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ASSESSMENT OF UTILITY AND FEASIBILITY OF PROPOSED USE OF PLATO COMPUTER EQUIPMENT IN JAMAICA

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EXECUTIVE SUMMARY

This document reports on a feasibility assessment of a Unified Curriculum Project (UCP) proposal to provide computer-based educational and vocational training in Jamaica using Control Data Corporation (CDC) software and equipment. The proposal was developed and submitted to the U.S. Agency for International Development-Jamaica by JOBS, Jamaica Opportunity for Business Success, Ltd., in cooperation with the Jamaican Ministries of Agriculture, Education, and Youth and Community Development.

The Agency for International Development contracted with the Pragma Corporation to assess the feasibility and cost-effectiveness of the proposed Unified Curriculum Project. A Pragma team visited Jamaica to collect cost data and to assess the project's feasibility. The team met with representatives of the three sponsoring ministries, the Ministry of Planning, and the President of JOBS, and visited many of the proposed sites for CBE instruction. Team members also met with Control Data representatives in Toledo, Ohio, and visited a number of training sites which use Control Data equipment and educational software. The team reviewed the literature on the cost effectiveness of CBE in general and the effectivess of CDC's eduational software programs, and surveyed users of CDC software in the United States to determine their satisfaction with CDC training materials and equipment.

Under the proposed Unified Curriculum Project, computer-based educational (CBE) training would be delivered by using PLATO educational software programs and equipment sold by the Control Data Corporation (CDC). The project proposes to use CDC microcomputers to deliver remedial reading and mathematics and vocational education training in Jamaica. Much of the proposed vocational CBE training is dependent on the development of appropriate software programs in Jamaica--approximately one half of the proposed project funds would be used to develop vocational software for use in Jamaica.

The primary purpose of the proposed project is to improve the employability of Jamaicans. This purpose has meaning for individual Jamaicans--and justifies the high cost of training--only if trainees become employees who satisfy the skill needs of employers. Although the UCP document cites a number of objectives which are generally relevant to the development of the Jamaican economy and increased employment, the proposal did not evolve out of a rigorous

analysis of the most appropriate approach to meeting each objective. Rather, training was assumed to be an appropriate response, and CBE training was assumed to be an effective training strategy.

A total of fourteen different training applications are proposed by the Unified Curriculum Project, four in the Ministry of Education, four in the Ministry of Agriculture, and six in the Ministry of Youth and Community Development. In general, the objectives--the purpose of the training, the nature of the target audience, the numbers to be trained in specific subject areas--for each proposed application were not clearly defined in the proposal or by the ministry officials with whom we spoke.

It is difficult to specify precisely what instruction would be provided under the contract. Although the focus is on computer based education, the proposal also discusses audio visual instruction, paper and pencil materials, and traditional instructional modes. Training curricula described in the proposal appear to be a mix of the curricula currently offered by the Jamaican training institutions, CDC's Basic Skills curricula, and CBE materials which would be developed by the software development centers proposed in the document.

To analyze the cost of the Unified Curriculum Project, the project team divided the proposal into two major components: the learning centers and the courseware development centers. Total annualized costs were derived for each type of center. We divided the cost of each center according to the following categories: facilities and equipment, training, administration, personnel, curriculum, maintenance and miscellaneous.

The proposed training applications depend to a large extent on the development of CBE agricultural and vocational software in Jamaica. However, the UCP document did not indicate the particular topic areas in which CBE software development would be most productive for Jamaica, nor did it indicate a time schedule for the development of CBE courseware which could be tied to the implementation of the training component of the project. No indication was provided of the expected quantity or quality of software which would be produced, beyond the rough estimate of 1,000 CBE hours for the $10 million invested (IX-6). Although the proposal indicated that CBE software developed in Jamaica could be sold to other countries, no marketing data supported that assumption, and little information was provided about how this possible return on Jamaica's investment in software development might be realized.

Software development would use over half of the proposed project resources, but very little attention was given in the proposal to the software development process or its management, and costing details were too limited to allow us to make a detailed assessment of full costs. These problems, combined with the limited success of software development in the United States (the literature review indicated that most educational software is of little instructional value), led us to conclude that there is little justification for a major investment in software development in Jamaica at this time.

Even though over half of the requested $20 million funding is for the two courseware development centers, little attention and care were devoted to estimating their actual cost. Therefore we had no basis on which to develop more detailed cost estimates, and could only conclude that the proposed costs were probably underestimated.

When we compared the relative costs and benefits of purchasing CBE courseware as compared to developing it in Jamaica, we found little economic justification to support its development. This factor, combined with the limited information provided in the proposal about specific courseware development objectives, costs, schedules, or marketing potential, lead us to recommend that U.S. AID not consider funding this portion of the proposal.

We conclude that U.S. $4.0 million would be required annually to run all of the learning centers. This is 135 per cent more than the annual amount suggested in the UCP proposal. If the project were to be fully funded as requested, the Government of Jamaica would have to provide an additional $2.3 million annually to operate the learning centers.

Our crude cost comparisons between a ten terminal Fair Break Center (which provides remedial education) and the traditional educational system indicate that computerized instruction is substantially more expensive than traditional instruction. According to our cost estimates, it would cost $236 to raise one student one (remedial) grade level using CBE. It would cost $67 to raise one student one grade level in the traditional Jamaican educational system, according to cost estimates provided in the UCP proposal. However, since the Fair Break centers used for this cost comparison provide job readiness training and counseling in addition to remedial instruction in basic skills, realistic cost comparisons cannot be made since programs with quite different objectives are being compared.

There is very limited data in the literature on either the comparative cost or the effectiveness of CBE instruction for vocational and agricultural instruction; apparently comparatively little CBE instruction has been attempted in these fields. The absence of information about the comparative costs or effectiveness of these applications, combined with the lack of clearly specified objectives in the UCP proposal for these applications, leads us to conclude that U.S. AID should not consider funding the proposed CBE instruction in these areas at this time.

The proposed project does not involve any substantive transfer of technology and does not propose to develop computer literacy among Jamaican students. As a result of project funding, Jamaican students and instructors will not become educated consumers of computer technology, nor will Jamaicans develop a capability to design, build or program computers. Except for a limited number of people who would be trained at great cost in the software development centers, Jamaica would not develop a substantive courseware development capability. Even this limited number of Jamaicans would not be trained to develop commercial applications. The availability of a computer is necessary but not sufficient to establish computer literacy, any more than a stove in a kitchen guarantees edible meals. Specialized instruction in computer-related topics such as programming is needed if computer literacy is a training objective.

RECOMMENDATIONS

In the previous section we stated that we do not recommend that AID consider funding the vocational and agricultural CBE applications or the software development component of the Unified Curriculum Project. We do feel that CBE remedial academic skills training, which was costed out in Chapter IV of this report in the context of a ten terminal Fair Break-type Center, effectively provides remedial instruction for many students who in the United States have previously failed in academic settings. The costs are considered high by our respondents, but not unreasonable or beyond "tolerable costs," given established instructional and training costs in the United States.

Our review of the literature and our survey of users of Control Data equipment and software programs indicate that these are good products, that the Control Data Corporation is responsive to its clients, and that many persons who have

failed in traditional educational systems learn basic skills using computer technology. Since many of these individuals were previously considered academically hopeless, there is no real basis for comparing the costs of using computerized instruction with these individuals with other approaches.

We conclude that CBE instruction may be an effective means of providing remedial instruction in Jamaica. However, decisions about funding CBE remedial education must be decided by determining tolerable or acceptable costs of remedial education in Jamaica. Simply put, the Government of Jamaica/USAID will have to decide whether they are able and willing to fund computerized remedial education programs at the cost levels described in this report. They must decide whether it is likely that a successful demonstration project using CBE instruction would lead to continued and increased funding for CBE remedial training. Based on the limited information available to us, we question the wisdom of spending large amounts of money on remedial education, given the full range of Jamaica's ecucational needs.

If extensive funding of CBE remedial skills training appears to be warranted, we recommend that a demonstration project be developed in which basic skills are taught in individualized education centers which are separate and distinct from existing academic institutions. The project should include at a minimum two centers, each of which would provide basic skills instruction from approximately grade 3 through the CXC. One center should provide paper and pencil instruction, the other CBE instruction. The two centers should be evaluated in terms of effectiveness and cost by an outside contractor who participates in the design of the demonstration project so that major variables such as differences in the student body, teaching staff, and learning environment can be controlled.

Total first year costs for the two centers are $512,129; second year costs are estimated at $231,684. The total cost for the two centers for the two year period would be $743,813, excluding evaluation costs. Over the two year period, this investment would provide remedial training for 1,000 students in the two centers. We would expect 600 of those students to progress four years in remedial reading and/or mathematics for a total of 2400 grade level advancements. Costs could be somewhat reduced by using existing facilities and by making adjustments in staffing patterns. We recommend that such a demonstration be run at least two years so that the costs and effectiveness of the two programs can be assessed over time.

Since we are recommending that the demonstration be assessed by AID and Jamaica in terms of tolerable costs for remedial education, we think it is reasonable to compare these costs with the training investment Jamaica currently makes in its secondary level students. Using the traditional instruction costs cited in the UCP proposal, traditional instruction is provided in Jamaica at the (underestimated) cost of $67 per student for one academic year of instruction in a single topic. The Jamaican system now trains 1,000 secondary students in four subjects at a cost of $269 each, for a total cost of $269,000. Assuming a 60 percent effectiveness rate, this training would result in 2400 grade level advancements.

If implemented and successful, the paper and pencil-based center could serve as a prototype for other, similar centers on the Island. Access to appropriate paper and pencil materials could be obtained by contacting Robert Taggart. Such a center also could serve as a laboratory for developing and pretesting the individualized paper and pencil materials which should precede the development of CBE programs.

At the same time, the PLATO prototype could demonstrate the comparative effectiveness of CBE instruction under the best of conditions. Our survey respondents described PLATO as the "Cadillac" of CBE training programs, and the Control Data Corporation has a proven ability to establish and manage such training centers. No other arrangement could be installed as easily or as quickly. Jamaican personnel could learn effective CBE implementation and management techniques by observing the development of PLATO training centers, and this expertise could be used to develop other CBE prototypes if experience with the PLATO center suggest their feasibility. If the PLATO remedial training centers appear to be worth the cost, JOBS could be urged to offer other PLATO training services such as secretarial training.

This approach would provide an incremental strategy for the introduction of a new educational technology to Jamaica. It would provide data on the relative costs and effectiveness in Jamaica of two different individualized educational approaches with similar remedial training objectives. In addition, the demonstration could provide a resource base for the development of additional paper and pencil materials, for use either as is or as the basis for further CBE software development; and for the training of personnel in the implementation and management of individualized instruction and CBE learning centers.

A demonstration of this kind could serve as a model for private industry cooperation with government. By contracting out for these training services, the Jamaican Government can establish and enforce performance and cost limits for the project. The private sector push for profits could then support the government's efforts to increase employment and productivity.

I. INTRODUCTION

This document reports on a feasibility assessment of a Unified Curriculum Project (UCP) proposal to provide computer-based educational and vocational training in Jamaica. The proposal was developed and submitted to the U.S. Agency for International Development-Jamaica by JOBS, Jamaica Opportunity for Business Success, Ltd., in cooperation with the Jamaican Ministries of Agriculture, Education, and Youth and Community Development.

Under the project, computer-based educational (CBE) training would be delivered by using PLATO educational software programs and equipment sold by the Control Data Corporation (CDC). The project proposes using CDC microcomputers which use 8 inch "floppy disks" and require no telephone connections with mainframe computers. Initial CBE training primarily would be remedial reading and mathematics using existing PLATO software programs. Additional CBE training would depend upon the development of appropriate software programs in Jamaica--approximately one half of the proposed project funds would be used to develop vocational software in and for Jamaica.

As a result, although the proposed project is very complex, it can be described as having two major components: computer based training in basic education and vocational skills, and software development. Because of the scope and complexity of the proposed project, implementation issues are of major importance.

The Agency for International Development contracted with the Pragma Corporation to assess the feasibility of the proposed Unified Curriculum Project. The assessment involved four tasks:

1. Review the literature and survey current users of PLATO programs to determine the cost effectiveness of CBE and in particular of PLATO programs in the United States. This task also requests that Control Data's capital and recurring costs for equipment and programs be compared with the costs of equipment and programs of comparable vendors.

2. Assess the feasibility of the proposed use of equipment and programs in Jamaica, given the country's current political, social, and economic condition. In addition, determine the true and complete costs and the physical requirements (e.g., maintenance, electrical supply, security problems) of carrying out the proposed program.

3. Conduct a least-cost and additional-benefits analysis of alternative methods for achieving the purposes of the project.

4. Assess the organizational and managerial ability of the Jamaican instructional system to implement the project as proposed.

The assessment was carried out by a Pragma team which visited Jamaica. The team met with representatives of the three sponsoring ministries, the National Planning Agency, and the President of JOBS, and visited many of the proposed sites for CBE instruction. Two of the team members met with Control Data representatives in Toledo, Ohio. While there they visited training sites making use of Control Data equipment and discussed data requirements for the study. The team members made independent visits to CDC-equipped learning centers in the United States, and each consulted with CDC to obtain additional information as needed. The team reviewed the literature on the cost effectiveness of CBE in general and the effectivess of PLATO software programs, and telephone interviews were conducted with users of PLATO software in the United States.

This report is organized as follows:

Chapter II describes the findings of the literature review and Chapter III describes the survey findings.

Chapter IV addresses the required resources and costs of training, and Chapter V addresses the costs of Courseware Development.

In Chapter VI an assessment of the costs and effectiveness of alternative training programs is presented. A cost effectiveness analysis of courseware development is presented in Chapter VII.

Implementation issues and the physical feasibility of the proposed project are discussed in Chapter VIII. The social and economic implications of the project are discussed in Chapter IX.

Policy implications and recommendations are presented in Chapter X.

II. REVIEW OF THE LITERATURE

A. INTRODUCTION

This section summarizes a brief review of the literature on computer-based education (CBE), including PLATO. The review focused on studies of costs and benefits and the use of CBE as a remedial instructional strategy, implementation issues, and alternative CBE vendors and approaches to improving educational productivity.

Computerized searches were made of the ERIC Clearinghouse on Information Resources. In addition, a number of technical and educational libraries were consulted. The Control Data Corporation (CDC) provided a summary of evaluations of its Basic Skills programs, and several manufacturers of hardware contributed product and costing information. Telephone conversations and interviews were conducted with persons active in the field of CBE, and the team visited an organization which is developing PLATO software. Members of the Pragma assessment team also visited several Control Data training centers which provide remedial education services.

Some Definitions. The instructional use of microcomputers can generally be divided into two broad categories: computer managed instruction (CMI) and computer based education (CBE) or computer assisted instruction (CAI). CBE is a teaching process in which the computer presents instructional material. CMI is an instructional management system which uses the computer to direct and maintain records for the instructional process.

PLATO is the name for instructional software marketed by the Control Data Corporation. Although PLATO software falls under the CBE category of instructional materials, PLATO also offers CMI capabilities. The Basic Skills Learning System is one of many CBE programs offered by PLATO. These remedial reading, language, and math CBE programs provide instruction in academic skills which usually are acquired in the third through eighth grades of public school in the United States. The management of instruction (CMI) is integrated into these instructional materials, and as a result they can be used as individualized, "stand alone" materials without additional classroom instruction. The programs also can be used to complement traditional classroom instruction.

This complete integration of CBE and CMI is not typical of most computer based instructional materials, however. Most CBE materials consist of individual lessons which can be used selectively to complement other instructional modes. Usually these materials must be carefully selected to assure their relevance to and integration with the particular course being offered and the overall curriculum.

The term hardware refers to the computers and other equipment needed to support CBE. In general, such equipment is either "on-line," which means "dumb" terminals that are connected by a telephone linkage or a cable to a large, centrally located computer, or micro computers, smaller, stand-alone computers that can be used without any linkage to a main computer. However, "micros" often can be linked to an on-line computer or networked together to provide on-line teacher access to student activities if the user desires to do so. Generally speaking, terminals and programs used in conjunction with on-line systems are leased from the supplier. Microcomputers can be either purchased or leased.

Control Data proposes using the CDC 110, a micro computer, in the Unified Curriculum Project. We understand that if the project is implemented the CDC Viking, a new CDC microcomputer, will be substituted. In the past, CDC's PLATO system was available only through online telephone linkages with a mainframe (e.g., big) computer. In the past two years, however, many PLATO users have converted to CDC microcomputers.

Software for micros is typically available on 5 or 8 inch "floppy disks," soft plastic diskettes (much like flexible plastic phonograph records) which are inserted into the disk drive of the micro computer. These diskettes contain software, the information which is presented on the terminal. In some instances microcomputers use cassette tapes for software presentation. Although software normally is purchased, in some instances it is included in leasing arrangements. Diskettes need replacement approximately every six months.

Although CBE refers specifically to programmed materials designed for use with a computer terminal, the terminal and CBE diskettes are rarely the only means of instruction. Usually an instructor and/or technician helps trainees to operate the terminals and software programs, and to complete other instructional materials. For instance, the CDC training centers we visited were characterized by a team

approach in which each center staff member, from the center secretary to its director, showed enthusiasm about the learning process and concern about each trainee's progress in learning the materials and achieving their stated goal, whether it was getting a job or passing a General Education Examination (GED). These staff members, and a number of the persons who were interviewed in the survey of users (see Chapter III), emphasized the importance of staff involvement with and support of students who have experienced past failures in educational settings.

In addition, courses which include CBE programming usually offer written materials, and in some instances audio visual materials and group counseling sessions. CBE is an instructional tool; only rarely is it expected to function as a stand-alone instructional methodology.

The remainder of this chapter is organized around the following topic areas: a general discussion of the costs and benefits of CBE, including cost effectiveness; software and its development; implementation considerations; other vendors; and alternative approaches used by U.S. AID to increase educational productivity. Conclusions and recommendations drawn from the literature review are presented in the final section.

B. COSTS AND BENEFITS OF CBE

Cost benefit analysis depends upon a clear articulation of project objectives and some consensus about both the costs and monetary benefits of the project. Cost effectiveness analysis involves cost comparisons of alternative approaches to obtaining the same results or benefits, which are not necessarily defined in monetary terms.

Both cost benefit and cost efficiency analysis depend on the the identification of quantifiable costs and benefits. This section presents information obtained from the literature about the costs and benefits of computer based education.

1. Assessment of Benefits

Although much of the literature on benefits discusses effectiveness, there is no commonly used definition of effectiveness. As a result, studies which attempt to measure effectiveness are not comparable. As Chambers and Sprecher point out, effectiveness can mean the amount of initial learning that takes place, the degree of retention

of learning, or attitudinal changes (p. 335). In some instances writers include the rate of learning (more often defined as efficiency) in their discussions of effectiveness. The following discussion describes the major benefits attributed by the literature to CBE.

Achievement. A comparatively large number of studies compare learning gains of students using CBE with other, usually traditional, modes of instruction (Hofstetter, Slattow, Simutis). In her comprehensive review of the literature on CBE, Forman cited nine "well designed and tightly controlled studies" which showed that the use of CAI either improved learning or showed no difference when compared to traditional classroom approaches. In general, research indicates that CAI can be used successfully as individualized supplemental instruction to assist learners to attain specified instructional objectives (Forman, Gleason, Splittgerber).

There is some disagreement about whether retention following CAI is as good as retention following conventional instruction. For instance, in a review of 33 empirical studies on CAI (conducted from 1966-1973) Taylor concluded that the retention rate of material learned under CAI appears lower than for traditional instructional approaches (Splittgerber). Gleason, however, concludes that retention following CAI is at least as good if not superior to retention following conventional instruction.

Efficiency. A number of studies report that when CAI and traditional instruction are compared, equal or better achievement using CAI is obtained in less time (Boettcher, Forman, Gleason, Missel). Gleason reports substantial savings in time (20 percent to 40 percent) required for (CBE) learning as compared to "conventional" instruction.

Student Attitudes. The literature indicates that many students have a positive attitude towards CAI, frequently accompanied by increased motivation, attention span, and attendance in courses (Braun, 1980; Forman; Splittberger).

Computer Literacy. Many discussions in the literature cite "computer literacy" as a major objective of CBE. Many writers and educators suggest that for today's world an adequate education requires that students be familiar with and able to use computers. Computer literacy is rarely defined in measurable learning objectives, however, and no quantifiable benefits were attributed to computer literacy in the literature we reviewed.

Remedial Education. PLATO is reported extensively in the literature as an effective tool for remedial education (Maser, Simutis, Rudisill, Smith). Forman reports that reluctant learners become active and interested when involved in computer supported programs. In fact, there is some indication that tutorial and drill modes are more effective for low ability students than for middle or high ability students (Braun, Forman, Splittberger). Findings from the Job Corps' comprehensive comparative study of the use of CBE as an instructional mode with disadvantaged youth indicates that CBE is successful and cost effective (1).

Vocational Education. This brief review identified few vocational (skill training) applications of CBE. CBE clerical and computer training is being used to some extent by private firms for inservice training, and it is being marketed commercially by CDC and others. A number of CBE courses have been developed for use by the military and some domestic federal agencies for use in high technology and/or high risk training areas, such as air traffic control, pilot training, etc. It appears that vocational training CBE applications in agriculture and the blue collar trades are infrequent, and that there are few models--much less cost-effectiveness studies--of vocational applications.

CDC Review of Benefits Attributable to PLATO. A check list summary of CDC's review of evaluation findings on the effectiveness and efficiency of their Basic Skills Learning System is presented in Exhibit III-1. These findings indicate that in most cases PLATO is at least as effective as traditional instruction and suggest that students using PLATO learn more rapidly.

CDC's description of student benefits in the Baltimore Public Schools is fairly consistent with the benefits described above:

- Students learn more effectively and rapidly on PLATO.

- PLATO's presence in the classroom reduces tardiness and absenteeism.

- With PLATO, more students pass proficiency exams.

