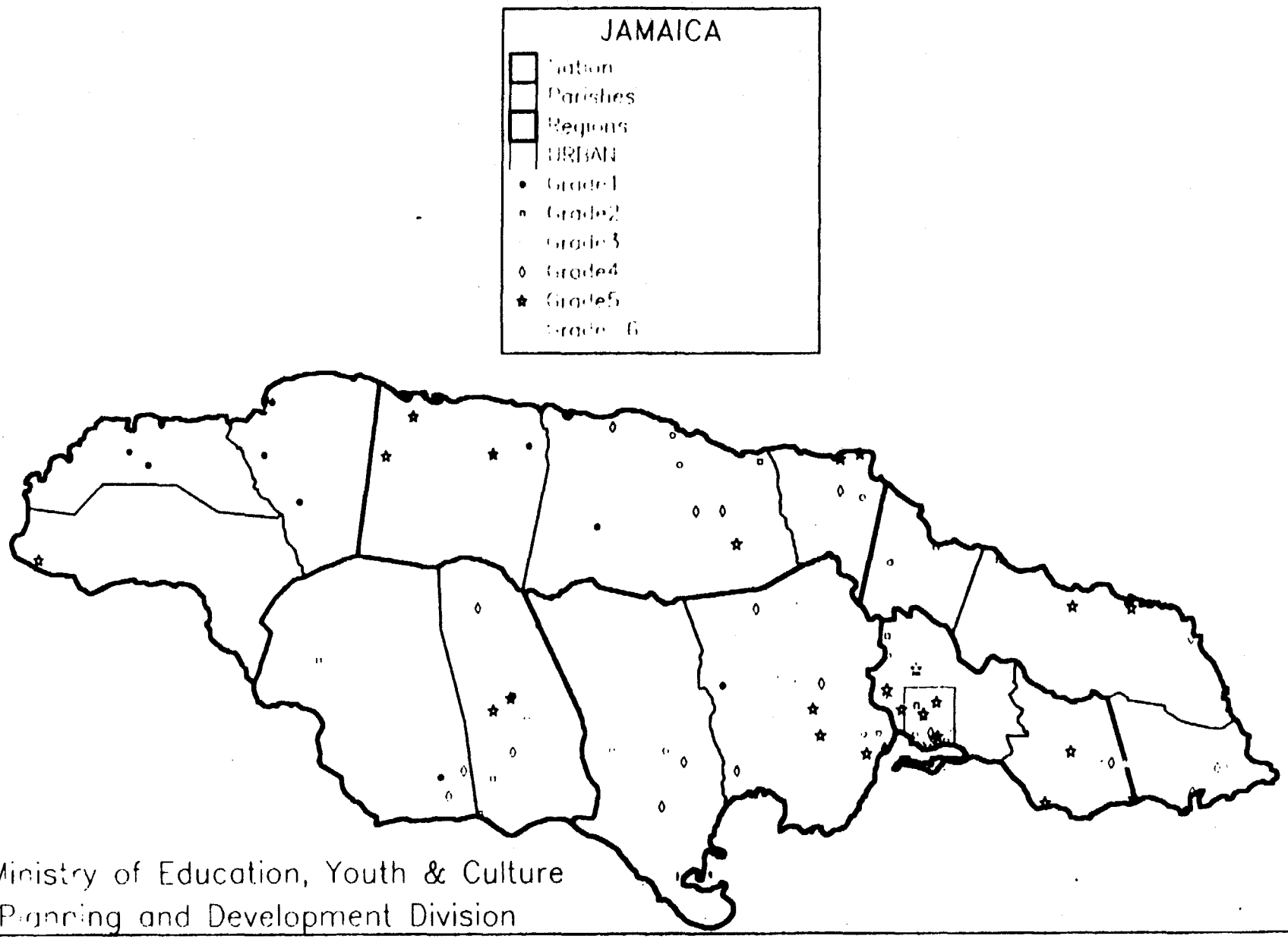
JAMAICA PRIMARY EDUCATION ASSISTANCE PROJECT

ESC/PEAP II (Mathematics Resource Teachers)



Ministry of Education, Youth & Culture
Planning and Development Division

Visualizing Effective Mathematics Teaching

By reflecting on the traditional and alternative practices in teaching mathematics, teachers and teacher educators can strive toward improved instruction as illustrated in the third column.