- PLATO improves the self-confidence and self-esteem of educationally disadvantaged students.

- Disciplinary problems are significantly reduced among students using PLATO.

EXHIBIT II-1

EIGHT STUDIES OF PLATO EFFECTIVENESS

Source, Time Frame		Gain Reported	Significant Difference	Greater Efficiency
R,M	Adult Learning Center, Md., 1978-79 (p.7-11)	+	N/A	N/A
R,M	BSLS PLATO Project, Minn., 1979 (p.11)	+	N/A	N/A
M	Bexar County Detention Ctr.,Tx.1978 (p.13)	+	+	+
M	Precollege Remediation,Mich., 1978 (p.15)	+	-	+
M,R	Army BS Educ Program, Ft. Meade 1980 (p.24)	+	-	+
M,R	Fair Break, Minn., Va., (p. 28)	+	N/A	N/A
M	Instruction Project, Florida 1979-80 (p.30)	+	N/A	N/A
M,R	Baltimore Public Schools, 1980 (p.51)	+	+	N/A

Key M = Math
R = Reading
+ = Positive Results
- = No significant differnce/negative results
N/A = No control group, no data reported

Drawn from CDC Summary of Evaluation Studies of the Basic Skills Learning System (unpublished, July, 1981)

- Students using PLATO show increased motivation and attention span (CDC, p. 51).

When we discussed CDC's description of these benefits with an evaluator in the Baltimore Public School system, he strongly disagreed with CDC's interpretation of the findings. First, he felt that CDC does not have an adequate statistical basis for its judgements about benefits. Secondly, he felt that the study's discussion of cost effectiveness was inappropriate, since students are required to remain in classes regardless of the amount of progress made--in short, he feels that program effectiveness will not result in demonstrable cost savings in the Baltimore Public Schools. In addition, he maintains that the student-teacher ratio in PLATO classes is lower than that in traditional classes, and that this difference could a) account for the difference in achievement levels and b) would increase the cost of PLATO Instruction (2).

Significant Variables. In commenting on the difficulty of comparing studies of effectiveness, Gleason cited the large number of significant variables which interact in most instructional settings. He listed the following research topics which can support analyses of effectiveness:

1. What are the most effective CAI strategies? What type of feedback is most effective? How often? At what point in the program? What types of learner interaction are most productive? Which instructional paradigms are most effective in the various content areas?

2. What are the interactions of individual learning styles in CAI? How much cognitive complexity can the learner manage? What concept-learning strategies are most appropriate for which types of learners?

3. What are the effects of individual learner characteristics, such as memory span, perceptual skills, sensory preferences, intelligence, motor skills, etc?

4. Which hardware configurations are most effective and efficient in various types of program? Audio? touch-sensitive screens? Videodisc? Light pens? Etc.

5. What affective characteristics of the learner are important? Motivation? Persistence? Delayed gratification? Locus of control? Etc.

6. What are the most effective strategies for program development?

7. What are the most effective strategies for integrating CAI with other instructional activities? (Gleason, p. 38)

The literature indicates that these variables greatly affect the effectiveness of CBE, and that until their relationship to expected benefits are understood few assumptions can be made about the effectiveness of planned CBE applications in new environments (Splittgerber).

2. Cost-effectiveness.

In Seidel's discussion of the value or purpose of computers in the classroom, he identifies five instructional purposes:

- Opportunities for students to become familiar with computers
- Developing skills with computers
- Curriculum enhancement
- Educational reform
- Cost effectiveness (p. 482).

This list makes some useful distinctions which are relevant to the proposed Unified Curriculum Project. The first two purposes, familiarization and skills develoment, fall under the general category of computer literacy, an objective which was not cited in the UCP proposal but which presumably is important to Jamaicans. The third category, curriculum enhancement, refers to new and otherwise unavailable presentations of information. This appears to be at least part of the purpose of the proposed UCP vocational CBE applications.

The fourth category, educational reform, refers to individualized instruction as an instructional strategy. Although this is not a stated objective of the proposal, the effective use of CBE requires that the existing instructional system be competency-based, meaning that the learning program responds to individual rather than group needs and achievement. A competency-based, individualized curriculum would represent a significant educational reform in most instructional systems in both the United States and Jamaica.

Seidel describes these first four purposes as adding new skills or knowledge to instruction. When something new is added, the concern should be with assessing the value of the additional objectives to the student or institution, rather than with comparing costs with other instructional approaches which do not provide the same value (p. 491). This framework clarifies cost issues associated with the use of the computer in the classroom. The question becomes, "How much is the additional value worth?" rather than "How does the cost compare to other educational approaches?"

Cost effectiveness appears to be a major purpose of the proposed UCP project, and this report is responding to a U.S. AID request for a cost-effectiveness analysis of the proposed project. Seidel lists cost effectiveness as a separate purpose because, unlike the first four topics which address added value considerations, cost effectiveness analyses require that educational approaches providing equal or better achievement gains be compared on the basis of resource costs.

Cost effectiveness questions can be placed in three general categories:

1. The relative advantage of CBE over traditional and perhaps less expensive instructional methods;

2. Whether less expensive methods can effect the same or better instructional gains as CBE;

3. Whether technological advances have (or will soon) reduce costs to the point that most school districts can implement CBE (Splittgerber, p. 21).

Seidel lists the following measures for use in answering these questions: student efficiency (achievement/time, money), cost avoidance, student enrollment, attendance, and attrition. Other effectiveness measures are student attitudes, instructor ratings, and attrition and absentee rates.

Although several studies have assessed the cost effectiveness of timeshare systems (Forman cites six studies), we identified no cost effectiveness studies based on the use of microcomputers. Seidel reported that in a study of 370 institutions which were identified as having outstanding educational computer programs, only 16 institutions provided cost effectiveness information, and none provided data that could be used to determine the cost-effectiveness of their computer programs. He concluded

that these institutions view the computer as a "tolerable cost" rather than as a cost-effectiveness strategy (p. 483).

In general, cost savings can be realized from cost avoidance, such as reduced numbers of students requiring remedial instruction; lower resource (training) costs; and/or shortened learning time. For instance, when participants are paid stipends or salaries while in training, decreases in work time lost or in stipends paid offset the higher cost of the training.

A number of issues relate to costs. For instance, many studies which show CBE to be effective use CBE as an adjunct in a classroom in which a teacher is readily available. This means that the cost of CBE instruction is in addition to established classroom costs. In many instances neither student-teacher nor student-machine ratios are discussed, although they impact heavily on costs. In addition, the costs of teacher training and of software development and/or adaptation usually are not included in cost considerations.

In general, decisions to use CBE are not typically based on cost effectiveness considerations (Seidel). For instance, Dr. Raleigh Jobes of the University of Oklahoma described decisions about the development of agricultural CBE courseware for use in the extension service as attributable to its being a "coming thing," "a good idea," and CBE's educational potential (3).

Dr. David Holder of the U.S. Extension Service indicated that the computer might be most effective as a business management tool for farmers. He added that in his opinion the costs and problems associated with updating agricultural CBE courseware are not worth the time and cost involved--most farmers (and perhaps more importantly, he himself) prefer to look information up in a book or magazine. He said that an on-line information service for rural farmers is being considered, however, since research indicates that rural libraries have comparatively little up-to-date information to offer farmers (4).

C. SOFTWARE AND ITS DEVELOPMENT

Software and its development is a major issue, since CBE is only as good as the courseware it delivers. In a comprehensive review of the literature and assessment of the state of the art, Gleason concluded that very few of the thousands of software programs have any instructional value, and that the poor quality of software is acting as a

deterrant to the widespread acceptance of CAI. Lambert states that CBE may not be widely accepted as an alternative instructional medium because good courseware is unavailable and few educational institutions will make the substantial investment required to create good courseware.

Gleason listed the following constraints to software development by the private sector:

1. Production of high-quality programs is expensive. Estimates vary widely, but $10,000 per instructional hour is not excessive. (The proposal cites $10,000 per hour of CBE as an average cost.)

2. Most companies find that production staff require extensive training. Although writing and teaching skills are applicable, CAI program writing is very different from textbook writing.

3. The market is unstable at best. Hardware development is continuous, and progress is being made in software authoring languages (see the description in Appendix A of the WICAT authoring system). It is risky to spend large amounts of money to develop programs to be run on machines that may be replaced in a short time.

4. The problem of transferability restricts the market. A program written for an Apple may not run on an Atari or a PET. It is possible, but expensive, to translate programs to run on other machines.

Bramer reports that at the British Open University the long lead time associated with software development proved to be a major problem--by the time software was produced, it was outdated. On the other hand, Rahmlow & Pedrick discuss steps for the development of CBE materials which make them less expensive and time consuming to develop and implement than other materials. Although opinions vary on the ease of producing software, the literature consistently reports that most software produced has been of poor quality.

Some of Control Data's most popular software is being adapted by the Texas Instruments Corporation for use on several microcomputers. However, this adaptation will be constrained by the limited capabilities of smaller micros. For instance, the CDC 110 (the micro cited in the proposal) offers 60 horizontal lines of text. The Texas Instruments micro offers just 24 lines and comparatively poor resolution (clarity), which sharply limits the amount and presentation

of data on the screen. In addition, less expensive micros do not offer touch screen capability nor the same level of graphics capability as the CDC 110. The effect of these limitations on the quality of the software is unknown.

Although several organizations are evaluating software programs, there are no generally accepted qualitative standards and there is no comprensive library of existing CBE software. However, a useful evaluation guide has been developed by MicroSoft, a project of the Computer Technology Program of the National Regional Education Laboratory. The evaluation process determines whether the program has instructional value, is operationally ready, and computer compatible. A description is written, and an evaluation addresses topics such as content accuracy, cultural stereotyping, the definition of learning objectives, clarity of content presentation, level of difficulty, appropriateness of presentation, motivational levels, student controls presentation of format, etc.

Descriptions of CBE software which have been evaluated using this approach are available from Resources in Computer Education (RICE). RICE expects to have approximately 2,000 citations on-line by 1983; RICE can be accessed through the BRS on-line information service.

A comprehensive review of remedial and vocational education software has been conducted under the Youth Knowledge Development Project and the Remediation and Training Institute, headed by Robert Taggert. Information about these software reviews can be obtained from the Institute. Because of the cost and time involved in software development, Taggert maintains that new courseware should not be developed unless absolutely necessary, and that it is better to adapt and reformat than to develop from scratch (Appendix A, p. 8).

Considerable time, effort, and money is required to review the applicability and quality of available software. Even an organization which develops its own software has no guarantee of success since so many variables affect the success of CBE applications. However, if poor software is selected or developed, students can be trusted to reject it (Gleason). The most expensive software is that which is not used.

D. IMPLEMENTATION

Our conversations with users, CDC center managers, and our review of the literature identified a number of issues which appear to be critical to the success of a CBE project.

Sponsorship and Definition of Objectives. All of the applications that we reviewed involve one sponsoring institution which was responsible for specifying the project objectives and overseeing the efficient and appropriate implementation of the project. In addition, the literature suggests that the clear definition of the role and purpose of CBE before the project is implemented greatly affects the chance of project success (Misselt; Seidel, Hunter, and Wagner, Sinclair and Denis).

Efficiency and Productivity may be best achieved through contractual arrangements. Educational institutions have little incentive to increase productivity through technology. A possible implication of increased productivity is that educators may not be as greatly needed in the future, and no profession promotes advances which may reduce its own importance. Secondly, and perhaps more important, educators are not evaluated on productivity (Heinich).

CDC learning centers operate on a profit motive. The centers do not win contract renewals, and in some instances does not get paid, unless trainees achieve at established levels. This requires that the client receive quality services, defined as specific levels of achievement within specified cost limits or time periods.

Introducing CBE If CBE is to be accepted as an ongoing educational strategy, careful attention to change strategies is needed. Teachers, administrators, and some students may resist CBE for a variety of reasons, and many will need both specific incentives and general encouragement to use it (Heinich, Magidson, Milner). In addition, the support of the wider community is needed. For instance, the Baltimore Public Schools have contracted with the University of Maryland/Baltimore Campus to provide both evaluation and teacher support services for its new PLATO project (Lippman).

Integration and Cross Referencing. A number of writers emphasize the importance of integrating CBE into the classroom methodology and existing curricula (Taggert, Team Associates, Sheingold). In essence, either the existing

curricula has to change, or the software has to be adapted to meet the specific instructional objectives of each application (See note 1). Normally it is much less expensive to adapt the existing curriculum, but instructors and often administrators resist such changes. In either case, the instructional approach must accommodate individualized instruction, which can be provided on a paper and pencil basis as well as via the computer.

Lead Time Several sources familiar with the problems of implementing change in developing countries stressed the need for adequate lead time for planning and implementation. For instance, in a university setting in South Africa, it required nearly 18 months to get the PLATO project fully implemented (Sorlie & Essex, 1978; Sinclair & Dennis, 1982).

Staff Selection and Training. Staff selection, training, and retention are often the critical features of a CBE project, and may well outweigh hardware and software considerations in terms of what is potentially and actually achieved (Misselt, Sorlie & Essex, Hebenstreit, Sinclair & Dennis, Milner, Meyer, Congressional Research Service).

Evaluation. Virtually every manager and researcher, when asked the question, emphasizes the importance of evaluation research, at the very least as a management tool to help clarify project objectives and accountability. (Comparatively few managers dedicate dollars to collecting and analyzing evaluative information, however.) When costs are high and little is known about conditions under which CBE is effective, evaluation becomes almost a necessity if it is to succeed as a cost-effective instructional technique.

Commitment Although never cited as such, the importance of committed individuals and institutions nearly always underlies any successful project. This factor was apparent in a review of the success of U.S. AID-sponsored alternative educational technologies (Merrick), and in the implementation of a PLATO project at the University of the Western Cape in South Africa (Sinclair & Dennis).

E. IMPLEMENTATION RECOMMENDATIONS

Robert Taggert makes a number of useful recommendations for the design and development of a computer-based education system (See Appendix A).

1. Computers are a supplement to, not a substitute for, more traditional educational approaches. Begin with an individualized, self-paced paper-and-pencil instructional system, integrating computers into this system, rather than trying to build a curricula around existing CAI software or around lessons promised sometime in the future.

Individualized, self-paced instruction is effective and absolutely necessary in environments where students enter with widely varying skill levels, where they will progress at different rates, and where education may be necessarily combined with other activities and will vary in its intensity and duration. Most integrative studies indicate that individualized self-paced instruction without computers increases learning rates by two-thirds. Indeed, much of the reported gains of computer-based education reflect the fact that it is inherently individualized and self-paced, and is frequently supplemented by individualized, self-paced paper-and-pencil instruction.

Three widely-used, individualized, self-paced paper and pencil systems which organize the best of available published materials offer different options for instructional objectives which range from the most elemetary academic levels up through college preparation, and cover basic life skills training. These three organizational and referencing systems have been, and can be, adopted to different operating environments. The materials and systems have proven effective in maintaining student interest, maximizing learning activities during instructional time, operating with or without skilled teachers, and yielding tested learning rates for the disadvantaged which are far in excess of those achieved in traditional classroom environments.

They have been used, for instance, in Job Corps. The Job Corps serves a predominately minor population which is drawn from ghetto and rural poverty areas. Most trainees (85%) are dropouts, and the average entry reading and math skills are below the sixth grade level. Using these self-paced materials, gains of 1.6 grade levels in reading are obtained in an average of 90 hours of instruction, and 1.3 grade levels are obtained in math skills in 90 hours of instruction. In South Carolina, where a parallel set of materials have been used for 10 years with a somewhat less disadvantaged

population, the gains have been 1.8 grade levels in reading and 1.5 in mathematics for 90 hours of instruction. The Adult Performance Literacy system, which emphasizes a functional competency approach, yielded academic gains similar to those in the regular Job Corps program.

A paper and pencil based system can be used with or without computers. This is important, since computers are not feasible in many settings and, when used, have a relatively high probability of down-time. No computer-based instructional system, including PLATO, has enough courseware to adequately cover a comprehensive range of instructional objectives. In addition, paper and pencil-based systems tend to be more acceptable to teachers as well as to that minority of students who do not like computer instruction. Since paper and pencil materials are much less expensive than CBE programming, the combination is much less expensive than a terminal-bound approach. For instance, a mixed system would have one or two students working in booklets for each student working on a terminal.

2. Computers are most useful when used to manage individualized instruction using paper and pencil materials as well as to deliver lessons on the terminal.

The evidence from experiments in Job Corps is that the augmentation of paper and pencil materials with PLATO lessons and those delivered on other terminals increases the reading gain rates by a third, and the chances of completing the GED tests and certifications by a sixth. However, there is no significant impact on math gain rates. There also appear to be slight but noticeable effects on student attendance and retention in learning activities.

Of equal importance, however, is automating the scoring of the frequent competency tests which are part of an individualized self-paced system, and formulating lesson assignments based on computerized analysis of test scores. This computer managed instruction (CMI) frees up 40 to 60 percent of teacher time in the classroom which permits either larger class sizes or more personalized attention for individual students. Experiments with student aides suggest that there is no sacrifice in gain rates when class size is increased by the use of a student aide along with a teacher. Indeed, when test forms are standardized and test interpretations plus prescriptions are computerized, the learning centers can be operated with very little teacher input.

These computer-managed instruction dimensions tend to sell the computer to teachers already involved in individualized

self-paced instruction because computers save their time. Many traditional teachers are thrilled with the "high tech" aura of the computer, and built-in CMI makes them more likely to accept the underlying individualized paper and pencil curricula. Students like computerized instruction, whatever its comparative instructional effectiveness, as a break from the repetitive nature of paper and pencil exercises.

All programs involve record-keeping of some sort. Management information (MIS) functions can be integrated with CMI. For instance, periodic test scores can be stored by the computer along with instructional hours and student characteristics. When properly and simply designed, this record keeping function builds in an evaluation and reporting of instructional effectiveness capability. Cost attendance of other simple data can be collected and or processed using the same terminals.

In summary, the U.S. experience suggests that computers are most accepted and most effective when they integrate the CAI, CMI and MIS functions with the other instructional activities in the class room and the administrative procedures of the project.

3. <u>The educational system, whether solely paper and pencil-based, totally computer-based, or a combination, will only be accepted by students and instructors if it references into, and prepares for, those educational certifications and milestones by which their performance is judged</u>.

In the individualized, self-paced instructional systems developed for the U.S., the skills and lessons are organized hierarchically, usually leading and referenced to the General Educational Development (GED) Test. After completion of basic skills instruction, an individual without a diploma will take the GED practice test. The tests results are used to prescribe specific lessons from the skills hierarchies so that students may achieve mastery of the skills tested by the GED. The Armed Services Vocational Aptitude Battery (ASVAB) and the Stanford Achievement Tests also have been used as alternate references when the selected lessons from the skills hierarchies are aimed at achieving entry to the military or college. It is relatively easy to add a new reference system (such as the CXC or the General Certificate of Education accepted in Jamaica) when old versions of the tests are available for use as the diagnostic/prescriptive tools and as the mastery tests. As an example, the integrating and referencing of the ASVAB into the Job Corps' individualized, self-paced instructional system cost around $10,000, including the prototyping in an operational setting.

Computers usually are not utilized effectively when they are adopted by schools or other settings which have their own separate achievement objectives and CBE instruction is not "cross walked" or carefullly related to the instruction going on in more traditional ways. Teachers and students do not know which lessons to use or how to relate them to their established learning objectives. In contrast, when CAI is integrated, the teacher easily identifies and assigns computer lessons instead of traditional instructional approaches. When lessons achieve desired objectives quickly, with less effort, or attractively, they are utilized.

The best way to achieve this is to use existing systems which already reference most available CAI lessons as options to paper and pencil materials in an individualized, self-paced instructional system referenced to accepted certification tests. The skills hierarchies leading to "high school equivalency" or CXC equivalency are largely the same. Only the level and prescriptions vary. The existing hierarchial framework can be utilized without much change by "leveling" it to an accepted certificate test such as the CXC, putting it in place, and gradually weeding out the paper and pencil or computer lessons which prove less effective in the new setting.

4. <u>Do not develop new courseware unless absolutely necessary</u>.

The inventory of available CAI for almost all purposes is increasing exponentially. The cost of screening and organizing lessons appropriate for any specific purpose is small relative to the cost of lesson development. Extensive screening and cross-referencing of lessons relative to basic skills instruction has already been completed, reducing the options which need to be considered and the costs of screening and cross-referencing. In contrast, new lesson development is highly risky, as demonstrated by the low rate of useable lessons found in the screening process. For instance, 20,000 lessons on the Minnesota Educational Computing Consortium public domain tape were reviewed to find the 200 considered useable in remedial education below the 8th grade level. Projects to train lesson developers, such as the Chanute AFB PLATO project yielded few useable lessons after extensive investments in training individuals in lesson development.

Each learning environment will differ, but these differences are best accommodated by choosing among available lessons for any specific skill, rather than starting development from the ground up. Observation in an operational setting is the best way to determine the appropriateness of lessons when there are

several reasonable options. New lessons can then be developed only when no available lessons serve the purpose.

Even in these cases, however, it is better to adapt and reformat existing lessons than to develop from scratch. For instance, there are over 16,000 hours of PLATO lessons in the CDC and University of Illinois libraries. Some of these can be adapted for diskette much less expensively than developing entirely new lessons. Alternatively, condensed versions of PLATO lessons have been adapted for Texas Instruments and Apple computers.

5. A range of hardware and software options need to be developed which operate under consistent frameworks but adapt to different circumstances by piecing together different combinations of hardware, software, and paper and pencil materials.

The individualized, self-paced instructional systems of paper and pencil materials must be (and are) modularized so that a subset of materials and tests can be provided for delivery sites emphasizing just beginning reading, CXC preparation, or functional skills (world-of-work) training. The materials must be "unitized" so that the instruction can carry an individual the full span from entry to advanced skills, and useable when there are only a few hours for remediation. For sites training large numbers of students with well trained instructors, a comprehensive range of materials are needed. "Stripped down" options are required when there are fewer students and staff with less ability to utilize varied options.

In some cases, it will be appropriate to use only paper and pencil materials. A range of inexpensive microcomputers can be (and are) programmed to supplement the paper and pencil materials with limited drill and practice lessons and to score tests and prescriptions. More expensive microcomputers, such as the CDC 110 which delivers PLATO lessons on a stand-alone basis, should be used for more elaborate instruction lessons. CDC 110 equipment can be used effectially in conjunction with other microcomputers dedicated to more pedestrian drill-and-practice lessons and CMI.

In a somewhat larger scale operation which operates in an isolated setting, it makes sense to "cluster" the microcomputers using a hard-disk drive for numerous terminals. For instance, eight or more Apple terminals could be linked to a Corvus disk which contains a range of pre-selected lessons and a CMI/MIS system for testing, assigning and tracking students.

A more elegant and versatile approach is to cluster 10 to 120 PLATO terminals into a minicomputer (a larger than microcomputer with comparatively large system capabilities) linked to a hard disk containing up to 2000 program hours and including a CMI/MIS program. Where communications systems are adequate, it is possible to use a minicomputer linked by telephone line to terminals in distributed sites. The minicomputer can handle the CMI and MIS and deliver some CAI lessons to supplement and manage paper and pencil instruction. This approach might be integrated with microcomputers, so that students get most CAI from the micros while the testing, scoring, and record keeping is handled by the CRT's linked to the minicomputer. Software has been developed for several different minicomputers with references to the CAI available from several different microcomputers.

Finally, a dedicated and self-contained networked instructional system such as the PLATO on-line system is feasible when there is a large enough scale of operators and reasonably good communication. The approach provides a comprehensive library of materials, a built-in CMI, and centralized assistance and control.

Different systems make sense for different circumstances. If all use the same general framework--i.e., the skills hierarchies referenced to similar diagnostic and mastery tests and based on accepted paper and pencil materials--and if all contain cross-references so that the correspondence is known between each paper and pencil lesson, PLATO lesson, APPLE lesson and the like, then it is possible to pick and choose the right combination for each delivery circumstance.

6. <u>An incremental "building-block" approach will reduce the risks and facilitate more rapid implementation</u>.

In several different settings under the Youth Employment and Demonstration Projects Act, we tried to develop comprehensive, minicomputer-based systems covering all uses and meeting all needs. This approach was basically unavoidable when microcomputers were not available and software had to be developed from scratch. However, circumstances have changed. Microcomputers are more and more powerful. Their capacities for communication have increased. It is possible to add memory, or to link units with hard disk drives once enough units are secured to make this economical. Software for most purposes can be acquired off the shelf and the power of micros is increasing so much that the use of a centralized, one-stroke system risks technological obsolescence.

A better approach is to begin with the lowest common denominator--the paper and pencil instructional system with a

hierarchial skills framework referenced to existing competency tests--and to add computer capacities as needed and as experience is acquired. For instance, an Apple II and CDC 110 might both be added, with the former handling the tests and scoring and doing some CAI while the latter is used as a primary instructional supplement. After the delivery agent becomes familiar with the materials and capacities, a choice might be made on whether to move to an Apple cluster or a CDC cluster, or perhaps to just add a few more stand-alones. The already purchased terminals will still be used in the new systems, so that there is no loss. A minicomputer with CRTs might later be added to link distributed sites. It could handle record-keeping and number-crunching which would only be necessary when there were more users with roughly compatible systems. Again, this would be fully integrated with existing micros and clusters.

In order to inform the decisionmaking process, the various options must be demonstrated so that each potential user can determine the least cost and most simple system for a particular setting. The implementation of a range of compatible options will also provide information on the economies of operation, i.e., at what student throughput level and for what instructional purposes it makes sense to upgrade the hardware and software combinations.

7. Primary emphasis should be placed on using computers for remedial education and life skills training.

As a general rule, computer-based systems only become cost-effective when they are maximally utilized. In specialized applications, such as the presentation of vocational lessons or advanced education offerings, there is rarely enough software or enough student usage to maximize efficiency. For instance, it has been estimated that the terminals which deliver occupational information to schools and which serve no other purposes are utilized in the U.S. less than half of the normal school day. Specialized applications usually also require more advanced programming and instructional skills. Where lessons must be developed or adapted, these high costs of development are difficult to amortize unless there is very intensive usage.

In contrast, the software and systems for remedial education and life skills training are useful for a broad range of students. The materials are obviously useable for any number who are lagging in or have left the regular school system, whether youth or adults. The available materials reach up through the college preparatory level, and have proved useful

in catch-up courses offered by most colleges in this country. These groups provide the numbers necessary to fully utilize the equipment and to achieve necessary economies. It is best to begin with this base and to add on special purposes. Then the payoff is increased by expanding the applications and adding capacity only after full usage is demonstrated. But the system will be cost-effective whether or not additional fuctions are added.

Remedial applications also reduce the need to integrate offerings with existing curricula in schools and colleges. At least in the U.S., every high school district and college varies in its materials, lesson organization, performance standards and the like. Where computers are used in regular classrooms, lessons must be developed or screened specifically for these requirements. In other words, the screening and development must be repeated over and over. There is nothing more challenging than trying to get agreement among teachers and school officials on standardized systems and approaches. Without this standardization, the economies of scale which make computers useful can rarely be achieved.

In contrast, this is less of a problem for remedial applicants since the students have fallen behind or are outside the regular educational track. In the U.S., it has been possible to establish remedial centers which use a standardized individualized, self-paced system in schools having a very difficult time using computers in the regular classrooms. It is easier to establish learning centers outside the schools, and to thus avoid all negotiation with the education establishment.

8. <u>Simplicity of design and operation are crucial</u>.

All too frequently, the most skilled and thoughtful personnel dictate the design of computer-based systems. As a result, options are incorporated for evaluation purposes, course design, or micro management, but which can only be used by those who are equally skilled and thoughtful. When Cadillacs are used where a Ford pick-up would be more appropriate, the acquisition and maintenance costs become so great that the systems are rarely used effectively.

The systems should be designed for use by those with no computer expertise, and without trained teachers. CBE systems in the U.S. have been operated solely with student aides. Where teachers are available, they can spend their full time in one-on-one instruction rather than lesson planning, testing, scoring, and prescribing.

The aim should be to provide users with already packaged "kits" of a) paper and pencil materials; b) pre-coded testing forms when scoring is automated; c) already screened or developed software on diskettes or hard disks; d) record-keeping forms and reports; e) detailed handbooks to assure that this "turnkey" system is implemented correctly. The "kits" should include a variety of materials and the software should allow for lesson authoring and for the incorporation of any locally developed or preferred paper and pencil materials where appropriate. But the systems must be operable <u>without</u> any screening of materials or lesson development.

Perhaps the most important element is to build up a technical assistance and networking capacity so that the users can get help from a centralized source whenever problems occur. This same source can evaluate the use of materials and equipment in order to finetune the system over time. It can coordinate or centralize lesson development and screening for specific users, so that this skill-intensive task can be effectively achieved even where skilled manpower is limited.

F. OTHER VENDORS AND CBE CONFIGURATIONS

Although our scope of work requests that the team compare Control Data capital and recurring costs with those of other vendors for comparable equipment and programs, no other vendor offers the range of educational software offered by Control Data. In addition, no other vendor manufactures a micro computer which is fully comparable to the CDC 110. Therefore, we briefly describe below the range of available CBE equipment and software development options as an indication of the various possible CBE configurations. Pragma also contracted with Robert Taggert for a concept paper on possible CBE configurations, based on his evaluation and analysis work with Job Corps and CETA remedial and vocational training. His paper is presented in Appendix A.

There are two major but possibly contradictory thrusts in the area of hardware for instructional purposes: the development of microcomputers and the adaptation of time-shared systems to facilitate more widespread and complex applications. PLATO represents each. In the recent past, instructional institutions either purchased expensive computers or leased timesharing equipment. But now schools can--and do--purchase microcomputers at a cost of well under $1,000 per unit.

Although a large number of microcomputers currently are competing for the market, Business Week predicted in a recent article that the number will sharply decrease in coming months as the market solidifies. Comparisons among different systems are difficult because there are many different micros on the market, each offering slightly different features. More important, at present most vendors use different operating systems, which means that there is no guarantee that any program will run on any machine other than the one for which it was designed. Therefore, the availability of appropriate and machine-compatible software, and the system's software development capability, become major considerations in a project of this type.

PLATO is currently the largest contender in the field of CBE, and has the strongest reputation for software, both in terms of quality and quantity. In selecting articles for this review, PLATO was the only software regularly identified in the literature, and it has been the subject of a large number of research studies. According to several of our survey respondents, the availability of large libraries of software make PLATO's online services desireable, despite their comparatively high costs.

It is unclear to what extent Control Data will convert this software to microPLATO. However, the United Curriculum Project will bear the costs of converting the majority of the software which it selects from PLATO's libraries to microPLATO. It is unclear whether the PLATO software being marketed by Texas Instruments for use on a variety of micros can be used on CDC equipment. Since they are written in a different language (CPM) than that used for PLATO (TUDOR), the Texas Instruments programs may be quite different from those offered by CDC.

No single company offers an alternative to the comprehensive applications proposed in the Unified Curriculum Proposal. However, alternative approaches could be developed by selectively combining features offered by several different firms.

In our review of the published literature, we identified only one CBE application which approaches that proposed by this project. It is the Minnesota Educational Computing Consortium (MECC). It was created in 1973 by the State of Minnesota to coordinate the use of computers by the state's 433 public school districts and 30 public college campuses. Its joint powers agreement includes four tax-supported educational systems: the University of Minnesota, the State University System, the Community College System, and the State Department of Education (Rawitch).

MECC provides leadership and coordination for instructional computing in 95 percent of all state public colleges and school districts. It offers educators access to a large Control Data central computer as well as software, technical assistance, and inservice training. Users pay only for their onsite equipment and for time used.

In 1978, MECC established a "precedent setting statewide contract" that allowed schools and colleges to purchase Apple II computers at a reduced price. (Current price: $1,577 (5). In three year's time nearly 3,000 computers have been purchased under that contract. In addition, about 1,000 microcomputers of other brands have been purchased. In 1981 MECC added a second microcomputer option (following competitive bidding) under which districts which desired less expensive equipment (with fewer capabilities) could purchase the Atari 400 model with disk drive and television for under $600.

MECC's teacher-trainers help educators learn to use the equipment and assist with the development of courseware. The MECC-supported courseware now encompasses nearly 50

diskettes containing several hundred programs, each of which is accompanied by a teacher's handbook which provides learning objectives, sample lesson plans, and student worksheets (Rawitsch).

Several firms market systems primarily for education and training purposes. They include TICCIT, a comprehensive system designed for educational uses which uses cable to tie microcomputers to a Data General minicomputer. (A complementary stand-alone microcomputer capability is currently under development.) The system, which is currently used by seven military installations and three colleges and universities for training purposes, provides terminal displays in color with visual media including film, videotape, and slides which also appear on the terminal rather than on separate equipment. The user develops and retains ownership of all software; none is marketed by TICCIT. TICCIT provides intensive training in software development. We did not pursue this alternative further because the system must be used only when the various microcomputers can be linked by cable to the main computer (6).

WICAT Systems offer similar services to those offered by TICCIT, except that it offers stand-alone microcomputers and a software development capability (WISE) which it maintains greatly reduces the cost of software development. WICAT does not market software for use on its systems. Current users are primarily business and government agencies. (See Appendix D for costing estimates and descriptive materials on the WICAT equipment).

Major vendors of microcomputers with educational applications include Texas Instruments, Apple, Atari, Commodore, and Tandy. Each offers catalogs of educational software (quality unknown) and some networking capabilities. Cost of microcomputers of varying capabilities range from under U.S. $500 up. However, the equipment provided varies greatly. For instance, the price quoted above for a low cost microcomputer covers only the computer--it does not include a printer, a terminal, or disk drives. These items must be added before cost comparisons are made.

G. OTHER ALTERNATIVES TO PRODUCTIVITY IMPROVEMENT

In considering educational alternatives, U.S. AID's past experience with educational technology should be considered, although the quality and quantity of the data on these projects vary (Merrick, 1980). The following brief summaries

of these projects provide some indication of the costs and potential benefits of radio and television projects which were designed to provide low cost solutions to needs similar to those cited by Jamaican officials.

1. Instructional Television and Educational Reform, El Salvador. Under this project, which began in 1971, 223,350 students in grades 4 through 9 in 838 schools received educational television programming (ETV) at a cost per student hour of $.07, or approximately $12 per student each year. ETV cut schools' operating costs by allowing increases in class size, school consolidations, and lengthened teaching hours.

2. Formal and Nonformal Educational Television Programs, the Ivory Coast. Based on current rates of enrollment, projections estimate an increase in students reached by ETV in the formal classroom to increase from 231,211 in 1975-76 to 888,118 by 1982-83. Over the 20-year projected life of the project, an annual average cost per student of $20 is estimated. For nonformal programming, evaluations have shown an average of 305 schools open per broadcast, and some 15,500 viewers per broadcast, at an annual cost of each broadcast per viewer of something less than $2. No data on effectiveness was provided.

3. The Korean Educational Development Institute (KEDI), Korea. KEDI developed and transmitted educational television and radio programming as part of an educational reform effort. In a 1978 comparative study, experimental school students showed a 24 percent increase in mean achievement across all subject areas as compared to students not participating in the program. In addition, students in rural schools performed as well as those in urban schools. No data on costs were provided.

4. Radio Mathematics, Nicaragua. This program combined radio transmittals with systematic instructional design for primary school mathematics. A selection of posttest scores for control classes over experimental were statistically significant: 25 points higher in the first grade, 10 points in the second, and 13 points in the third. According to Morrick, results indicate that in this context radio can carry the main teaching burden for primary school mathematics and effect higher learning gains in rural primary students. The project produced a cadre of trained personnel who are now involved in implementations of projects in other parts of the world. No cost data is provided.

5. The Rural Radio Education Project, Paraguay. In this program designed to reach rural school dropouts (dropout rates range from 18 to 54 percent), radio was used as the primary instructional medium in 70 learning centers in community centers, schools, and homes. Of the 700 initially enrolled in the program in 1978, 589 completed the year and 520 passed (88 percent) achievement tests in three areas. Learning centers are growing, and a trained team of multimedia instructors are now administering the program and positive effects are reported for instructional development, staff training, research and analysis, and educational services for rural poor. From January 1977 to April 1979 total project costs were $1,412,331.

6. Basic Village Education, Guatemala. In 1973, this five year experiment used varying communications mixes of radio, study groups, village monitors, agronomists, and complementary graphics materials to bring new cultivation information to farmers. Results showed that in the relatively advanced area of the country, radio alone had an effect on changing behavior. In more traditional areas, the reinforcement of an agronomist and/or monitor was needed to help farmers translate the information into behavioral change. Cost-benefit analyses of twenty-year projections show that all BVE media combinations showed favorable economic rates of return except the radio-monitor-agronmist option.

In each of these projects, a significant investment was mdae in the design and dissemination of systematically structured learning materials since teachers were often poorly prepared. The host countries' commitment to "make the project work" also is apparent.

H. SUMMARY

A number of conclusions can be drawn from the literature. Those listed below were selected either because of their relevance to the proposed UCP/CBE project or because of the emphasis they received in the literature.

1. Few solid studies are available on the cost effectiveness of CBE. Since both hardware and software development capability are constantly changing and CBE implementation strategies are still developing, definitive studies will not be available for some time.

2. Decisions to use CBE appear to be based on "added value" or "tolerable costs" rather then cost-effectiveness. Many

users are seeking computer literacy, the ability to teach new and different subjects, and different educational approaches rather than increased productivity per se or more cost-effective service delivery strategies.

3. Cost-effectiveness is directly related to the computer's instructional application in a specific setting, rather than to specific computer equipment and production costs. Specific instructional techniques which may be extremely efective in one educational setting cannot be generalized to other settings.

4. Most writers agree that most existing software is useless. Although the reasons for poor quality software are not described, we surmize, based on our review of the literature, that poor quality may be due to the fact that most CBE programming is not based on tested paper and pencil programmed materials. More sophisticated and/or less costly software development procedures will not resolve this "garbage in, garbage out" problem. Because of the cost and the apparently poor probability of "good" courseware resulting from software development, existing, proven programs should be used rather than investing in the development of new CBE programs.

5. Delivery systems have dominated the computer field at the expense of instructional design and development. CBE is an individualized educational methodology, and as such both the methodology and the content of the CBE courseware must be integrated appropriately into the classroom procedures and the curriculum. If CBE instruction is used as a "stand alone" methodology, as in the learning centers proposed in the UCP proposal, then the insruction must be carefully referenced into the established curricula. This is easily accomplished when the student obtains specific "credit" for CBE work successfully completed. When individual lessons are involved the referencing is not as easily accomplished, since the instructor must integrate courseware completed independently by students into classroom instruction.

CBE is no better than the instructional design supporting it. CBE software should be based on paper and pencil materials which have been pretested and evaluated before a decision is made to use CBE courseware to present the material. CBE should be selected only when it can do something better and/or at less cost than any other existing media.

6. The effectiveness of CBE appears to be dependent on a large number of poorly understood variables. For instance, What are the most effective CBE strategies? To what extent is CBE more effective as a remedial tool than for presenting new information? What are the effects of individual characteristics and learning styles? What hardware and software configurations are most effective and efficient?

NOTES FOR CHAPTER II

1. Telephone interview with Dr. Robert Taggart, Director of the Remediation and Training Institute, November 15, 1982.

2. Telephone interview with Mr. Jacob Schuchman, Baltimore Public Schools, 11/04/82.

3. Telephone interview with Dr. Raleigh Jobes, University of Oklahoma Extension Service, 11/09/82.

4. Telephone interview with Dr. David Holder, U.S. Extension Service, 11/10/82.8.1

5. Advertisement by The Math Box in the Washington Post, 11/25/82, Section C.

6. Information obtained from TICCIT marketing brochures.

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III. SURVEY OF PLATO USERS

As part of this assessment, the Pragma team was asked to conduct a survey of users. Time constraints limited the number surveyed to less than 15 users. All interviews were conducted by telephone. The questionnaire was used both as an interview guide and as a mechanism for collecting quantitative data about user experiences with PLATO. The questionnaire and survey responses are presented in Appendix B.

The data reported is descriptive and should not be generalized beyond the users surveyed.

A. PROCEDURES

Selection of Users. Fourteen users participated in the telephone survey. All but one of the users were selected by the Control Data Corporation in response to our request for a list of comparable users. Control Data selected the 13 users on the basis of their comparability to the proposed project in Jamaica, their maturity, and their established track record with CDC software.

Conduct of the Survey. Each person on the list was contacted by telephone to request his or her participation in the survey. All agreed to participate, and each respondent was mailed a questionnaire prior to the interview. All respondents referred to the questionnaire during the survey; two respondents mailed us a copy of a completed questionnaire. A great deal of explanatory detail was offered by respondents when they responded to the objective questions. This explanatory information is included in the description of the survey findings which follow. The questionnaire was pretested with an individual who had been involved with the installation and evaluation of PLATO in the Baltimore Public Schools. His responses to the questionnaire are included in the data.

Responses. Objective data is reported for 12 respondents. Objective data from two questionnaires is not reported, since one individual who was assigned the task of responding to the questionnaire was unfamiliar with both the purposes and the content of the CDC program, and a second respondent felt the questionnaire was inappropriate since he sent trainees to a CDC center on a contract basis. A limited amount of descriptive data from these two respondents is included in the report.

B. PROFILE OF SURVEY RESPONDENTS

Funding Sources. Of the fourteen users contacted, eleven were funded by U.S. employment training funds (CETA). Two respondents conducted training in penal institutions, and one user was a public school system which used PLATO primarily for remedial instruction at the secondary level.

Type of Equipment. Five respndents were using CDC micro computers; six were using telephone hook-ups to a CDC mainframe (one respondent was using micros and retained a hook-up to the mainframe). Three respondents considered the questions nonapplicable since they contracted with a CDC training center to provide their CETA clients with training services (Questions 2, 5).

Background of Survey Respondents. Eight of the users had been involved with PLATO programs since 1980 or before (Qtn 1). All but one of the respondents had worked with the PLATO system since its installation in their institution. Eleven of the twelve survey respondents are now working in an administrative, project director, or oversight role. Many had been instrumental in the development of their institution's initial relationships with the Control Data Corporation (Qtn. 3,4).

How PLATO is Used. All of the users made use of basic skills and GED remediation training (Qtn 6). They served primarily adults or high school dropouts who are unemployed (or in prison) and who are disadvantaged in terms of socioeconomic background (Qtn 7). One user indicated that his program successfully used the PLATO basic skills programs with students learning English as a foreign language. Three respondents provided vocational skills training using PLATO programs and three reported some use of life coping skills programs (Qtn. 12). Those linked to the mainframe computer make selected use of other programs, including games. Four users reported using PLATO for the management of instruction (CMI) (Qtn. 50).

In most instances, the survey respondents indicated that they are using PLATO in a competency-based, individualized instructional system. This means that each student works at his or her own pace with workbooks and other earning materials. The teacher's role is to help individual students, and little if any group instruction takes place. In CDC learning centers students who are not working on the computer are either involved in individualized academic study or in group counseling sessions, if they are provided.

C. DATA ON COSTS AND BENEFITS

Based on the literature review, a number of questions were asked about the benefits claimed by CDC for computer based instruction using PLATO. In addition, respondents were asked to provide some general information which we hoped might illustrate how they identify cost benefit factors. Questions were also asked about the respondents' opinion of the best use of the equipment in the classroom and the need for qualified teachers to assist with instruction, the quality of PLATO software and CDC services; and user's recommendations for other, similar users.