	Traditional Practices	Alternative practices	Desired practices
Lessons	A lesson per day, organized around specific and/or general objectives. Lesson includes: (1) Application example, (2) instruction in how to do a specific procedure, perhaps some with simplified explanations, (3) a few exercises to "check for understanding", (4) practice exercises as "seat work".	One or two day lesson. Worksheets provide specific directions for the student on what to do and how to record results.	Most lessons are multi-day and generally involve more than one big mathematical idea. Students work with important ideas over an extended, continuous period, sometimes as long as six weeks, depending on the grade level.
Assignments	Assignments are given from the textbook, teacher-made exercises and other sources. They are expected to be done individually. "Drill and practice" assignments from the textbooks are given frequently. Much of this is done as classwork.	Students use manipulatives and work in small groups, but fairly prescriptive worksheets often guide students' work.	Assignments develop students' mathematical power; they are challenging and multidimensional. They may extend over several days and require considerable time outside of class. Often they are cast in the form of a broad, complex problem to investigate as a group. Findings or results may be presented in an individual or group report, an oral presentation, and/or visual displays.
Computational procedures	A major focus. Emphasis is on learning the steps to perform an algorithm, and on providing enough practice so that the procedure becomes automatic for the students.	A major focus. Manipulatives are used to teach and explain the algorithm, although students are still expected to become proficient performing the algorithm with paper and pencil so they can do well on tests that require quick and accurate computation.	Students develop a range of computational procedures, with a greater emphasis on "number sense" than algorithms. They invent and use a number of different computational procedures to assist them in solving problems. Students are expected to decide the most efficient means to calculate an answer for a given situation: paper and pencil, mentally, or calculator. In brief, the teacher would serve as the facilitator.
Manipulatives	Used in primary grades at teacher's discretion. (Not part of student textbooks or related to course of study.)	Used frequently, but in prescribed ways to teach specific concepts or procedures.	Students have manipulatives available at all times. Sometimes students use manipulatives for specific purposes. At other times the choice of manipulatives is up to the students.
Calculators	Available in few schools. Where available they are not used or used only on a few calculator lessons. Not permitted on daily assignments and tests. Most teachers are opposed to its use in primary grades.	Used for calculator lessons and "problem solving lessons." In some programs, students use calculators to check paper and pencil computations. In others, students use calculators after paper and pencil algorithms are mastered. Students are not permitted to use calculators on tests.	Students have calculators continually available for use in class, on homework assignments, and on tests. Students conduct experiments based on using calculators to explore the behaviour of mathematical structures.
Computers and Software	Computers are seldom available, and only where given as gifts, mainly in private schools. Used for drill and practice, if at all, and then often in a computer lab staffed by a specialist or aide. At best, the computer helps the teacher only as a gradebook. Non-existent or limited use in primary schools.	Used more frequently and more in the classroom. Students use a few imaginative pieces of software that usually focus on specific types of problems. The computer work is considered "enrichment;" it is not connected to students' core work. Students work in groups because there aren't enough computers.	Computers are available at all times. Students can use them individually or in groups. Teachers and students use more sophisticated special-purpose programs and are fluent enough with tool software – such as word processors, spreadsheets, and databases – to use the computer to meet their particular needs. The computer extends human capability; it is not an end in itself.

	Traditional practices	Alternative Practices	Desired practices
Student interaction	Most of the time students are expected to work alone. They sit in individual desks/benches facing the front of the room, although some primary grade students may sit at tables. Students seldom have opportunities to make mathematics relevant to other subjects and life.	Most of the time students are expected to work alone. For problem solving activities, sharing limited resources and other general activities students sometimes move their desks into groups of four to six.	Students sit in small heterogeneous groups. They are encouraged to interact with each other. For many assignments students may choose whether to work alone or with others. Cooperative learning is an integral part of the teaching-learning process
Grouping	Students are put in "ability level" groups mainly on how quickly they can perform paper-and-pencil computations or algebraic manipulations. Students often work in the same class and study the same material throughout the school year. Preparation for Common Entrance Exams strongly influences grouping.	The teacher teaches the heterogeneous class as a whole group, but pulls out and gives additional assistance to students who are having difficulties. Secondary teachers discuss tracking problems but see no workable alternative.	All students study a common core curriculum. Students with special interests or talents go more deeply into some investigations, often working with an interest group. Students having difficulty sometimes get additional assistance, often before or after school. Some students accelerate studies individually or in groups.
Review	For each new topic the review cycle is as follows: •Pre-requisites •Review •Present new material •Practice exercises •Evaluation. Work is compartmentalized, and reviewed in fortnightly, monthly and/or term tests.	Review is provided during "warm-ups" at the beginning of the period or in "sponge" activities done sporadically. Occasionally students work on problems that incorporate work they have studied from several strands. Partial cumulative and full cumulative reviews are also done at convenient times.	Review is built into the rich and complex problems students work on.
Tests and assessment	Testing is often the main focus. Tests closely match assignments with a narrow focus on skill. Questions have one correct answer. Tests can be scored objectively. Student "mastery" is expected. The goal of testing is to assess – and classify – the student.	Formal tests are important. Although teachers question their usefulness and their impacts, they expect their students to do well on norm-referenced tests. Some teachers include open-ended questions and require students to explain their thinking on their tests. Alternative test forms are also used.	The goal of assessment is to evaluate student work, rather than the student. There are many forms of external and internal assessment, including portfolios of student work, observation, interviews, and group work. Students are expected to revise their work to meet essential criteria and standards. Students participate in assessment.

Acknowledgement

"Teacher Profile: Visualizing the Effective Mathematics Teacher" is based on one of the several resources contained in *They're Counting on Us! Mathematical Power for our Children's Future* which was developed by the California Coalition for Mathematics and Science. The Education Strengthening Component/Primary Education Assistance Project (ESC/PEAP) II (Mathematics) wishes to express its thanks to the Coalition for the generous manner in which it encouraged the use of its approaches and material to enhance mathematics teaching and learning. For limited copies of *They're Counting on Us!* contact The California Coalition for Mathematics, P.O. Box 1279, Santa Barbara, CA 93116.

This "Teacher Profile" can be copied and used by Jamaican teachers' colleges, other teacher education institutions and individual trainers for preservice and inservice training purposes. Suggestions for the improvement and use of this material may be addressed to the Mathematics Section at the Caenwood Centre, 37 Arnold Road, Kingston 5, Jamaica.

Prepared by the Jamaica Ministry of Education, Youth and Culture in collaboration with the USAID sponsored ESC/PEAP II (Mathematics) Project.

APPENDIX E

SELECTED DELIVERABLES

A Proposed Classification of Strands
Activity Booklet for Grades 1-3
Advanced Cooperative Learning
An Introduction to Cooperative Learning
Cognitive and Content Taxonomies
ESC/PEAP II Classroom Impact Evaluation
ESC/PEAP II Implementation Plan
ESC/PEAP II Material Resource Pilot-Study Cycle (October - December 1994)
ESC/PEAP II Mathematics Instructional Delivery Cycle 1 Pilot Study, September - November 1993
ESC/PEAP II Mathematics Resource Teachers "Extended Practice" (October - February 1994)
ESC/PEAP II Third Year Plan
Formative Evaluation Report of the Mathematics Resource Teacher Training Workshop (June 7 - 9, 1994)
Glossary of Educational Assessment Terms
Glossary of Mathematical Terms
Grade 3 Diagnostic Test in Mathematics
Grade 3 Diagnostic Test in Mathematics: Item Response
Learning Units Assessment Guidelines
Learning Units Assessment Guidelines: Multiplication and Statistics
Mathematics Activity Booklet Grade 4-5
Mathematics Instructional Practices in Selected Jamaican Primary Schools: PEAP II Baseline Study
Mathematics Resource Kits
Mathematics Resource Teachers Activities Report
Mathematics Resource Teachers Activities
Mathematics Resource Teachers Post-Training Report (May - June 1994)
Mathematics Resource Teachers Orientation Conference
NAP Teacher Development and Administrative Procedures
Primary Mathematics Textbook Review
Profile of a Teacher: Visualizing Effective Mathematics Education
Report on Scanning Equipment Acquisition for the Jamaican Ministry of Education and Culture
1994 Grade 6 Mathematics Curriculum Objectives and Associated Items
1994 Grade 3 Diagnostics Tests Rosters

APPENDIX F

The final quarterly report was waived as per a January 29, 1996 memo from Martin Napper Regional Contracting Officer. What follows is the financial information which would have appeared in the February 10, 1996 quarterly report to fulfill the requirements of the last quarterly report.

Administrative Information (as of January 31, 1996)

Person month information is not included since the contract is not based on level of effort.

Contract Data: Total estimated cost $2,078,574

1. Expenditures (last three months): $158,156
2. Cumulative expenditures to date: $2,003,372
3. Remaining unexpended balance: $75,202