Effectiveness. The survey asked a number of questions about the perceived effectiveness of PLATO programs. The questions were developed by reviewing CDC statements about the effectiveness of PLATO programs in the Baltimore Public Schools (CDC, p. 51). Survey responses attribute benefits to PLATO as follows:

Question (abbreviated)	Responses: Always/ Usually	Sometimes	Rarely/ Never	N/A
23. Students learn more rapidly	8	2	0	2
24. Students are absent less frequently	7	2	0	3
25. More students pass tests, graduate,etc.	6	2	0	4
26. Students show more self-esteem & confidence	8	3	0	1
27. Students have fewer disciplinary problems	6	0	0	6
28. Students have more motivation to learn	10	1	0	1
29. Students show increased attention span	8	2	0	2

In general, both the quantitative data and the additional comments made by respondents indicate that they agree rather

enthusiastically with CDC claims about the effectiveness of PLATO. The N/A response was made when the situation does not arise (i.e., discipline problems in prisons), when the respondent felt that he or she had no data to support the judgment, or when the respondent was contracting for services from CDC centers and therefore had little knowledge about the item.

The majority (10 of 12 respondents, Qtn. 37) of the respondents recommended PLATO as a more effective method than traditional instruction in situations similar to theirs.

Responses to an open-ended question about the most important benefits of using Plato can be categorized as follows (Qtn. 58):

Client Success (5)
Individualized instruction/flexibility (4)
Instructional alternative for students who have done poorly in traditional settings (4)
Range of courseware available on-line (3)
Cost-effectiveness (3)
Introduction to computer technology (2)
Motivates and stimulates (2)
Increases self-esteem (2)
Students learn faster (2)
Good public relations for the center (1)
Consistent quality of presentation (1)
Helps control client flow through the center (1)
Enables us to handle more students (1)

In general, these responses add further support to respondents' earlier ratings of PLATO effectiveness, and support statements made in the general literature about the general effectiveness of CBE. In most instances this is observational data; respondents offered little objective evidence in support of these observations.

Data on Cost Effectiveness. We approached cost effectiveness issues by asking several questions about the extent of user evaluations of the PLATO system. Seven of the 12 respondents indicated that they had formally evaluated how well the system helps students to meet planned objectives (Qtn. 17). We received copies of several of these studies; they were primarily attitudinal and/or process evaluations.

Five respondents indicated that they had assessed the cost effectiveness of the PLATO system (Qtn 18) by dividing the total cost of the PLATO contract by the total number of students who used it. These costs ranged from $4.50/hour per trainee to a total cost per trainee of from $400 to $3,615. These costs do not tell us much, however, because they are cited for several different applications, including vocational skills training, on-line hook ups, and one-time capital costs due to a recent purchase of micro computers. Four respondents reported full instructional costs, as when CDC services are delivered under contract. In two instances costs were described as being in addition to traditional classroom costs.

In general, users were unable to compare the costs of PLATO with other instructional systems. The cost data we did receive (questions 17, 18) usually were based on the total cost of the contract for PLATO services divided by the number of students using the system. A number of adjustments would be needed (i.e., amortizing costs over several years) to make these costs comparable among users.

When asked users why they were willing to pay the high costs of sending clients to a CDC training center for remediation, users stated that clients complete PLATO remedial training more rapidly than other available courses, and that the savings in stipend payments more than offset the costs of training. They added that CDC's job placement rates are higher, and gave the following reasons: CDC places more emphasis on job placement; employers consider CDC training to be "better" than that provided by other centers; CDC training is more business-oriented.

When asked why clients (including parents of children doing poorly in school) are willing to pay the comparatively high cost of computerized remedial instruction, CDC center managers responded that the program works, and that the importance of literacy to an individual's self esteem and their ability to function in today's society is well worth the cost. Estimates that 60 to 80 percent of the nation's prison population is illiterate lends support to this idea (1).

Respondents did not have information about the number of hours required to raise a student one grade level in mathematics or reading (Qtn. 19).

Cost Savings. Users responded as follows to three questions about whether they have realized cost savings by using PLATO:

Survey Questions	Responses Yes	No	N/A
33. Fewer students need to repeat classes or do remedial work	5	1	6
34. Class size is increased	1	4	7
35. Instructor upgrading is not needed to improve student performance	2	8	2

The largest number cited faster learning (6 respondents) and less need for remedial work (5 respondents). Only one felt that class size could be increased by using PLATO (some later responses contradict this finding, however) and just two felt that PLATO could be used instead of instructor in some subjects.

D. IMPLEMENTATION ISSUES

Reduction of Need for Trained Teachers. A general purpose of the Unified Curriculum Project is to either increase the student/teacher ratio or to reduce the extent of involvement of highly trained teachers. When asked about how the student-teacher ratio varies when PLATO is used as compared to traditional classroom teaching, the response was very mixed. Six respondents considered the question nonapplicable since they either contracted out services to CDC or did not provide traditional classroom teaching. Two indicated that the ratio is about the same; one said that larger classes are possible when PLATO is available; and two said that smaller classes are required when PLATO is available (Qtn. 20).

Our visits to CDC training centers helped to explain the variation in student/teacher ratio. When well educated, highly motivated individuals use PLATO systems in a learning center, very little support is needed from teachers or technicians. However, students who have experienced relatively little academic success in the past or who for some reason the machines threatening may need a great deal of encouragement and assistance, particulary when they first begin using the system. In general, the student-teacher ratio is increased rather than decreased when CBE is used for remedial education.

Teacher Qualifications. Most respondents indicated that trained teachers are needed to supplement the system in training centers. Although some felt that the system could "extend" a good teacher to a certain extent, no respondent was willing to unequivically state that PLATO could in any way "substitute" for well trained teachers (Qtn. 57). However, five of ten respondents felt that PLATO would work well with poorly trained and/or poorly motivated teachers (Qtn. 39). It should be noted, however, that most respondents had little or no experience with PLATO in traditional classroom settings or with poorly trained teachers.

Several respondents indicated in their background comments and CDC directors who themselves had educational backgrounds tended to agree, that the most important teacher qualifications are intelligence, enthusiasm and involvement with the student and the learning process. Several CDC center directors pointed out that the best training in the educational material is working through the basic skills programs, especially for those with rusty mathematics skills.

Classroom Management with PLATO. A completely different situation is encountered when a few terminals are placed in a classroom setting, however. First, the teacher must have good classroom management skills since individualized instruction must be carefully integrated into a group setting. Students involved in individual instruction must receive attention as well as those involved in group learning. Secondly, the teacher must be willing to review the CBE materials so that only materials which are relevant to the teaching objectives are presented. In this setting CBE becomes merely an instructional tool which is only as effective as the teacher using it.

When asked about changes in classroom management to accommodate PLATO, most respondents emphasized that only minor adjustments were needed since they were already using individualized instruction (Qtn. 55). Two respondents indicated that considerable inservice training was required to support the change to individualized instruction, however.

Several respondents felt that smaller classes are required when PLATO is present in the classroom. However, when asked whether PLATO instruction would be beneficial in classes with large student-teacher ratios, 8 said "yes" (4 no opinion, Qtn. 38). When questioned further, they indicated that each student should have access to a terminal in this

situation. Under these conditions, six of seven respondents felt that PLATO allows teachers more time with individual students (Qtn. 49).

Student-Terminal Ratios. Seven respondents reported three or fewer students for each terminal in the learning center setting. One reported a 6:1 ratio, and four considered the question nonapplicable. In general, students were in the center only when they were working on a terminal or on individualized instructional materials. In some instances, two students might work together at one machine, but this was usually a function of student interest and the subject matter (e.g., using Basic Skills to learn English or reviewing fractions).

Choosing PLATO. When choice is available, some students and teachers use the system more than others (Qtn. 44 & 45). However, in several instances users indicated that PLATO is the only remedial training provided, and that teachers and students therefore are required to use PLATO. A number of users commented that teachers are frequently threatened by the equipment, either because they are afraid that they will not be able to master the machine or because they are afraid that the computer threatens their job. Some encouragement, including inservice training, is often needed to get more teachers involved.

There was a general concensus among users that PLATO is in general a good educational tool, but that it may not meet the needs of everyone (Qtn. 51). In particular, persons who are not stable emotionally and those who have certain types of learning disabilities may have difficulty using the equipment. However, PLATO may meet the needs of some persons in these categories better than other educational alternatives.

Security Problems. All respondents who considered the question applicable reported that security and vandalism are not a problem. Some respondents indicated their own surprise at the lack of problems; they explained that since students respect and like the equipment, they do not vandalize it.

Other Problems. When asked about major problems with the PLATO system, most respondents said they had few if any major problems (Qtn. 59). One user stated that his agency's management and scheduling of the system needs improvement. In a related comment another respondent indicated that PLATO training needs to be tied more closely to the next step--job placement or further training. One respondent criticized

PLATO because of the limited amount of good software, its cost, and because it threatens some teachers.

Administrative Requirements. Six of nine respondents indicated that additional administrative resources are needed to support PLATO, and mentioned inservice training and clerical support (Qtn. 48). When asked about other organizational changes, two respondents mentioned the necessity of informing everyone in the organization about what's happening (Qtn. 56).

E. SOFTWARE

Eleven of the twelve respondents indicated that PLATO software programs are of high quality and meet the instructional needs of their students (Qtn. 52). Eight of the twelve indicated that the software needs no adaptation to meet the particular needs of the user; three felt that instructors needed a thorough knowledge of available programs in order to mix and match instructional modules as needed. In general, users meeting generic objectives, such as passing the GED, felt less need to adapt programs then did users attempting to match the system with nonstandarized learning objectives.

F. QUALITY OF CDC SERVICES

The quality of vendor services should be a major consideration when making a decision about the purchase of a computer-based educational capability. Therefore, we asked survey respondents about the quality and adequacy of CDC equipment and support services:

Question	Responses Always/ Usually	Sometimes	Rarely/ Never	N/A
40. CDC equipment is sturdy and requires little maintenance	10			2
41. CDC staff are responsive when we call with maintenance problems	8			4
42. CDC staff are responsive when we call with software problems	9			3
54. Generally speaking, implementation of PLATO proceeded as planned and without major problems	Yes (10)		No (2)	

The large majority of PLATO users were well satisfied with Control Data equipment and services. One user commented that he selected CDC equipment and software because he was convinced that its high quality is worth the cost. Another user indicated that a learning center is producing much better results now that it is managed by CDC rather than by another agency.

G. RECOMMENDATIONS TO POTENTIAL USERS

We asked, as a closing question, whether the respondent would recommend that other systems with limited resources (including poorly prepared and motivated teachers and a comparatively small educational budget) should use PLATO for similar applications (Qtn. 60). Ten of the twelve said yes, and gave the following restrictions and/or rationale for their response:

- Use on a trial basis to see how it works (2)
- The system is expensive, so careful scheduling and management is needed, as well as careful screening to assure that only those who need remediation use the equipment (2)

- Although expensive, the system can be cost-effective
- Valuable because it provides individualized instruction, allows more individual attention, and students progress faster(2)
- The system motivates and teaches the teachers (2)
- Valuable because of the quality and consistency of the programs.

One respondent had no opinion, and another felt that the system is not cost-effective. In addition, eight respondents recommended PLATO as a cost-saving method of instruction when used under circumstances similar to theirs. In general, survey respondents were pleased with their involvement in PLATO programs and felt that they were receiving a good value for their money. These comments were made in the context of the extensive and comparatively well funded training system in the United States.

H. CONCLUSIONS

The PLATO users that we surveyed were pleased with PLATO programs and the services they receive from the Control Data Corporation. They suppport CDC claims about the benefits of using PLATO instruction for remedial education, and would recommend that other institutions use PLATO for purposes similar to their own. The users surveyed gave CDC service staff, hardware, and PLATO software uniformly high marks.

Users provided no comparative cost data. They considered PLATO beneficial because, when compared with other approaches, trainees learn basic skills in less time and greater numbers pass tests, graduate, etc. They feel that PLATO works when other approaches fail, and that when trainees have access to PLATO there are fewer absences and discipline problems. They also feel that trainees working on PLATO show more self-esteem and confidence, more motivation to learn, and increased attention span, benefits which users attribute to trainee success with the methodology. All of the users surveyed used PLATO in conjunction with individualized instruction.

Respondents report cost savings in terms of cost avoidance, as when trainees learn more rapidly or do not have to repeat courses or do remedial work. Some savings are realized when CETA participants participate in PLATO, since reduced learning time results in reduced stipend payments. CETA

trainees sent to training centers run by CDC have higher job placement rates, which affects CETA program success rates. Increased learning efficiency has comparatively little cost impact on public schools, howver, since students must spend a fixed amount of time in the classroom whether or not progress is made. Users reported that class size is not reduced when PLATO is available, and that the need for well trained teachers is as great as in traditional classrooms.

Chapter IV

COST ESTIMATES FOR THE LEARNING CENTERS

A. INTRODUCTION

In the evaluation of the Unified Curriculum Project, we divide the proposal into two major, but distinct components. The first major component establishes various types of learning centers in each of three Ministries (see Appendix E, Table 1). These learning centers are to upgrade the basic academic and life-coping skills of entry level students so that they can function in the world of work.

The second major component of the proposal establishes two courseware development centers which are to develop courseware for future use in the learning centers.

The purpose of the learning centers is quite different from that of the courseware development centers. Learning centers are to train and upgrade basic academic skills. There is an immediate need to improve the basic academic and work readiness skills of large numbers of Jamaican workers. The purpose of the courseware development centers is comparatively long term, since the training of courseware developers and the design and development of CBE courseware will require several months. Because of these differences, we treat the training and software development components as two separate entities in this analysis.

Although the term cost benefit analysis is often used for any economic analysis of a project, an understanding of the distinction between cost effectiveness analysis and cost benefit analysis will help explain the team's selection of a methodology for use in this project. Cost benefit analysis depends upon the assignment of dollar values to both the resources used and the expected outcomes of an activity. When project benefits cannot easily be reduced to monetary values and are best described in terms of meeting specified objectives, an analysis of the comparative costs of achieving the desired objectives, or cost effectiveness analysis, becomes the methodology of choice.

Our scope of work requested an analysis of the costs and benefits of various methods of achieving the project purposes. Since the project purposes are varied and include a number of social benefits which are difficult to quantify in monetary terms, the team selected cost effectiveness analysis as the methodology of choice.

Before beginning the analysis, we identified a number of social benefits which could be addressed by the project. For instance, the project could have major distributional implications, meaning that it could respond to USAID and the Government of Jamaica's concerns about the income disparities among different social-economic groups in Jamaica. Time limitations and the absence of relevant data and of defined project objectives precluded our attempts to quantify such social benefits, however.

The cost-effectiveness evaluation of the UCP proposal involved several discrete steps: the identification of project resources and their costs; adjusting these costs across the life of the project by considering social discount rates, inflation, and distortions which cause market prices to differ from resource values; defining and valuing project outcomes and benefits; and relating project outcomes to project costs. In the process we considered possible alternatives to the UCP proposal. We also assessed organizational and scheduling aspects of the project, since they affect project costs and benefits.

We began by listing all of the ingredients or resources required by the project. The resources are grouped in the following categories: 1) equipment, including installation and delivery costs; 2) fixed plant costs, such as construction and renovations; 3) personnel training costs; 4) personnel and administrative costs; 5) curriculum materials and supplies; 6) maintenance costs; and 7) miscellaneous costs, including insurance, telephone, utilities, etc. These resources were priced in terms of their value in best alternative uses. We then determined the exact quantities needed, the durability of each resource, and the expected usage of equipment and other project resources, since extent of usage can cause substantial variations in costs. For instance, variations from expected usage rates may result from equipment breakdowns, social and weather emergencies, etc.

This chapter focuses on resource cost estimates for the learning centers. The next chapter explores resource costs for the courseware development centers. The organization of this chapter is as follows: First, we discuss briefly the different educational delivery systems in which the various learning centers are to operate. Second, a brief description is given of a typical learning center configuration in the various ministries. Third, cost estimates for replicating the proposed computer-based

education and non-CBE instruction are made. Fourth, the costs of adopting this CBE system are evaluated, including the cost implications of retaining the necessary personnel to manage such a system.

B. LEARNING CENTERS

1. General Description

This section briefly describes two different educational delivery systems proposed by the Unified Curriculum project. As proposed by the UCP, (see Table 1 of Appendix E), fourteen different types of learning centers will be housed across the three ministries. Approximately 56% of students in the proposed project will study in the computer-based educational delivery system over the five years of the project.

One delivery system consists of mobile vans which are to provide training on agricultural topics to farmers and agricultural extension personnel throughout Jamaica. No CBE instruction will be provided. Instruction is to consist of video tape, lecture, and other traditional instructional methodologies (UCP, VI-8). Approximately 44 percent of the 80,912 proposed trainees for the project will receive instruction via these mobile vans.

Thirteen of the fourteen learning centers will deliver CBE educational services. Under the Ministry of Education, a one-terminal learning center is to train ministry staff, ten-terminal learning centers will train students in each of two Teachers' Colleges, and six ten-terminal Fair Break learning centers will be established.

The Ministry of Agriculture is to have a one-terminal learning center in the Ministry to train staff, four five-terminal learning centers in the Regional Offices, and thirteen two-terminal learning centers in the local Land Authority Offices.

The Ministry of Youth and Community Development is proposed to have one ten-terminal learning center in VTDI, one in GTTS/Comm., and one in each of two Youth Camps. Also, there will be a five-terminal learning center in JAGAS, four one-terminal learning units within the Rural Settlement Scheme and a one-terminal learning center housed physically within the Ministry.

Since each of these proposed delivery systems has its own configuration, each system has different resource costs and effects.

2. Computer Based Education (CBE) Centers

This section briefly describes the implementation of computer-based education in the UCP proposal. The UCP proposes using a particular type of microcomputers and curriculum in a specific way. Since each CBE approach and installation is associated with different resource costs and effects, it is important to provide some description of the system and its application. However, this evaluation of this particular CBE approach cannot necessarily be generalized to other CBE approaches. Our results apply specifically to the proposed UCP proposal.

In the context of the UCP proposal, all CBE activities will take place in a learning center. Such centers will be located in educational institutions, industrial training centers, or agricultural extension offices. Learning centers usually provide self-paced instruction which may be instructor-free and is often multimedia. The instruction often requires students to use audiotapes, computer-based instruction, filmstrips, and videotapes. These learning centers will provide remedial courses in mathematics, reading and life-coping skills, etc. There are personnel available to assist learning. In addition, the center provides study space that is free of most disturbances, conference space that allows a counselor to work with students, and small rooms for group discussions. (UCP, Chapter III.)

The Control Data 110 microcomputer presents CBE concept and drill and practice instruction. In learning centers, students normally are scheduled for two hours on a computer terminal and for two hours with other media such as textbooks, filmstrips, etc. The readily available curricula for the Control Data 110 include the subjects of mathematics and reading for all grades from the third to the twelve, and the subject of life-coping skills. These curricula are called PLATO lessons.

Generally before taking an on-line PLATO lesson, students are pre-tested with the appropriate PLATO on-line test. If they pass according to the test's norms, they proceed to the next pre-test. Students complete lessons only when their pre-test scores show a lack of mastery. After completing each lesson, students post-test themselves with the corresponding test. If successful, they proceed to the next lesson to repeat the cycle at a higher level (Reive, 1982, p.8). Meanwhile the PLATO testing disk keeps a record of the lessons that is taken, and/or the test scores which they receive (Ibid.).

Two principal functional roles are required to manage the centers and to assist students working with the CBE system. Any given learning center may combine roles in one job, or split roles among several people. Even though the total number of personnel required to manage a learning center may vary from center to center (see Table 2 of Appendix E), the principal functional roles remain the same.

The manager/instructor/counselor manages the learning center's staffing, budgeting, and planning. The person in this functional role counsels students, conducts evaluations, and responds to student's questions about particular courses (UCP, pp. III -7 to 8 and Appendix C). The technician/ secretary/clerk coordinates, schedules, and monitors students. In addition, he/she keeps student records, aids students with the operating equipment, and is responsible for the security and proper maintenance of the equipment (Ibid.).

3. Mobile Training Centers

Of all the learning centers proposed (See Table 1 of Appendix E), only the mobile training centers of the Ministry of Agriculture are not equipped with microcomputers and thus operate in the traditional mode of educational delivery. In each of the four regional centers, a mobile van will provide training services to local farmers and extension workers.

In general, each mobile van will be staffed by an instructor/counselor and a driver. The instructor/ counselor will operate the van's videotape equipment, deliver seminars in agricultural-specific topics, disseminate research information, basic knowledge and recommendations about farm production practices, make decisions, and prepare business plans (UCP., p. VI-8).

C. COST ESTIMATES

Ingredients are classified as a first step in developing cost information. The classification of ingredients can be done in any way that is functional to the questions raised. The derivation of cost information for the various ingredients is done in a number of ways. Budgetary and accounting information are used when appropriate. If such cost data are inappropriate or misleading, other methods of obtaining costs are utilized. In all cases the sources and methods of cost estimation are specified. With this information, thje reader easily can modify the assumptions of cost estimation to determine the sensitivity of costs to varying premises (Levin and Woo, 1980, pp. 7-8).

For purposes of cost estimation, the ingredients of the CBE and mobile training center approach are divided into six categories: (1) Facilities and Equipment; (2) Training; (3) Administration; (4) Personnel; (5) Curriculum; (6) Maintenance; and (7) Miscellaneous Factors. Each is evaluated in turn and then combined to obtain teh total costs of each type of the learning center.

Before evaluating each ingredient category, we reviewed the configurations of facilities and equipment, and those of staffing requiremetns. Table 3 of Appendix E indicates six different cluster arrangements of facilities and equipment. The number of Control Data 110 micro computers to be installed in the learning centers range from twenty terminal stations to none. However, the pattern of ingredient requiremetns for facilities and equipment, maintenance, curriculum and miscellaneous factors will be similar in all learning centers. The quantity of specific ingredients will be different for different types of learning centers and will depend on the number of the terminal stations.

Table 3 of Appendix E suggests four different configurations of staffing. The number of staff required for a learning center ranges from four persons per shift[2] to one person per shift. Similarly, the pattern of training and personnel ingredient requirements are similar for each learning center. The number of specific types of personnel may differ from center to center, depending on the nature of the learning center and the quantity of facilities and equipment.

In light of the similar patterns of ingredient requirements across learning centers, we have developed detailed cost estimations for a typical learning center and we have assumed that the cost estimates for each center should be calculated in a similar fashion. As our model, we have developed detailed cost estimates for a Fair Break Center in the Ministry of Education.

The Fair Break Center will be equipped with ten terminal stations and staffed with one manager, one instructor/ counselor, one secretary and one clerk for each shift of six hours. In terms of facilities and equipment, the Fair Break Centers are typical of all training centers which will have ten terminal stations. In terms of staffing, the Fair Break Centers require the most personnel support as compared with all other learning centers.

Cost estimates of the Ministry of Agriculture's mobile training centers are developed separately since they offer a traditional educational delivery mode.

1. Fair Break Center Facilities and Equipment Costs

The Fair Break Center's estimated facility costs include the cost of constructing a 12,000 square foot learning center and renovations to accommodate the CBE equipment. Renovation costs include furniture, protective devices, and electronic work unique to the CBE installation. These facilities costs are estimated to be about $78,786. The computer-related equipment costs for a Fair Break Center with ten Control Data 110 terminals and a PLATO Printer are estimated at about $84,000. The complete breakdown for each type of computer-related equipment is shown in Table IV-1. This table also presents the estimates of video/audio and other equipment costs. These include the costs of videocassette playback units, television receivers,

Table IV-1

Facilities and Equipment of a Ten-Terminal Learning Center*

Facilities		
Cost of construction of a Learning Center[a]	$58,286	
Renovation cost[b]	$20,500	
		$ 78,786
Equipment[c]		
Computer-related:		
10 Control Data 110 Delivery Station at $7,950/each	$79,500	
One Plato Terminal (Graphics) Printer	$ 3,950	
Delivery (computer-related)[d]	$ 635	
	$84,085	
Video/Audio:		
2 Audio cassette players at $66 each	$ 132	
One filmstrip projector	$ 350	
2 Television receivers 12" at $390/each	$ 780	
2 Video cassette playback units 1/2" at $625/each	$ 1,250	
6 Headset at $9/each	$ 54	
Delivery (video/audio)[e]	$ 192	
	$ 2,758	
Others:		
3 Voltage regulators at $950/each	$ 2,850	
Installation[f]	$ 49	
1 Typewriter (electric)	$ 750	
1 Electric pencil Sharpener	$ 13	
Delivery (others)[g]	$ 266	
	$ 3,928	
		$ 90,771
TOTAL		$169,557

* All calculations are in U.S. dollars at an exchange rate of US $1.00 = $1.75 Jamaican dollars.

Notes to TableIV-1

a. It was estimated by Private Sector Organization of Jamaica that to replace space in which a learning center of ten terminal stations will be housed in the 1982 construction market would cost $58,286. The estimation of the cost is based on a 1,200 square foot area at an average of $48.57 per square foot. (See Appendix G-1 of UCP proposal for reference to the size of a learning center.)

b. The renovation includes facility preparation, room partitioning and appropriate furniture required for a ten-terminal learning center. (See Apendix G-1 of the proposal for detail.) The figure is obtained in p. 1X-5 of the UCP proposal.

c. These costs are derived directly from the UCP proposal and documents furnished by the Control Data Corporation.

d. Weight of CDC 110 and disk drive = 87.5 lb.
Weight of a Plato (Graphics) Printer = 83.0 lb.
Total weight computer-related equipment of a ten-terminal center = 958 lbs.
Freight rate to Jamaica for computer related equipment between 440 lbs to 1100 lbs.
= $0.60/lb.
Miscellaneous fee per order.
= $45
Fee for inland transportation.
= $1.10 per hundred weight
Total cost-of delivery
= $45 + 958 lb *(80.60/lb. + $1.10/100 lb.)
= $630

e. Weight of a audio cassette player = 4 lbs.
Weight of a filmstrip projector = 20 lbs.
Weight of a television receiver = 35 lbs.
Weight of a video cassette playback = 45 lbs.
Weight of a headset = 0.5 lb.
Total weight of video/audio equipment
= 4 lbs. *2 + 20 lbs. + 35 lbs. *2 + 45 lbs. *2 + 0.5 lbs. *6
= 191 lbs.
Total cost of delivery
= $45 + 191 lbs *($0.76/lb. + $1.10 (100 lbs.)
= $192

f. 2.5 person-days are estimated to install 3 voltage regulators for a ten-terminal learning center (Watson, Oct. 25, 1982). Assuming that the salary of a technician is equivalent to a Secretary II, the cost of installation will be $3,994 *2.5 days/205 days or $49.

Notes to Table IV-1(continued)

g. Weight of a voltage regulator = 75 lbs.
Weight of an electric typewriter = 60 lbs.
Weight of an electric pencil sharpener = 1 lb.
Total weight of other equipment
= 286 lbs.
Total cost of delivery
= $45 + 286 lbs. * ($0.76/lbs. + $1.10/100 lbs.)
= $266

filmstrip projectors, etc. The costs of video/audio equipment are calculated at about $2,800. The estimates of other equipment include the cost of an electric typewriter and voltage regulators. Each voltage regulator can carry up to 3.8 times the voltage required by a CDC 110 and its disk drive, and is used to maintain a constant videotape. The other equipment costs total $4,000.

At the beginning of the project, the total value of the facilities and equipment is assessed at about $170,000 for a typical ten-terminal learning center as a Fair Break Center. Estimation of the costs of facilities and equipment for other learning centers with different configurations of terminal stations are summarized in Appendix B.

However, we are more concerned with the annualized costs than the total costs of these ingredients. That is, the building of a learning center is assumed to have a life of 25 years, so that only a portion of the cost should be allocated to a particular annual period.[3] The renovations are assumed to have a life span of 10 years, and the equipment is estimated to have a life span of 5 years.[4]

In each case we use a standard approach to convert the cost of each type of ingredients to annualized costs. Annualized costs include annual depreciation and interest costs foregone on the investment, and depend on these factors: (a) the overall capital cost; (b) the life of the facilities or equipment or the amortization period; and (c) the rate of interest on the investment foregone (see Levin 1975, 1981); and Jamison et al. (1978)).

Table IV-2 shows the annualized values of facilities and equipment costs with specific assumptions about the amortization period and three different interest rates. The 1982 rate of interest in U.S. treasury bonds of about 10 percent seems to be a reasonable figure for calculating foregone interest on the investment. On that basis, the annualized cost of facilities for a 10-terminal Fair Break Center is about $9,753 and that of equipment is about $23,964. Thus the estimated cost of facilities and equipment is about $33,717 per year. Estimation of this annualized cost for other learning centers are reported in Table 25, Appendix E.

Since the mobile training centers of the Ministry of Agriculture are not equipped with computer-related equipment, the following paragraphs briefly describe the facilities and equipment required to establish these mobile training centers.

Table IV-2

Annualization of Facilities and Equipment Costs of a Ten-Terminal Learning Center

Cost Categories[a]	Amortization Period (Year)	Annualized Costs			
		Cost	0%	10%	15%
Facility:					
Construction of a 10-terminal center	25	$ 58,286	$ 2,331	$ 6,411	$ 9,034
Renovation	10	$ 20,500	$ 2,050	$ 3,342	$ 4,080
Facility Subtotal		$78,786	$ 4,381	$ 9,753	$13,114
Equipment					
Equipment subtotal	5	$90,771	$18,154	$23,964	$27,050
Total		$169,557	$22,535	$33,717	$40,164

a. Refer to Table IV-1 for the details.

According to the UCP proposal, $30,000 is budgeted for the acquisition of a mobile unit equipped with all necessities, including video/audio equipment. Since the cost of the mobile unit itself constitutes a majority of the total facilities and equipment cost, we can simply assume that the life span of all equipment is equivalent to that of the mobile unit. Such an assumption simplifies our calculations and has little effect on the overall cost implications. With an 10 percent interest rate and a life span of 10 years, the annualized cost of the facility and equipment of a mobile training center is estimated at $4,890.

2. Staff Training Costs

Training costs are composed of two types: direct and indirect. The direct costs are the most obvious ones, consisting of such items as salaries of instructors and costs of materials. The indirect costs refer to the value of the time of trainees. In the case of the UCP proposal, the salaries of instructors are equivalent to the costs of the technical assistants budgeted in the proposal. The direct costs of training center staff vary slighty among learning centers (see Table 15 of Appendix E for details). The differences in the cost of training depend on the number of staff needed to be trained and the setup time required for a learning center to begin operation. For example, the cost of training for a Fair Break Center is $20,000.

Meanwhile, the indirect costs have to be calculated separately. According to the UCP proposal, the training time for the staff of a learning center averages one month (p. I-5). In the case of a Fair Break Center, for each teacher-related position, we need to train four individuals. The reason is very simple. While a learning center is scheduled to operate 3,000 hours a year (see Table 5 of Appendix E), a teacher on the average works 858 hours a year.[5] Therefore, the Fair Break Center will require three and a half-time teachers for each teacher-related position.[6] That is, we need to train four teachers for each teacher-related position of a Fair Break Center.

Since a teacher works an average of 143 days a year (see note 5), a training period of a month will amount to 21/143 of the annual salary. This fraction of the annual salary will be used as a basis for calculating the costs of time required by teachers to obtain training. For the positions of manager and instructor/ counselor, a total of eight teachers will be trained. Thus the indirect costs of professional training are estimated at $6570.[7]

A Fair Break Center is generally staffed by teachers who are trained to be managers, instructors and counselors, and by others who function as secretary, clerk and teacher's aid, etc. Fair Break Centers also have a secretary and a clerk. While the teachers are not regarded as civil servants, the secretary and clerk are. They adhere to a different set of guidelines and regulations for vacation and personal leave. As a result, on the average, two individuals should be trained for each civil servant position. The estimated costs of training four individuals to fill the secretary and clerk positions are about $1,720.[10]

Each of the Ministries will have an overall coordinator to oversee the operation of the learning centers in that ministry. It is assumed that the actual hours of operation of the office of the coordinator does not depend on the operating hours of the learning centers. Therefore, a coordinator with a secretary will be sufficient to manage the office. Since the office administers all learning centers and the professional personnel requirements of each center reflect the magnitude of its operation, we use the number of professional personnel requirements (see Table 3 of Appendix E) as a basis for allocating the costs of training the office of the coordinator. The total estimated direct and indirect costs of training for this office is about $13,208.[11] Fifteen professional personnel are required to administer the learning centers of the Ministry of Education.[12] Based on our assumption of allocating joint costs, the estimated costs of training of the office of the coordinator for a Fair Break Center are 2/15 of $13,208. That is $1,761.

Since the total costs of training include both the direct and the indirect costs, the total costs of training of a Fair Break Center are estimated at about $30,051.[13]

It is unlikely that training costs of this magnitude would be required for each year, since the carryover of trained personel from year to year will be quite high. Yet any turnover of personnel will require some training to take place each year. In Jamaica, it is believed that an average employment period of a teacher or a civil servent is about five years. This suggests that the lifetime of the training

is five years. The translation of the costs of training into an annualized cost will account for the depreciation cost and the interest foregone on investments for training in previous years. For the depreciation cost, we will use five years as the lifetime of investment to account for the replacement on the turnovers of trained personnel. For the interest foregone, we will use 10% on the usual discount rate. On the average, an interest rate of 10% of the investment on training over a 1-year period will be about $7,933.[14] This is the annualized cost of training.

Our process of estimating the costs of training for all other learning centers is equivalent. The figures are tabulated in Table D.2 of Appendix D. It should be noted that the annual cost of training for the non-computer-based mobile learning center is estimated at about $5,311.

3. Administration and Personnel Costs

Personnel ingredients for the learning centers of the UCP proposal can be seen as three separate but interrelated echelons (see Figure 6, Appendix E for the organization chart). The top two echelons can be considered the general administrative body. The bottom echelon is responsible for the day-to-day management of the learning centers.

The general administrative body includes the office of the project director with two technical personnel from JOBS and the offices of coordination of the three respective ministries with their own technical assistants furnished by JOBS. These four offices constitute the administration unit. The cost of running these four offices will determine the cost of the administrative overhead.

The office of the project director oversees the operation of all learning centers and the two courseware development centers. Thus only a portion of the costs of running this office should be allocated to the learning centers[15]. We will therefore assume that 39 percent of the costs of running the office of the project director will be allotted to the administration of the learning centers. Using the same criteria, we can further assign a portion of the 39 percent to the learning centers of each ministry. Approximately 10.4 percent will be allotted to the Ministry of Youth and Community Development, and 12.1 percent to the Ministry of Agriculture, with 16.2 percent to the Ministry of Education[16] as part of the administrative overhead.

In terms of personnel, the office of the project director will include the director, a secretary and two technical personnel provided by JOBS. The cost of the director can be determined directly by calculating salaries, provision for housing, travel, entertainment and automobile, and fringe benefits. The total cost of the director is estimated at about $27,087 per annum.[17] The cost of a secretary is estimated at about $6,246.[18]

The cost for the technical assistants is relatively straight forward. As budgeted in the UCP proposal, each technical personnel will cost $120,000 per year. Thus the two technical consultants will amount to $240,000 annually for the office of the project director. The cost of $240,000 for the technical assistance includes the salaries, fringe benefits, travel and long-term per diem expenditures. (UCP, p. IX-1.) The total annual personnel costs of the office of the project director is calculated at about $273,333.

The amount of $273,000 only accounts for the personnel costs of the office of the project director. In order for this office to operate, it needs office space, furniture, supplies and materials, maintenance services,. etc. Such nonpersonnel operating cost is estimated at about $23,467 per annum.[19] Therefore, the total estimated annual operating cost of the office of the project director will amount to $296,800.

Only portions of this total annual cost of this office will be assigned as part of the overhead required for the management of the learning centers of a Ministry. The other part of the overhead will be directly calculated from the annual costs of the office of the coordinator within a specific ministry. It should be remembered that a technical consultant is also assigned to work with such an office to help administer the learning centers within the ministry. The cost of the coordinator can be obtained directly from Table 4. Together with a secretary, the total cost of local personnel for the office of the coordinator in the Ministry of Education will be about $31,318. The total personnel cost for this office will jump up to $151,318 with the addition of a United States expatriate consultant providing technical assistance (U.C.P. p. IX-1 and p. 1-2).

This $151,318 represents the personnel costs for the office of the Ministry Coordinator only. In addition to the personnel cost, an estimated overhead cost of $15,645[20] is required. Thus a total sum of $166,963 is the estimated annual operating costs for the office of the Ministry Coordinator. The total personnel overhead costs

for all the learning centers in the Ministry of Education can be estimated at $296,800 x 16.2% + $166,963 or $215,045 per annum.

Again, only a portion of this amount of administrative overhead should be allocated to each learning center within the Ministry of Education. Using the example of a Fair Break Center and the criteria which we have set up in the allocation of training costs in the previous section, we will assign 2/15 of the personnel administrative overhead to each of the Fair Break Centers. Thus the estimated administrative overhead for a Fair Break Center is calculated at 2/15 x $215,045 or $28,673 per annum.

The same estimation procedure and assumptions are applied to the calculation of the administrative overhead for a mobile training unit of the Ministry of Agriculture. It appears that the annual cost of administration, including the office of project director and the office of the Ministry Coordinator, will amount to $9,660. (see Table 17 for the details).

In every Fair Break Center we have two professional positions. One position is a manager/instructor, and the other is an instructor/counselor. Their responsibilities cover a wide range of administrative duties, instructional functions and counseling activities (see UCP, Appendix C). For each of the professional positions, we require 3.5 full-time persons to fill the position because of the proposed 3,000 annual operating hours if a Fair Break Center (see Note 6). The cost of the manager position can be directly determined by multiplying the salaries by 3.5 for a total of $21,210.[21] Similarly, the cost of instructor/counselor is estimated at $17,934. Therefore the total cost of seven professional personnel amounts to $39,144.

Since a secretary and a clerk will be required to help manage a Fair Break Center at all times, a total of 1.8 persons are needed for each position in order to keep a Fair Break Center operating 3,000 hours a year (see Note 9). Therefore the cost of the supporting personnel can be calculated by multiplying the combined salaries of a secretary and a clerk by 1.8. Assuming their salaries are similar, the total cost of the supporting staff is about $15,098.

The reader should be reminded that the cost of substitutes to cover the absences of the professional and supporting staff are included in the figures (see Notes 5.6 and 8.9 for details). To recapitulate, the

personnel ingredients for a Fair Break Center proposed by UCP include 3.5 managers, 3.5 instructor/counselors, 1.8 secretaries and 1.8 clerks for a total cost of $54,242 per annum to keep the center operating 3,000 hours a year.

Similar procedures are used to calculate the annual personnel and administrative overhead costs of all types of learning centers. These costs are summarized in Table 17 of Appendix E. As for the non-computer-based mobile training centers of the Ministry of Agriculture, the total annual costs of personnel are estimated at $28,747.

4. Curricula Costs

The curricula that will be used in the learning centers proposed by UCP are purchased from CDC. The curricula will include 1) mathematics; 2) reading; 3) writing skills; and 4) life-coping skills. This curricula will be presented in a mixed-media format. Part of each curriculum will be on flexible diskettes to be used with microcomputers; part in video/audio tapes to be used with appropriate playback units, and part in text formats.

Since each type of medium has its own life-span, the purchase costs of some types are considered capital costs which need to be annualized, while others are regarded as recurrent costs because of the short life-span. Specifically, flexible diskette life is estimated at six months (UCP, p. IX-1) so the costs of obtaining these diskettes are recurrent. Video/audio tapes generally last two years on the average (Watson, Nov. 5, 1982). The costs of purchasing these tapes will be annualized at a 10 percent interest rate and for 2 years of life. We assume the text life to be one year, partly because it is an easy target for pilferage. In any event, the cost of text materials for the curricula will be relatively minimal. Whatever the assumptions are about the costs of this component, the overall cost implications are so small that they will have little impact on the total cost calculations.

We have estimated annual cost of curriculum for a 10-terminal learning center such as the Fair Break Center (see Table IV-3 and Table 18 in Appendix E). Annual costs for a 20 terminal, a 5-terminal, a 4-terminal, and a 1 or 2-terminal and 1-terminal learning centers are displayed in Tables 19, 20 and 21 in Appendix E. The reader should be aware that we purposely avoid estimating the annual curriculum costs of the different terminal learning centers by simply dividing the cost of a 10-terminal center by a

Table IV-3

Annual Cost of Curriculum

For a Ten-Terminal Learning Center[a]

Categories	Life in Year	Cost	Annual Cost
Diskettes:			
Mathematics	0.5	$10,500	
Reading	0.5	$ 8,150	
Writing	0.5	$ 1,425	
Life Coping Skills	0.5	$ 1,219	
Delivery[b]		$ 95	
	Subtotal	$21,389	$42,778
Video/Audio Tapes:			
Life Coping Skills	2	$ 4,330	
Delivery[c]		$ 76	
	Subtotal	$ 4,406	$ 2,539[d]
Texts:			
Basic Skills	1	$ 599	
Life Coping Skills	1	$ 155	
Delivery[e]		$ 110	
	Subtotal	$ 864	$ 864
		TOTAL	$46,181

Table IV-3 (Continued)

a. For detail information on the breakdown within each category, please refer to Table F-1 of Appendix F.

b. The total weight of all diskettes is 44 lbs. Since the general cargo rate of up to 100 lbs is $1.12/lb., and the overhead per shipment is about $46.1, therefore the cost of delivery is estimated at $95.

c. The total weight is only 27 lbs. and the cost is estimated similarly as above at $76.

d. Since a(10%, 2) = 0.576, the annualized cost of the audio/video tapes can be calculated by multiplying a(10%, 2) by $44.06 for an amount of $2,539.

e. The weight is about 57 lbs. and the general cargo rate is equivalent to previous cases. Therefore, the cost is estimated at $110 including the overhead per shipment.

single factor since many of the required curriculum materials are not divisible. For example, the video/audio tapes for life coping skills come as one set. Therefore complete sets of these tapes will be purchased for each center. This component of the curriculum is a fixed cost.

The estimated annual cost of curricula for a Fair Break Center is $46,181. The mobile training unit curricula are limited to formats other than computer-based. The curricula cost is an estimated $1,250 per annum for each mobile van learning unit (UCP, p. 1X-4)

5. Maintenance

Maintenance of the computer-related equipment will be arranged through contracts with the Control Data Corporation. The annual cost of maintaining a Control Data 110 Delivery Station is $984 and a Plato Terminal Printer $600. A Fair Break Center with 10 CDC 110 micros and a printer will require $10,440 for annual maintenance of this equipment.

The maintenance cost for the non-computer based mobile learning centers is largely related to the maintenance of the van. Since the subsidy for automobile upkeep for an extension officer is about $1,371 per annum, the same amount is assumed for the required maintenance of a mobile unit.

It should be noted that other non-computer-related equipment are assumed to be maintenance free. One of the reasons for this assumption is the relatively small magnitude of costs for this category. Secondly, no maintenance policies are offered by firms selling this non-computer related equipment. In any event, this assumption has little impact on the overall costs of operating a learning center.

The maintenance cost for computer-related equipment for every type of learning centers is summarized in Table 23 of Appendix E.

6. Miscellaneous Cost Factors

Miscellaneous cost factors include insurance, supplies, and the cost of energy and routine maintenance of the learning center. The appropriate insurance costs are those that are incurred directly from the learning center facility and equipment, including the additional insurance costs for theft, fire, and liability. It is estimated that the annual insurance cost is about $519[22] for a Fair Break Center.

Supplies, energy, and routine maintenance of the learning center of a Fair Break Center contain many items. Supplies typically include pencils, paper, copying, and paper for the printer. Energy and telephone costs and facility maintenance refer to the telephone in each learning center that is necessary for rapid access to maintenance personnel in case of breakdowns and to the Ministry coordinator and to the technical personnel in case of consultations; normal lighting; power for the equipment; and routine cleaning and maintenance of the learning center. Taken together, these costs are estimated at about $7,438.23. The total cost of miscellaneous items is estimated at an annual rate of $7,957 for a ten-terminal learning center.

For the non-computer-based mobile learning center, the miscellaneous cost factors include insurance, gasoline, paper, pencils, etc. at an estimated annual rate of $6,000 (UCP, p. IX-4).

The miscellaneous costs of each type of learning center are summarized in Table 24 of Appendix E.

7. Summary of Annualized Costs

The annualized costs in 1983-1984 for a 10-terminal Fair Break Center utilizing the Control Data delivery system can be summarized in the following tabulation.

Facilities and equipment	$33,717.
Training	7,933.
Administration	28,673.
Personnel	54,242.
Curriculum	46,181.
Maintenance	10,440.
Miscellaneous	7,957.
	$189,143.

It appears that in 1983-1984 it will cost about $189,143 a year to provide enough space, administration, personnel, and equipment to serve a ten-terminal learning institute in a Fair Break Center with this particular approach to computer-based education.

As for the non-computer-based mobile learning units, the annualized costs in 1983-1984 can be summarized in the following tabulation.

Facilities and equipment	$4,890.
Training	5,311.
Administration	9,660.
Personnel	28,747.
Curriculum	1,250.
Maintenance	1,371.
Miscellaneous	6,000.
	$57,229.

The annual cost of operating a non-computer-based mobile learning center is estimated at about $57,229. This amount is the cost to provide a mobile unit with audio and video equipment, personnel, and other operating necessities on a per annum basis.

The summarized annual cost table for every type of learning centers can be seen in Table 25. The total annual costs for the learning centers range from $264,852 for a twenty-terminal learning center of the College of Agriculture to $56,727 for a two-terminal learning center of a Land Authority Office. It also should be noted that even among the learning centers equipped with similar numbers of CDC 110 terminals, there is no uniformity in annualized costs since each type of learning center has different staff configurations.

For instance, a Fair Break learning center will be staffed by two professional personnel at all times. The additional staff person is responsible for the counselling required in a Fair Break Center. The administrative overhead for each Ministry is similar, although the number of learning centers and the total number of required professional staff differ in each Ministry. As a result, the allocation of the administrative overhead of a specific Ministry to its learning centers depends on the total number of learning centers and the total number of professional staff. Thus the administrative overhead for learning centers with the same

number of CDC 110 will differ from Ministry of Ministry. The differences in both staff configurations and administrative overheads are the major factors contributing to the varied annual costs of learning centers with similar numbers of CDC 110 terminals.

D. Conclusion

In Table 26 of Appendix E, we have detailed the annualized costs for each type of learning center according to the proposed sources of funding. We assume that if the U.C.P. proposal is funded as proposed the remaining portion of the expected annual costs will be the burden entirely of the government of Jamaica. We have expanded our calculations from each type of learning center to all learning centers [24] in order to ascertain the full cost implications. The detailed breakdown is presented in Table 27.

A total annual cost of $4,000,000 is projected to run all the learning centers as proposed in the U.C.P. Even if the U.C.P. were to be fully funded as requested, the proposed funding will cover about $1,700,000 or about 42% of the projected annual expenditure. In other words, the government of Jamaica would have to fund 58% of the required annual expenditure for these learning centers. The annual amount is about $2,300,000. Thus it appears that the projected costs of running these learning centers will require <u>135 percent more</u> than the annual amount suggested by the U.C.P. proposal.

If this amount of $2,300,000 were shared among the three Ministries, the Ministry of Education will bear about $980,000 or 42 percent of the share, while the Ministry of Agriculture will bear $860,000 or 37 percent (Table 28). The Ministry of Education would receive $740,000, or about 43 percent of the annual budget proposed by U.C.P.; the Ministry of Agriculture would receive $520,000, or about 30 percent of the proposed UCP annual expenditure; while the Ministry of Youth and Community Development would receive $450,000 or 26 percent of the proposed budget.

In the proposed U.C.P. budget, about 52 percent of the annualized expenditure will be for the purchase of equipment and curriculum from the Control Data Corporation. About 35 percent is allotted for the remuneration of the expatriate technical consultants provided by JOBS. Another 11 percent is contracted through JOBS for the provision of regular maintenance on the computer-related equipment. In sum, 98 percent of the proposed UCP annual funding is either for the

purchase of computer-related equipment and curricula manufactured by the Control Data Corporation or for the purchase of services provided by JOBS.

How is the expected annual expenditure to be funded by the Government of Jamaica to be distributed among different cost categories? It can be observed from Table 28 that over 50 percent of the annual expenditure to be contributed by the GOJ is for the purchase of services of indigenous administrators, teachers, and other professional and supporting staff. Another 10 percent is for the equivalent of space rental for all the learning centers, the offices of ministry coordinators, and the office of the project director. About 27 percent of the government funding will be for the purchase of curricula which is not fully covered by the budget of the UCP proposal. In other words, an annual amount of $630,000 will be required from the GOJ for the purchase of additional curricula to facilitate the operation of all the learning centers.

In terms of the overall operating costs, an amount of about $4,000,000 is required per annum. About 42 percent of this amount will be for the purchase of facilities and equipment and curricula. Another 44 percent will be mainly for administrative overhead and personnel costs (Table 29).

When compared with the overall annual expenditure, the non-computer-based mobile training centers constitute a relatively small portion of the spending. In total all non-computer-based mobile training centers require only $230,000 or about 5.7 percent of the overall projected annual expenditure.

In this chapter we explored the many elements which are required to operate the different types of learning centers. We have priced out each element in terms of the annualized costs for each type of learning center. By aggregating the annualized costs of each type of learning center, we have obtained the total annual cost of running all of the learning centers as suggested by the UCP proposal. We have determined the portion of the aggregated annual costs to be funded by the UCP budget and the portion to be funded by the Government of Jamaica.

What do these costs mean? Is the projected expenditure "expensive"? These questions will be answered in the next chapter when we put the cost analysis of this chapter in the context of cost-effectiveness analysis and attempt to understand whether this particular computer-based educational program is cost effective when compared with other

alternatives. What this cost analysis means to the Government of Jamaica is discussed in the following paragraphs.

The total annualized costs of running the learning programs proposed by the UCP proposal are for two basically different learning approaches. One approach involves computer-based learning centers; the other is non-computer-based. The computer-based learning program constitutes the majority of the projected annual expenditure, 94.3 percent, while the other 5.7 percent is for the non-computer-based mobile learning centers.

The total annual costs required to run all the learning centers as proposed by the UCP are estimated at about $4 million. The amount budgeted by the proposal is about $1.7 million. Thus the Government of Jamaica will need to finance about 58 percent of the projected annual costs. This amounts to $2.3 million annually. This amount is a "floor" level for the financial commitment required of the Jamaican Government. The "floor" level is based on the assumption that the level of funding requested by the UCP proposal would be fully honored. Therefore, the $2.3 million represents the least amount that needs to be funded by the Government of Jamaica in order to carry through the learning programs proposed by the UCP

The breakdown of the annual cost of $4 million will help us understand how the money is spent. About $1.5 million or 37.6 percent of the total annual costs is largely spent on the purchase of equipment and curricula from the Control Data Corporation (Tables 28 and 29), while another $0.8 million or 20.3 percent is for the provision of services in the form of expatriate technical consultants or maintenance from JOBS. Taken together, about 58 percent of the total annualized costs will be used for buying equipment and services from either Control Data Corporation or JOBS. Approximately $1.4 million or 33.7 percent is projected for the acquisition of services from indigenous personnel.

In other words, the operation of these learning centers as proposed by the UCP will require a substantial financial commitment form the Jamiaican government. Indeed the Government of Jamaica will bear 58 percent of the financial burden annually, while the proposed level of funding by the UCP only covers 42 percent of the total annual costs. Meanwhile 58 percent of the total annual costs is projected for the purchase of equipment and curricula from CDC and for the purchase of services of expatriate technical consultants and maintenance services from JOBS. Only the remaining 42 percent is projected for non-CDC or non-JOBS expenditure.

It is particularly important to note that over 98 percent of the requested funding from UCP is spent through either CDC or JOBS; and over 27 percent of the GOJ funds will be funnelled through CDC for the purchase of curricula. The foreign exchange implications of these projected annual expenditures should not be slighted.

NOTES TO CHAPTER IV

1. 80,912 persons are estimated to be trained in the five years of the project (JOBS, et al., p. vi). Of 80,912 persons, 35,520 will not be trained by computer-based educational delivery system (Ibid., p. VI-10). Therefore 45,392 of the 80,912 persons to be trained will receive computer-based education, i.e. 56.1%.

2. A shift is generally defined as six hours. Teachers are contracted to work about twenty-seven to thirty hours per work week. Since all personnel in the categories of manager, instructor and counselor are recruited from the teacher cohort, it is reasonable to assume that their working conditions will be equivalent to those of the teachers. Therefore, if a learning center is open twelve hours a day, two shifts of staff will be required.

3. The useful life of school facilities is taken from estimates by Levin and Woo (1981, p. 9). However, extending the estimted life from 25 years to 50 years would reduce the annualized construction costs by no more than 9 percent. Such effect is negligible on the overall cost of a learning center.

4. A figure of 5 years was fiven to us by CDC staff for the ammortization of the CDC 110 (Watson, Nov. 5, 1982). Obviously the life span depends on the level of utilization and assessments of technical obsolescence. Given the intense level of utilization proposed by the UCP and the rapid advance of microcompuer technology, a five year life span is assumed to be reasonable. In addition, extending the estimated life to ten years would have a minor effect on the overall costs. Since the video/audio and other equipment constitute less than 10 percent of the equipment costs, lifespan assumptions about these types of equipment have little impact on total cost estimations.

5. In any academic year of 180 working days, a teacher is entitled to 10 days of sick leave, 10 days of vacation, and 4 months of sabbatical leave for every five years

which amounts to an average of 17 days per year. Moreover, the average work day for a teacher is 6 hours.
Thus, the expected number of working hours of a teacher per year = (180 days - 10 days - 10 days - 17 days) x 6

hours/day = 143 days x 6 hours/day or 858 hours.

6. Total number of persons required for each teacher-related position
= 3000 hours divided by 858 hours/person
= 3.5 persons.

7. Indirect costs of training for a Specialist II (see Table 4, Appendix E).
= $6060 x 21/143
= $890
Indirect costs of training four persons for the position of Specialist II
= $890 x 4
= $3560
Indirect costs of training four persons for the position of Specialist I (See Table 4, Appendix E).
= $752 x 4
= $3010
Total estimated indirect costs of training for professional positions
= $3560 + $3010
= $6570

8. In any year of 260 working days, a civil servant is entitled to 31 days of vacation, 10 days of sick leave and 14 days of departmental leave. A normal working day is 8 hours. Thus the expected number of working hours of a civil servant per year = (260 days - 31 days - 10 days - 14 days) x 8 hours/day = 205 days x 8 hours/day or 1640 hours.

0. Total number of persons required for a civil servant position = 3,000 hours divided by 1640 hours/person
= 1.8 persons.

10. Number of days required for training a civil servant
= 21 days
Total number of actual working days of a civil servant
= 205 days (see note 8)
Indirect costs of training for a Secretary II (see Table 4, Appendix E).

= $4194 x 21/205
= $430
Indirect costs of training 2 persons for each position of a secretary and a clerk assuming that their wages are equivalent
= 2 x (2 x $430)
= $1720

11. Indirect costs of training the office of the coordinator of Ministry of Education (see Table 4 Appendix E for the details in salary) = ($25,072 + $6,246) x 21/205 = $3208.

12. In the Ministry of Education, there is one professional staff in College of Agriculture, one in each of the teacher colleges and two in each of the Fair Break Centers for a total of fifteen (15) staff. Since two professional positions are associated with a Fair Break Center, we assign 2/15 of the training costs of the office of the coordinator to a Fair Break Center.

13. It should be noted that we do not include the costs of training of the office of the director (see Figure 6 of Appendix E for the organizational chart). There are several reasons for this omission. First, the office of the director will be involved in general policy issues and strategic planning rather than the day-to-day management of the activities of all the learning centers. Therefore very little specific training will be required. Secondly, when the costs of training of that office are allocated to all learning centers and the two courseware development centers, the costs to a particular learning center will be negligible. Therefore we have not included the training costs for this office.

14. The calculation of the annualized costs depends on the lifetime (n) of the investment by which the depreciation cost is estimated and also the social rate of discount (r) through which the cost of foregone income on the investment of previous years is obtained. The anualization factor is given:

$$a(r,n) = [r(1+r)^n]/[(1+r)^n-1]$$

Since it is a common practice to amortize scientific equipment over a relatively short life-span because of its rapid obsolescence, the same logic is applied to training for the management of computer-based learning centers. Thus the lifetime (n) is assumed to be five

years. As for the social rate of discount (r), 10 percent is believed to be reasonable.

Therefore the annualized factor of a(0.1, 5) is equal to 0.264. Thus the annualized cost of $30,051 at 10 percent interest rate and a lifetime of 5 years is $7,933.

15. It should be noted that we are using different criteria of allocating the costs of the office as compared with the criteria of allocating the cost of the office of the coordinator in the respective ministries to the management of individual learning center within the ministry. In the case of the latter we are using the ratio of the number of personnel required to manage a particular learning center and the total number of professional personnel of all the learning centers within a ministry as a criteria. For a detailed example, please refer to the text on Training and Note 12). It is believed that this ratio is a good proxy of how much time the office of the coordinator will devote to a learning center. Along the same agreement we would have preferred using the same criteria of allocating the costs of the office of the project director to the management of the learning centers and the courseware development centers. Unfortunately the UCP proposal does not clearly state the number of professional personnel in the courseware development centers. Therefore we use the percent of the UCP budget allocated to courseware development to estimate how the costs of the office of the project director should be allocated to either the learning center or the courseware development centers.

The total costs of the project minus the costs of project management
= $19,450,000 - $1,200,000
= $18,250,000 (see UCP, p. IX-2)
The total costs of the courseware development centers
=$3,000,000 + $3,000,000 + $5,181,000 or $11,181,000
Percent of budget for the learning centers
= ($18,250,000 - $11,181,000)/$18,250,000
= 61

16. Of the amount of ($18,250,000 - $11,181,000) or $7,069,000 budgeted for operating the learning centers (excluding the budget for project-management), $1,903,000 is for Ministry of Youth and Community Development; $2,213,000 is for the Ministry of Agriculture; and $2,953,000 is for the Ministry of Education. Of the total budget of the proposal

excluding the portion on project management, $1,903,000/$18,250,000 or 10.4% is for Ministry of Youth and Community Development; 12.1% is for Ministry of Agriculture and 16.2% is for Ministry of Education (see details on UCP, p. IX-2). The reader should be cautioned that the sum of these percentages is only 38.7% which is approximately equal to 39% after rounding up.

17. According to the National Planning Agency, the Project-Director will be in the rank of Senior Management III. The basic salary will start at $16,000 with subsidies of $3,429 in housing, $1,143 in utility, $1,143 in travel; $1,143 in entertainment and $3,429 in automobile and 5% of the basic salary contributed by the government for pensions. Thus the total compensation amounts to $27,087 per annum for the directorship.

18. Refer to the salary of Secretary IV in Table 4, Appendix E.

19. According to the National Planning Agency, the office space of the program coordinator with a secretary will occupy an area of 500 square feet. Since office space should also be provided to the two technical personnel, it is estimated that an office of 1,200 square feet is needed for the office of the project director. Applying the same assumption as to the physical facility of a learning center, the annual cost of such facility with furniture and renovation will amount to $9,753. (see Tables 3.1 and 3.2 for the details). In addition, it is estimated by the Market Research Services Ltd. that such an office will require an annual amount of $2,058 for copying, $23,428 for electricity, $2,742 for paper and supplies, $3,428 for telephone, and $2,058 for janitorial services. In sum, an amount of $13,714 is estimated for miscellaneous and maintenance costs of the office of the project director. Thus with the cost of the facility, the total annual operating cost not including personnel will amount to $23,467.

20. According to the National Planning Agency, the office space of the program coordinator with a secretary will occupy an area of 500 square feet. Since office space should also be provided to an expatriate technical consultant, a total area of 800 square feet will require 800/12,000 or 2/3 of $23,467. In sum an amount of $15,645 will be required as the non-personnel operating cost for the office of the Ministry Coordinator.

21. It is assumed that we can hire qualified individuals or fraction of their time as substitutes to cover the absences of professional staff. The same assumption is implied in the employment of 1.8 persons hired in the capacity of a secretary or as a clerk. This assumption is only valid if a working schedule is well-planned ahead of time so that vacations, sabbaticals and alike will be coordinated with the substitutes. In any event, such estimation of the cost of personnel assumes an ideal and optimal situation in which the scheduling of personnel is well orchestrated. It represents a floor estimation which may substantially underestimate the actual cost of operation.

22. It is estimated by the Dyoll Insurance Company of Kingston, Jamaica that an annual cost of $5.70 is levied for every $1,000 worth of the equipment insured. Since the total equipment cost of a Fair Break Center is $90,771 (Table 3.1), therefore the annual insurance cost is calculated at $90,771 x 5.7/1,000 or $519.

23. According to the Market Research Services Ltd, an office of 1,200 square feet will require an amount of $13,714 for miscellaneous and maintenance costs (see note 19). It is assumed that a learning center of 1,200 square feet will need about one half of the costs. Moreover, there will be additional cost of power to operate the ten terminals at a marginal cost of $0.037 per kilowatt hours. Thus an additional amount of $581 is needed to run ten terminals for 3,000 hours per year. Thus the total miscellaneous costs include $519 + $13,714/2 + $581 or $7,957, where $519 is the insurance cost per annum.

24. This is only one exception. We have purposely excluded the on-terminal learning center in the Ministry. The reasons are twofold. First, there is a certain economy of scale involved in the facility preparation and staffing, a one-terminal learning center is simply atypical. Secondly, since there are only three such centers, excluding them will not have any major ramifications on the cost-analysis.

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V. COST ESTIMATES OF THE COURSEWARE DEVELOPMENT CENTERS

A. INTRODUCTION

We mentioned in the previous chapter that the Unified Curriculum Project is made up of two distinct and separate components. The first component would establish various CBE learning centers throughout Jamaica. The second component would establish two courseware development centers. In the last chapter, the framework of cost analysis was used to assess the proposed centers. In this chapter we estimate the costs of establishing courseware development centers.

This chapter is organized differently from the last chapter because the UCP proposal provided very limited costing information for the proposed courseware development centers. Although only 31 percent of the proposed budget of the U.C.P. is allotted for the learning centers, the bulk of the proposal was devoted to this component. The proposal gave proportionately little attention to the courseware development centers. Very little cost information on the courseware development centers was made available to us by the Control Data Corporation. The courseware development center activities are primarily research and developmental, activities which pay off over the long term and involve much uncertainty. Since the costs of research and development are seldom precisely measured and cost data simply are not available, we explored cost issues as carefully and fully as the available data allowed and we described what is needed to construct a meaningful cost analysis.

We begin by discussing briefly the purpose of these two courseware development centers. Secondly we describe available cost data for the establishment of the courseware development centers. Third, we suggest what is needed for a meaningful cost analysis. Fourth, we infer some cost estimates on the basis of available data. This process provides some tentative resource cost estimates with which we can examine the cost-effectiveness of the two proposed courseware learning centers in Chapter VII.

B. COURSEWARE DEVELOPMENT CENTERS

Two courseware development centers are proposed by the Unified Curriculum Project. According to the proposal, the two centers will be administered by the Ministry of Education. One development center physically located in the College of Agriculture, will develop microcomputer-based courses in agriculture. The other courseware development

center would develop all other microcomputer-based educational and training courses including industrial, business, and academic skill training.

In general, Jamaican personnel will be trained as course developers, designers, programmers, evaluators and managers to staff these courseware development centers. After their training they will be expected to develop courseware in several different formats. First, they will down-load existing and suitable PLATO vocational curricula which currently are available on mainframe computer systems so that they can be used in microcomputers. Second, they will convert some of the traditional training programs to individualized, paper-and-pencil delivery methods before adopting them to microcomputers. Third, they will "culturize" selected existing computer training programs from all over the world for use in the Jamaican context. Fourth, they will develop new microcomputer courseware specifically for use in Jamaica and other Caribbean countries. Last, they will produce other individualized and microcomputer-based training materials, including text, audiovisual, and microcomputer-based media.

Over the five years of the project it is hoped that a wide range of microcomputer-based vocational training courses will be developed by these two courseware development groups. It is explicitly stated in the proposal that, in addition to fulfilling the training needs of Jamaica, these courses will be produced and marketed in other Caribbean countries, bringing revenues in the form of royalties back to the Government of Jamaica. Moreover, JOBS will be prepared to act as the Government's publisher for the world-wide distribution of the CBE courseware produced in Jamaica.

Therefore, objectives for the establishment of these two courseware development centers appear to be twofold. The first is to develop and produce educational and training materials and programs which can be used in the microcomputer-based learning centers. The second objective is to market these materials and programs to other developing countries in the Caribbean.

C. AVAILABLE COST DATA

In the introductory section, we briefly mentioned some reasons why cost data are simply not available. In this section we delineate what cost data are available and how we should interpret them.

The U.C.P. proposal states that Jamaican personnel will be trained to staff the courseware development centers in all aspects of the operation, including design, development, programming, editing, evaluation, and production. The formal training program is expected to last as long as 73 working days[1] (Watson's memo, October 25, 1982). The estimated direct training costs for the thirty personnel[2] in the two centers are about $99,000.

Since this intensive training program is to be delivered through the Control Data PLATO terminals in the mainframe computer systems, the direct costs of training are estimated on the assumption that the training will take place in the States where the mainframe computer systems are readily accessible. Thus the indirect costs of training of these thirty Jamaican personnel include remuneration for the period of the training, transportation to and from the States and living expenses while in training in the States. These total indirect costs of training are estimated at about $274,000[3]. Together with the direct costs of training, the overall costs of the formal training programs for the professional personnel in the two development centers will total $373,268.

The previous training programs were formal. The Jamaican personnel are not expected to be productive immediately after their formal training programs. It is implicitly assumed that an additional six months of on-the-job training by the expatriate technical consultants will be required. Total indirect costs of on-the-job training is about $113,000[4] for an average period of four months for the thirty people selected. Assuming that the technical consultants will render four months of their services for the on-the-job training, the direct costs of on-the-job training will amount to $80,000. Therefore, the overall costs of direct and indirect training on both the formal and on-the-job programs will total $566,265. In other words, close to $0.6 million is required to train thirty Jamaican personnel for a period of six months before the two development centers can be put into operation. The reader should be reminded that the $0.6 million does not include training materials, capital and property investments, nor administrative overheads which might be incurred during the period of on-the-job training.

The U.C.P. proposal presents some cost data on the operation of the courseware development centers, which presumably are costs after the Jamaican personnel have been properly trained. It is assumed that the cost for developing one

hour of new computer-based training materials is about $10,000 (U.C.P., p. IX-6). This amount is further broken down into 70 percent labor cost, 15 percent computer time, and 15 percent production materials. Of the 70 percent labor cost, 10 percent is for design, 20 percent is for development, 35 percent is for programming, and 5 percent is for evaluation. The 15 percent computer time cost includes the cost of time-sharing the mainframe systems and communicating between the terminals in Jamaica and the mainframe system in the States. The 15 percent production materials cost is for the production of the educational and training materials in the forms of text, audio, video, and disk.

It is further assumed that over the five years of the project, 1,000 new courseware hours will be developed and produced by the two development centers. Therefore, $10,000,000 is budgeted for the development and production effort (Ibid.). Together with the $1,080,000 budgeted for the services of two expatriate technical consultants and about $10,000 for the purchase of computer and communication equipment, the total projected budget over the five year period is $11,180,000[6].

We are presented with an operating budget of over $11 million over a period of five years for the two courseware development centers. Together with the $0.6 million estimated for the training of Jamaican personnel, the tentative cost will amount to over $11.8 million.

The derivation of the amount of $11.8 million is based solely on two assumptions. The first is that the average cost of developing each hour of computer-based courseware hour is $10,000. The second assumption is that 1,000 new hours of courseware are to be developed and produced by the two centers over the five years of the project.

D. WHAT IS NEEDED FOR THE COST ANALYSIS

The UCP proposal requests $20 million for a period of five years. Over half of the requested amount, $11 millon, is for the establishment of two courseware development centers. This estimate is based on the assummed cost of $10,000 per new courseware hour, and the development and production of 1,000 new courseware hours.

It is difficult to ascertain whether the average cost of $10,000 is reasonable. The cost of software development depends on the subject matter. The mix of media also affects the cost since the production of an hour of video

instruction can range from $10,000 to $30,000[7]. In addition, courseware development is no different from any general research and development effort which inherently involves considerable uncertainties.

In addition, the projected cost of $10,000 per new courseware hour may not include all the cost ingredients of a courseware development center. Reviewing the breakdown of the curriculum development costs, we observe that there is no mention of capital investment in terms of facilities and equipment which will be utilized to produce these microcomputer-based coursewares. In the category of labor, the administrative overheads are not included. Moreover, there is no mention of subject matter experts who will participate in the courseware development. It is the intended strategy of the centers to subcontract out various tasks which include editing of developed materials, typesetting of any necessary printed materials, etc (UCP, p.VII-7). A large supporting staff will be needed to assist the professional personnel in these two centers. But there is no provision for the purchase of these services. Thus it is very likely that this projected average cost for an hour of new courseware is underestimated.

The second assumption for the development and production of 1,000 hours of new courseware seems to be equally arbitrary and ambiguous. The U.C.P. proposal states explicitly that the development centers will 1) down-load the existing and suitable vocational curricula from mainframe computer systems to microcomputers; 2) convert suitable traditional training programs to individualized, paper-and-pencil delivery methods before adapting them to microcomputers; 3) "culturize" the existing and suitable coursewares to meet the specific needs and context of present Jamaica; and 4) develop and produce new microcomputer coursewares (UCP, p. I-5). It is quite clear that the centers will not only develop and produce new microcomputer coursewares, but will also make full use of whatever suitable curricula are already available either in mainframe or in paper-and-pencil formats. Also the centers will first develop courseware in individualized, paper-and-pencil formats.

It is apparent that the development and production of new microcomputer coursewares are not the only major activities of the centers. Thus the development and production of 1,000 hours of new microcomputer courseware does not reflect the other major activities of the centers. Yet the requested funding for courseware development rests on this insufficient and weak assumption. Therefore, $11 million for courseware development is very difficult to justify.

Much more information is needed before a tentative figure for the two courseware development centers can be honestly constructed.

At least two types of data will be needed. The first is cost estimates of the development and production efforts in different subject areas and in various delivery modes. The second is the demand for courseware in different subject areas.

The cost estimates for developing and producing courseware for different subject areas should include facilities and equipment, administrative overhead, personnel and their training, maintenance of the facilities and equipment, subscription of mainframe computer time, communication between terminals in Jamaica and the mainframe computer systems in the States, and other miscellaneous factors. Moreover, there are at least four different approaches or phases in developing and producing courseware: down-loading, culturizing, paper-and-pencil, and completely new development. Different modes of delivery and different phases of development and production of even similar subject areas will vary in cost.

Down-loading requires time and effort for searching and evaluating the presently existing mainframe computer coursewares in North American and European countries so that those suitable to the Jamaican needs will be selected. A legal agreement must be negotiated with the publisher for the right of down-loading the mainframe computer coursewares and a royalty fee must be paid for privately-owned courseware. The costs of search, evaluation, selection, negotiation and royalty are integral parts of the cost estimates for the development and production of each CBE courseware. At least some of these costs will be required for down-loading and culturizing when original materials are not developed in the two courseware development centers.

Different modes of delivery affect the cost of development and production. The obvious example is a comparison of the paper-and-pencil and microcomputer-based instructional approaches. Only when data are made available can cost estimates be fruitfully constructed for the development and production efforts for each subject area in each phase of development and for each different mode of delivery. However, even these cost estimates are not sufficient to make tentative cost calculations for the courseware development centers.

Secondly, the type of programs developed depends on the

demand for coursewares in different subject areas, in different phase of development, and in different modes of delivery. This data is required to complete any rudimentary cost analysis on the proposed courseware development centers. For this purpose, a list of required courseware for different subject areas must be generated and prioritized in accordance with the planning agenda of the Government of Jamaica and the availability of both human and physical resources. This prioritized list of courseware will reflect Jamaica's needs and become the operating agenda of the two courseware development centers for the five years of the project.

Cost estimates for developing and producing coursewares for different subject areas in different modes of delivery and for different phases of development when combined with data on the demand for this courseware will provide a basis for estimating true costs for the two courseware development centers.

E. CONCLUSIONS

Even though over half of the requested $20 million funding for the UCP proposal is for the two courseware development centers, little attention and care is paid to the courseware development and production efforts and their subsequent costs. The $11 million funding proposal for the two courseware development centers is based on weak and deficient assumptions about costs and the demand for such courseware in Jamaica. Therefore it is impossible to justify the projected level of funding requested in the U.C.P. proposal.

A substantial amount of additional information on both the cost estimates of courseware development and production and the demand for CBE courseware in Jamaica must be presented before any serious cost analysis assessment can be made for the two development centers.

The proposal contains very crude and underestimated cost estimates for developing and producing an hour of microcomputer-based courseware. The cost for an hour of such courseware range from $3,500 to $10,000. The $3,500 per instructional hour is for the world-wide search of suitable courseware with some adaptation[8], while the amount of $10,000 is for new microcomputer courseware. As for the total costs of the two courseware development centers, the requested level of funding of over $11 million is simply not supported by any rationale and cannot be justified by any arguments. As long as the demand for

courseware in different subject areas has not been studied, there is no possibility of deriving a tentative cost analysis for the two courseware development centers even if cost estimates for the development and production of coursewares are known.

NOTES FOR CHAPTER V

1. The training program for the courseware development personnel is composed of two parts. The first is a comprehensive group workshop which includes topics on analysis, design, development, instruction management, lesson models, evaluation, adaptation, managing the process and publishing for a period of 23 days. The second part is a training program called "create". The managers are required to take the full create curriculum which lasts 250 hours. If we assume that the average number of course-hours one can manage a day is about 5 hours, then 250 course hours will require 50 working days. Thus a complete training program will need (23 + 50) or 73 working days.

2. The thirty persons to be trained to staff the two courseware development centers as mentioned in Watson's memo are six persons less than proposed in UCP (pg. IX-6). The breakdown of these thirty persons is contrasted with those originally proposed in the following tabulation.

	Watsons Memo	UCP
Manager	2	0
Designer	4	6
Developer	4	10
Evaluators	2	2
Editors	2	0
Programmers	16	16
Total	30	34

3. In addition to a workshop of 23 working days, personnel under training will have to take additional courses. The additional number of course hours are summarized in the following table for all personnel in the courseware development center.

	# of hours	Approx. No. of Working Days
Managers	250	50
Designers	96	13
Developers	107	21
Evaluators	19	4
Editors	83	21
Programmers	163	33

a. Refer to Note 1.

But we will still have to convert the number of working days into the actual number of days staying in the U. S. for training. Assuming for every five working days, it needs, in effect, seven days of stay. Thus we can construct the actual number of days staying in the U. S. for all personnel in the following.

	No. of Persons	No. of Working Days	No of Actual Days Staying	TOTAL
Managers	2	73	102	204
Designers	4	36	50	200
Developers	4	44	62	248
Evaluators	2	27	38	76
Editors	2	44	62	124
Programmers	16	56	78	1248
				2100

Thus the costs of living expenses are estimated at $75/person-day * 2,100 person-days or $157,500. Assuming all personnel are hired at the rank of lecturer in the college, the costs of renumeration for the 2,100 person-days can be calculated at ($6,744 x 2,100/143) of $99,038 (See Table 4 and the section on training in Chapter IV). The transportation costs for thirty personnel between Minneapolis, Minnesota and Kingston, Jamaica will be ($590 x 30) or $17,700. Thus the total indirect costs of training are ($157,500 + $99,038 + 17,700) or $274,238.

4. Assuming that the period of training requires 6 months, i.e. 26 weeks x 5 days/week x 30 persons or 3,900 person-days, and the number of working person-days for the formal training program is 1,504 person-days, it can be estimated that the indirect costs of on-the-job training are [$6,744 x (3,900 - 1,504)/143] or $112,997.

5. (3,900 - 1,504) person-days /30 persons or 80 days are the time period for the on-the-job training. Since there are two technical consultants assigned to the two courseware development centers, the total direct costs of training for four months or 80 days will be $120,000 * 2 * 4/12 or $80,000.

6. Of the amount of $11,181,000, both Ministry of Youth and Community Development and Ministry of Agriculture are scheduled to have $3,000,000 respectively for courseware development (UCP, pp. IX-2 to IX-4). Through the $6,000,000 budget, both ministries would have control over courseware developed by the development centers. The remaining $5,181,000 is budgeted through the Ministry of Education (op. cit., p. IX-5).

7. The cost of $10,000 to $30,000 to produce an hour of video instruction is furnished by Control Data Corporation.

8. This cost figure was provided by Control Data Corporation during the Toledo visit of two of Pragma team members.

VI. ASSESSING THE COSTS AND EFFECTIVENESS OF ALTERNATIVE TRAINING PROGRAMS

A. INTRODUCTION

In Chapter IV we reviewed the cost estimates presented in the proposal for the learning centers. We adjusted them to include certain hidden costs which will be born by the Government of Jamaica but which were not adequately included in the proposal because they did not involve cash expenditures directly related to the project. Our estimate of total annualized costs for a 10 terminal Fairbreack Center is $189,143, which greatly exceeds the UCP proposal estimate of $131,133 for a ten terminal center (UCP III-20). This new cost estimate can be used to update the cost comparisons presented in the proposal between the traditional educational system and the computer-based system.

B. COST COMPARISONS FOR A 10 TERMINAL FAIRBREAK CENTER

According to the proposal, "data provided by the Ministry of Education indicate that the per pupil cost of public instruction per year in Jamaica is approximately J$701 (US$404) in the secondary system. Assuming that six subjects are taught in the traditional method and that each student improves one grade level in each subject per year, the cost per grade level improvement is $67.33 (UCP III-20).

The UCP proposal estimates the equivalent cost of one grade level improvement using a ten-terminal Control Data center as follows. An average of one grade level improvement in one subject should be achieved for each 20-30 hours of CBE instruction using the Control Data PLATO mathematics and reading lessons. The total hours of instruction available with the ten-terminal center is estimated thus: 10 terminals x 60 hours/week x 50 weeks = 30,000 terminal hours, assuming that the center is operated for 50 weeks a year and 60 hours per week. Assuming that 80 per cent of the available computer time is useable, the UCP proposal projects 24,000 effective hours of instruction on the 10 Control Data terminals. These hours are translated to grade level

improvements by assuming that 30 hours of CBE instruction are needed per grade level improvement, (24,000/30) or 800 grade level improvements in mathematics or reading during the school year (UCP III-21, and 11/11/82 letter from R. C. Chinn).

According to the cost estimates developed in Chapter IV of this report, this improvement would be obtained at an annualized cost of $189,143. Using this cost figure, the cost per grade level improvement is $236, as compared to $67 for the traditional instruction in Jamaica. The traditional instruction costs may be underestimated. However, since this figure was provided by Control Data in the UCP proposal, and since we were unable to conduct a detailed analysis of the costs of the Ministry of Education, we have no alternative but to accept the figure for comparative purposes.

Over time, the cost differences between the two alternatives could decrease as each cost component changes. According to the proposal, instructor salaries constitute 80 per cent of the annual operating budget in the traditional system, as compared to only about 30 per cent for computer-based education (UCP III-21). However, our findings tell a different story. In fact, computer-based instruction is highly labor intensive. According to our calculations, labor (Administration and Personnel) will comprise approximately 44 per cent of the annualized cost of the Unified Curriculum Project. Therefore, any future increases in labor costs will substantially affect both alternatives and the cost differences between the two alternatives should not vary greatly.

Our analysis indicates that computer assisted instruction with Control Data equipment and programs is considerably more expensive than instruction delivered in the traditional system. This cost comparison was made for remedial instruction in mathematics and reading, areas in which PLATO instruction has been shown to be effective. We would expect the costs of CBE instruction to be even greater in areas such as agriculture where little good courseware exists.

These cost efficiency comparisons should not be interpreted literally, however. In the next paragraphs we discuss why such cost comparisons are inadequate.

C. CONCEPTUAL DIFFICULTIES

Ideally, a cost effectiveness analysis identifies various alternatives for reaching a set of objectives, calculates the cost of each alternative, and selects the least cost alternative. In theory such an analysis should be a valuable tool for selecting among alternative approaches to training. In practice, however, the analysis is difficult if not impossible to perform and when used may lead to inaccurate conclusions and poor decisions.

Cost effectiveness analyses are valid when the alternatives compared accomplish the same objectives. For example, it makes sense to compare two instructional programs that claim to improve the math skills of students in a certain grade, provided that a standard test exists for measuring the improvement in the student's achievement. Then, when a large number of cases are studied, a pattern should arise which allows one to decide which program is the most cost effective approach. Such a simple and clear case is rarely found when compairing alternative methods of delivering instruction, however.

Usually we are dealing with many objectives, some of which will be met by one alternative and not by the other. Often, as in this project, we try to compare a training situation with unlike objectives. We are comparing a traditional secondary school program with a remedial program which hopes to compensate for the poor outcomes of traditional instruction. A cost comparison between the two approaches is inappropriate since the two programs are not directed at the same objectives.

Additional difficulties arise when alternative modes of instruction which are not in the same stage of development are compared. There may be a built-in bias towards accepting traditional approaches as compared to new, more modern approaches simply because the old approaches have been thoroughly tested and operational for a much longer

period of time and they do not threaten practitioners and administrators. Although the new methods potentially may be very promising, they may carry a higher risk of failure or rejection. The question becomes one of risk assessment, which is difficult to estimate when the risk aversion of the decision makers is not known.

Finally, it is often difficult to define the various alternatives with enough precision to differentiate among them. We know that teachers make a difference in the success of any mode of instruction. Similarly, class size and curricula also play a significant role in the learning process. When comparing several methods of instruction we need to hold these variables constant across all alternatives, a practically impossible task when, as in this project, the training alternatives do not use these variables in the same manner.

The review of the literature indicated that CBE appears to be particularly effective for remedial education. However, Taggert argues that the success of CBE is due less to the use of the computers than to the use of individualized instruction which the computer makes possible. But individualized instruction also can be delivered by a traditional paper and pencil system at a much lower cost and with somewhat comparable success.

If cost effectiveness studies are difficult to interpret in education, capital intensity measures are even less reliable. It is easy to assume that since CBE implies the usage of fairly expensive equipment, the ratio of capital to labor embodied in the technology is going to be high enough to warrant a discussion of the relative capital intensity of that technology over more traditional modes of training. In the recently well documented ETS/LAUSD study of computerized instruction (1982), annualized capital costs came to less than 30 per cent of the total annualized costs. This finding is consistent with our cost estimates for this project.

Computer based education is, contrary to popular notions, relatively labor and material intensive. Drastic reduction in equipment costs therefore would not reduce total costs by very much. Labor costs, already a large fraction of total costs, constitute a powerful push towards higher total costs in CBE programs.

Chapter IV of this report provides estimates of the annualized costs of various training activities in the UCP project. Although the relative proportion of annualized capital costs to total costs varies across these different activities, the average is still only about 41 per cent. Although the system structure proposed in the UCP could benefit from rapid declines in equipment costs over the next few years, such declines could not substantially reduce overall costs if labor costs rise. For this reason we do not believe that measures of relative capital intensity should be used to assess alternative training delivery modes.

We recommend instead that AID employ the concept of "tolerable costs" when evaluating this proposal. "Tolerable costs" are those expenses that AID and the Government of Jamaica are willing to invest in CBE training programs for a specified set of objectives. This concept was first introduced by Robert J. Seidel in 1980. In a massive survey conducted by HUMRRO which involved 370 institutions with outstanding computer programs, Seidel found that only 16 of those 370 institutions had data which allowed inferences on factors such as cost avoidance, student enrollment or student efficiency, and none had data which allowed calculations of cost-effectiveness. Seidel concluded that these institutions think of their computer facilities in terms of tolerable costs rather than cost effectiveness. The use of tolerable costs instead of cost effectiveness has several important implications. First, a complete accounting of the cost of this project for the government, including hidden costs not reported in the proposal, is crucial. These costs should be divided among the organizations which will have final responsibility for paying for them. Such an analysis is presented in Chapter IV.

In addition, it is necessary to carefully define each objective that the government wishes to attain with each application of the new technology. Only in this fashion can the government determine whether it can bear the cost associated with reaching each objective. Moreover, this approach forces the government to examine whether there may be other, perhaps less costly ways of achieving the same objectives. In the next paragraphs we examine the objectives and their likelihood of achievement for each proposed application of CBE in the UCP proposal.

D. DISCUSSION OF UCP TRAINING OBJECTIVES IN MINISTRIES AND AGENCIES.

The team visited each of the sponsoring Jamaican ministries and the Natitonal Planning Agency to discuss project goals and purposes. Based on these discussions, we understand the general purpose of the Unified Curriculum Project to be to:

> Provide trained labor to support the structural adjustment of the Jamaican economy. Training will include basic academic skills and vocational-technical education.

This general goal assumes that the demand for trained labor is or will be such that trained personnel will find jobs. It also assumes that the working population needs basic academic skills (e.g., approximately ninth grade level mathematics and reading levels) before vocational training begins.

When discussing how computer based education could help Jamaica, ministry personnel described a number of problems, including low academic skill levels among a large number of youth who have left school without completing their education, secondary school graduates with inadequate academic skills for college work, and a continuing need for additional and better trained academic teachers and vocational instructors. Improved agricultural skills and methodologies were also cited, and the Ministries of Education and of Youth and Community Development discussed a general concern about the "poor" attitudes of Jamaican workers.

Fourteen different training applications are proposed by the Unified Curriculum Project, four in the Ministry of Education, four in the Ministry of Agriculture, and six in the Ministry of Youth and Community Development.
The objectives--the nature of the target audience, the numbers to be trained, and the purpose of the training--for each proposed application are briefly reviewed below. This information is derived from our review of the proposal and our discussions with officials in each ministry in which the proposed training is to take place. In the following pages we discuss how each ministry and the several agencies within the ministries would use the Control Data equipment and programs. A summary of the proposed distribution of computer terminals and trainee populations across the three ministries is presented in Table VI-1.

Table VI- 1

SUMMARY OF LEARNING CENTER DISTRIBUTION

Agency & Location	No. of Centers	No. of CRTs per Center	Persons to be Trained
1. Ministry of Education			
(a) Teaches College	2	10	5,359 (1,158 full time)
(b) College of Ag	1	20	5,693 (1,238 full time)
(c) Fair Break Center	6	10	4,080 (120 hrs CBE/Student)
(d) Ministry staff	1	1	?
(SUBTOTAL)	(10)		(15,132)
2. Ministry of Agriculture			
(a) Regional Centers	4	5	6,070 (1,354 full time)
(b) Land Authorities	13	2	11,100 (20 hrs CBE/Trainee)
(c) Ministry Staff	1	1	?
(d) Mobile Units	4	0	35,520
(SUBTOTAL)	(22)		(52,690)
3. Ministry of Youth/Comm Devel			
(a) Skill Centers	3		
i) VTDI	1	10	2,550 (850 full time)
ii) JAGAS	1	5	1,125 (270 full time)
iii) SITS/COMM	1	10	1,899 (931 full time)
(b) Youth Camps	2	10	5,716 (No. full time unknow
(c) Rural Settlement	4	1	1,800 (20 hrs. CBE/Trainee)
(d) Ministry Staff	1	1	?
(SUBTOTAL)	(13)		(13,090)
TOTAL	45	202	80,912

1. Ministry of Education

Four separate types of training institutions are proposed to use CBE in the Ministry of Education: two teachers colleges, the College of Agriculture, and six new Fair Break Centers for youth who have left school. In addition, one terminal would be installed in the Ministry of Education for skill upgrading purposes.

a. Teacher's Colleges (2)

When discussing the purpose of computer based education in the teacher colleges, Ministry of Education officials described a number of problems. They described a chronic shortage of trained teachers, and indicated that many of Jamaica's current elementary, secondary, and vocational teachers are poorly prepared and motivated for teaching.

For instance, we were told that many teachers dislike making lesson plans, and that they feel overwhelmed by the problems that they encounter in the classroom. Many teachers feel that they are badly underpaid. In addition, we were told that teaching experience often is regarded as a "stepping stone" to other careers--classroom experience provides individuals with the necessary communication and management skills to enter other professions. As a result, many students leave the formal education system with low levels of academic skills, and there is a continuing high turnover of teaching staff.

Under the proposal, one rural and one urban teachers college would each install a CBE learning center with 10 terminals. The proposal states that each center would be open 50 weeks per year, 60 hours per week. A total of 5,359 students (1,158 full time) would receive training in the CBE learning centers.

The teachers colleges would use the terminals for remediation work with first year students who are preparing to pass their CXC (Caribbean Council Examination) or General Certificate of Education exams so that they can matriculate into the teachers college as regular students. In order to matriculate, they are required to obtain a least "O" level passes in English, mathematics, and two other subject areas. Although the proposal suggests that all students will receive training in mathematics and reading skills as well as life management skills training, our interviews with education personnel indicate that not all teachers college students will need remedial work in mathematics and reading. Some may need remedial work in other academic areas, none of

which are currently available on diskette as stand-alone courses.

Since the current teachers college programs are residential, adding part time and summer programs may change their character somewhat. In addition, the current regular teachers college programs would have to be expanded, since they could not now accommodate the projected number of students who would be eligible (as a result of the project training activities) for training in the regular teachers college programs.

There is considerable empirical evidence that the teacher shortage is resulting from high teacher turnover rather than from shortages of new graduates entering the field. In addition, many persons interviewed felt strongly that at least some students who matriculate into the teachers colleges have no intention of entering the teaching profession. Therefore, training more students for matriculation into the teachers colleges probably would not affect teacher shortages in the island.

Providing remedial training to allow increased numbers of students to enter the teaching profession probably will not affect teaching shortages on the island nor increase the quality of private and secondary education.

b. College of Agriculture

The primary objective of training in the College of Agriculture is to upgrade the basic academic training of some students and to provide improved instruction in agricultural topics by using computer instruction. Expected trainees are students who have already matriculated into the College of Agriculture, and extension and agribusiness personnel. Subjects to be taught include basic numeracy and literacy skills, skills in science and mathematics, life management skills, and supervisory skill courses.

The proposal states that 20 terminals will be installed, and that the learning skills center will be open 50 weeks per year, 60 hours per week. It indicates that 1,238 full time students would receive 80 hours of CBE instruction, and that 4,455 students would receive 20 hours of CBE instruction, for a total of 5,693 students.

Since most trainees already will have matriculated into the College of Agriculture, the basic skills CBE programs should

not be needed to a large extent. No agricultural PLATO courseware is currently available on diskette. We understand that PLATO's agricultural courseware is under development, apparently for use with the main frame computer. Therefore, we do not anticipate that any agricultural software will be available in the near future. Since a relatively small--but unspecified--number of students are likely to need basic skill upgrading, the planned training for the College of Agriculture appears either to be unneeded or not currently feasible.

c) Fair Break Centers

Ministry of Education officials indicate that Jamaica has a large number of young people who left school before completing their education. Their academic skills are poor (approximately third or fourth grade), and they have few vocational skills to offer to employers. The Fair Break centers are designed to serve these school leavers, most of whom are between the ages of 16 and 21. They could be located in any suitable building, since they are not designed for identification with current training institutions. For instance, a Fair Break center could be sited in a youth camp. The general purpose of training is to prepare each trainee for either an entry level job, self-employment, or for more advanced skill training in established training institutions.

The Unified Curriculum Project proposes to establish six Fair Break Centers, to serve a total of 4,080 school leavers over the five year project period. Each Fair Break center would function as an an independent center offering CBE instruction in reading, mathematics, and life management skills. Counseling services also would be provided. As CBE training for occupational skills becomes available it would be incorporated into the Fair Break centers. Each center would have 10 terminals and be staffed by one technician and one counselor.

Because many of these young people have "hustling" jobs such as selling newspapers, the centers would be open on a "come as you can" basis for 50 weeks a year, 60 hours a week. Each trainee would receive 120 hours of CBE, or enough to raise the trainee four grade levels in reading and mathematics. As we understand the proposal, each trainee would be expected to spend roughly four hours in the center each day. Two hours would be spent on CBE instruction, and two hours would be spent with paper and pencil materials and in counseling activities.

Although Fair Break Centers would represent a new concept for Jamaica, they have been used successfully with disadvantaged youth in the United States. If the number of school leavers with deficiencies and the severity of their problems are compelling enough to justify major expenditures to improve the basic academic and work readiness skills of school leavers, Fair Break centers appear to be an effective approach to meeting these objectives.

d. Training Center for Ministry Staff

According to our interviews, ministry officials feel that a terminal to provide inservice staff training in each of the ministries would be a good thing. Neither the UCP proposal nor any ministry official described precisely what that training would be, what the training objectives might be, or the number of persons to receive training. As a result, we must conclude that this training should not be considered for funding unless clear objectives can be established, prospects for training and appropriate courseware are identified, and mechanisms are developed to assure that the planned training would take place as anticipated.

2. Ministry of Youth and Community Development (Vocational training is under this Ministry's jurisdiction)

There is a great scarcity of trained vocational teachers. Often trained vocational teachers rapidly move into the private sector where salaries are better and advancement opportunities are greater.

There is a heavy demand for skilled labor and managers--foremen, site mangers, and project directors. According to the Director of the Vocational Training Division, Mr. Lesly Johnstone, many highly skilled workers, and particularly those with managerial skills, emigrate to the United States and Canada. He feels that Jamaica's technical and vocational training schools are training adequate numbers of entry level workers. What is needed is more training to upgrade worker skills and to develop supervisory personnel.

Training under the Ministry of Youth and Community Development is organized under two divisions: the Vocational Training Divison, directed by Mr. Lesly Johnstone, and the Social Development Commission, to be directed by Winston Pagon. Team members met with each to discuss the proposal.

In general, the Unified Curriculum Project proposes offering all trainees CBE training in basic skills and life management skills. Vocational CBE training would be offered as it becomes available. Although the proposal suggests that summer school training would be offered in the Division of Vocational Development, the Division operates on a 48 week year and offers no summer school programs. Therefore, the following discussion treats the proposed part time and summer students in one category. The reader should note, however, that the UCP proposal schedules part time workers to receive 40 hours of CBE training and summer students to receive 20 hours of CBE training.

a. Vocational Training Development Institute (VTDI)

VTDI trains vocational instructors in Jamaica. The proposal indicates that CBE would enhance training in basic numeracy and literacy, life management skills, supervisory skills, and selected metals and automotive skills. However, since all trainees must pass a grade nine-level qualifying examination in order to enter the program, the demand for basic skills training should be minimal. However, we were told that part time students would benefit from basic skills training. Mr. Johnstone feels that the life management skill training, if proven to be useful in a pilot test, would be useful training for all VTDI enrollees.

The Unified Curriculum Project proposes to place 10 terminals in VTDI in staged intervals.
A total of 2,550 trainees would receive CBE training, of which 850 full time trainees would receive 80 hours of CBE instruction. Although some of these courses are available on CBE through CDC's mainframe computer, none have been reviewed by Jamaicans to determine their suitability for use in the VTDI curriculum nor the extent of adaptation that may be needed.

b. Jamaican-German Automotive School (JAGAS)

The Jamaican-German Automotive School (JAGAS) trains workers for the automobile industry in Jamaica. The project proposes to establish a job skill center with five terminals, to be used over the five year period by 1,125 trainees, of whom 270 would be full time. The proposal indicates that CBE will be used to enhance instruction in basic academic skills, life management, supervisory skills when appropriate, and automotive skills. Mr. Johnstone indicated that the regular three year program full time

students would have little need for the basic skills program. He felt that part time students could make use of the basic skills programs, however.

Since the actual number of JAGAS students who could use remedial training is unclear, and CBE automotive skills training is not yet available on diskette, the proposed CBE applications in JAGAS should not be considered until the training objectives are clarified, the number of students to receive specific types of training are identified, and appropriate CBE courseware is available.

c. Commercial and Garment Industry Training Schools (GITS)

The Commercial School trains primarily women students in commercial subjects such as secretarial and clerical skills and bookkeeping. Proposed course work for the Commercial School includes Basic Skills, Life Management, and training in clerical and secretarial skills. The Garment Industry Training School trains women students in the various garment trades. The Commercial School is an Industrial Training Center--the Seaga government plans to phase out the ITCs as it develops its youth camp program. Proposed CBE training would be basic academic skils, life management skills, and in the Commercial School, vocational skills. Mr. Johnstone indicated that although full time students in the Commercial School would have little need for Basic Skills training, part time students and about 90 percent of the trainees in GITS could use Basic Skills training.

Although the Control Data Corporation apparently offers comprehensive training courses in a number of courses areas offered by the Commercial School, the proposal does not indicate the extent to which these courses would be available for use in Jamaica. A better estimate is needed both of trainee demand for these courses, and of the cost and length of time needed to adapt and develop appropriate CBE courseware in the commercial areas.
Although it appears that Garment School trainees could benefit from basic skills training, it is not immediately apparent how such training would increase the likelihood of these students' success in the garment field. The level and extent of remdial training needed by Commerical School part time students also is not indicated. In general, it does not appear that the number of projected Garment School trainees is not large enough (573 students) and the objectives of CBE training in these two schools are clear enough to justify terminal installations during the early years of the project.

d. Youth Camps (2)

The Youth Camps in Jamaica are in a state of change. Apparently "old" youth camps are being converted to advanced skill centers which will incorporate equipment and instructors from some or all of the Industrial Training Centers. The "new" youth camps will serve school leavers who have few or minimal academic and vocational skills. Apparently the proposed skill centers are expected to be placed in the new youth camps.

Although the project proposes to serve a total of 5,716 young people in the youth camps, this may be impossible since we understand that a maximum of 500 young people will be served in each camp at any one time. (See Figure V-9) Since the camps are residential, and are placed in rural areas, part time students may not be available. Although the proposal indicates that full time students will receive 80 hours of CBE and that part time students will recive 20 hours of CBE, no indication is given of the number of students in each category, making it difficult to make any estimates of expected outcomes. The proposal does indicate that the skill centers will be open 52 weeks a year, 12 hours a day, which may be somewhat unreasonable, since even youth campers will observe holidays, vacations, etc.

The proposal indicates that students will receive training in Basic Skills, Life Management, introductory agricultural skills, farm construction skills, and farm mechanics skills.

Given the lack of clarity about the proposed training in the youth camps and the absence of currently available CBE programming in agricultural, farm construction, and farm mechanics, we feel that no CBE training should be funded as proposed at the current time. It is possible, however, that a youth camp could accommodate a Fair Break Center installation, provided that the training provided by the Fair Break Centers were to coincide with the desired training objectives in the youth camps.

e. Rural Settlement Schemes

Rural Settlement Schemes are a revival of an old program in Jamaica. Under the previous program, young people who had migrated to the cities were placed in rural settlements, with the expectation that they would use their new skills and remain in the rural environment. Although the purpose of the rural settlement schemes were not described by either

ministry officials or the UCP proposal, the proposal projects that 1,800 students will receive 20 hours of CBE programming over the course of the project. This instruction is to be provided by four computer terminals which would be transported between two rural settlement schemes in a mobile van. Students would be trained in basic skills, life management skills, and introductory and specialized agricultural skills as they become available on diskette.

We find the purposes of training in the rural settlement schemes to be extremely vague. In addition, the mobile vans may not hold up very well if they are expected to travel over rough terrain for long distances. A very rough ride may very well affect the durability and reliability of the terminals, as well. Therefore, the team recommends that this application not be funded until the training objectives are clarified and appropriate CBE programming is available on diskette.

f. Ministry Training Center

A single-training center is be installed in the Ministry of Youth and Community Development to train ministry personnel. As in the Ministry of Education, no specific objectives are provided for this training activity, no potentital trainees are identified, and no process is processed which would assure that the planned training would actually take place. In the absence of this information, we recommend that this training application not be funded.

3. Ministry of Agriculture

The problems facing Jamaica's agricultural sector are many and complex. According to Ministry of Agriculture officials, the current average age of farmers is 60 to 65. Although the College of Agriculture is actively training people, few return to the farms. Jamaica's farms tend to be small and unproductive. According to these sources, the farm marketing system is poor, and there is little incentive for young people to farm or for farmers to increase productivity since returns are small. When farmers die or leave the land, the land often lies fallow.

Ministry officials indicated that a number of efforts are being made to resolve these problems. The proposed computer based education training under the Unified Curriculum Project would be used primarily to upgrade the training of

extension agents and aids and to introduce research findings. Mobile vans are proposed to present other educational approaches (e.g., seminars and audiovisual presentations) for use with farmers, many of whom are functionally illiterate, according to ministry officials.

Agricultural officials have not reviewed any agricultural CBE software with the exception of a PLATO bee keeping course, and did not identify other specific programs which would be applicable in Jamaica. Apparently agricultural PLATO software is currently under development, and few programs are currently available for review either through access to the main frame computer or on diskette. In addition, although the Ministry of Agriculture has a training division, that division was not involved in any meaningful way in the planning for the proposed project.

As a result, all proposed UCP training applications in the Ministry of Agriculture should be carefully reviewed and revised before funding for this portion of the project is considered. In addition, any new training activities should be carefully coordinated with and integrated into current training efforts supported by the Ministry of Agriculture. A very brief review of proposed applications in the Ministry of Agriculture follow.

a. Regional Training Centers

Jamaica's four Regional Training Centers serve agricultural extension personnel. Each of four Regional Training Centers would receive five terminals, which would be used to provide CBE instruction to 1,796 extension personnel. The distinction between full and part time students is unclear, since the Regional Training Centers offer a series of courses and seminars of fairly short duration. However, the proposal indicates that over the five year period 6,070 students will receive CBE instruction. Since the number of students is far greater than the number of extension personnel, these numbers indicate that some of the same individuals will receive training each year.
Personnel are to receive CBE training in Basic Skills, life management, supervisory skills, and agricultural courses under the program.

Given the absence of more specific information about the availability of CBE courseware in agricultural topic areas and the need for basic skill training, we recommend that this portion of the proposed training not be funded at this time.

b. Parish Land Authority Offices

Jamaica's thirteen Parish Land Authority offices deliver agricultural training to extension personnel and farmers. Currently specialized agricultural skills training centers are located at eight sites, with an increase to fifteen being proposed. The proposal indicates that these centers train future agricultural workers. The proposed CBE skill centers would be associated with these existing skill centers.

The recipients of computer-based education in these CBE skill centers is somewhat unclear, since many of Jamaica's farmers are reported to be functionally illiterate. Many trainees may be agricultural extension agents; however, when this proposed training is combined with that projected in the Regional Training Centers, a great deal of training of extension agents is projected. According to the proposal, 11,100 individuals would each receive 20 hours of CBE instruction. The lack of clarity as to who will receive training for what purposes is complemented by the absence of any mechanism for the arrangement and delivery of training. It is not at all clear how this large number of individuals could be coaxed to spend 20 hours in front of a computer terminal, particularly if their fundamental academic skills are poor and they are physically located throughout the countryside and pursue agricultural occupations.

Although the topic of training is not clearly stated in the proposal, we assume that it would include basic skills, life management, and agricultural skills. More clarification of the training population and the learning objectives are needed before funding of this portion of the proposal is considered.

c. Mobile Training Units

The proposal indicates that 35,520 farmers will receive training that will be provided by four mobile training vans. This training would not involve CBE, and therefore no CBE learning objectives are presented.

Given the absence of specific training objectives for the mobile van, we recommend that funding not be considered until the objectives are clarified and the process by which farmers would make use of the van's training services be described. According to an FAO representative on the Island, the Ministry of Agriculture is already developing training services for use in a mobile van. If additional

training is to be provided under this project, we would recommend that it be coordinated with that provided by the FAO project and with the training provided under the auspices of the Ministry of Education's training division.

d. Training Center for Ministry Staff

A one terminal learning center is proposed for installation in the Ministry of Agriculture. As in the other proposed centers in the ministries, we recommend that training objectives and CBE courseware on diskette for specific populations be identified and that a process for implementing and assuring that training take place be developed before funding is considered.

E. CONCLUSION

Of all the programs examined in this chapter, only the remedial training components are clearly defined with measureable learning objectives. PLATO courseware for remedial training is available for the CDC microcomputers. These remedial programs have been thoroughly tested in the United States in self-contained centers which function pretty much outside of the traditional educational system. A major drawback of establishing such remedial centers in Jamaica is their high cost.

An important aspect of CDC's Fair Break Centers is its individualized instruction. Research indicates that individualized instruction can be provided effectively by a paper and pencil system, although it lacks the attraction of computers. Therefore, if Jamaica and AID counsider remedial education to be important enough to merit a considerable investment of training resources, we recommend that a training project be developed which will provide cost and effectiveness comparisons of remedial instruction in computerized educational centers and in paper and pencil individualized instruction centers. Such a project is discussed in more detail in Chapter X.

NOTES FOR CHAPTER VI

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VII. COST-EFFECTIVENESS ANALYSIS OF NEW COURSEWARE DEVELOPEMENT AND PRODUCTION

A. INTRODUCTION

In Chapter IV, we discussed two problems of estimating the costs of the two courseware development centers. Insufficient information is available on the costs of the development and production of courseware in different subject areas, in different phases of development, and in different modes of delivery and we have only crude cost estimates for the development and production of courseware. The second problem is an inadequate understanding of the demand for new courseware in different subject areas. There is no discernable study of demand for new courseware in Jamaica.

Therefore, we cannot effectively examine cost estimates for the two courseware development centers. The cost estimates provided by the UCP can be neither supported nor justified by available data. The only tangible cost measure provided is one cost estimate for the development of one new courseware hour. Therefore, our analysis is limited to the development and production of new courseware. That is why this chapter is called "the cost-effectiveness analysis of new courseware development and production", instead of "the cost-effectiveness analysis of courseware development centers."

B. COSTS AND EFFECTIVENESS OF COURSEWARE DEVELOPMENT AND PRODUCTION

We mentioned in Chapter IV that the cost estimates for developing and producing a single hour of courseware range from $3,500 to $10,000. We also discussed why these figures tend to be underestimated. Since we have no better figures to work with, we will simply accept these as underestimated projected cost figures for this discussion.

Even if the estimated development and production costs of one hour of courseware were acceptable estimates, we would still need to compare the costs to the outcomes or effectiveness of the courseware development and production efforts. For this comparison we use the obvious choice of an hour of microcomputer-based courseware and limit our cost-effectiveness analysis to a least cost analysis, and control the outcome (one hour of CBE courseware) at the outset. For one hour of CBE courseware, the development and production costs range from $3,500 to $10,000.

To determine an acceptable level of cost-efficiency of courseware development and production we need to compare the cost-effectiveness ratio suggested in the UCP document with that of other alternatives. One alternative would be to purchase the educational and training materials when they become available in the market.

Before making this comparison we need to review some of the intangible effects of both approaches. To recapitulate, the objectives of establishing the two courseware development centers in Jamaica are twofold. The first is to fulfill specific training needs in Jamaica's social, cultural, historical and economic context by developing and producing CBE courseware. The second objective is to generate revenue by marketing this courseware in other Caribbean counties.

When we compare the cost-effectiveness ratios as suggested by the UCP proposal with that of purchasing the coursewares as they become available in the market we in effect focus on the consumption aspect of the courseware development effort and ignore the investment aspect.

The investment objective of the courseware development centers was not a main thrust of the UCPproposal. Few specifics of this aspect were presented. No market study was done. No survey was carried out to determine if there is a demand for microcomputer courseware in the Caribbean countries; what the level of the demand will be at what price level; what types of training programs will be needed; how big the market is; the optimal quantity of courseware for different subject areas and the corresponding price level that the market can bear; and the time horizon.

Given this lack of serious attention to the profit-making aspect of the centers and the non-existence of any market information, we have not evaluated the business venture aspect of the courseware development centers. We concentrate on the consumption aspects of the centers, and focus on the cost of obtaining one hour of CBE instruction from the proposed courseware development centers. Then we can compare this cost per courseware hour with the market price of the available courseware.

C. MARKET PRICE OF AVAILABLE COURSEWARE

We obtained a price list of available microcomputer courseware and their length from the Control Data Corporation. Only about 5 percent of the total number of course hours on PLATO is available on

diskette. The majority of these courses are in reading, mathematics, writing, science, and social studies. The only commercial subject available is keyboarding. There are CBE courses in computer technology, programming, and operations. Agricultural courseware are mostly in the process of development and will be available on disk at a later date (Watson's Memo, Nov 11, 1982).

Insufficient information is available on the price of the limited number of available courseware. The price list is limited to the courses which are proposed to be used in the learning centers. Therefore we have available only the prices of the reading, mathmatics and life coping skills series and their course lengths. We use this limited span of cost and course hours to develop a range of cost-effectiveness ratios.

In terms of per courseware hour, the reading series cost an average of $9.40, while the mathematics series cost $11.10 and the life coping skills series cost $68.70 [1]. The major difference seems to lie in the mix of media of presentation. Both the reading and mathematics series rely entirely on computer and text. The life coping skills series depends heavily on video and audio presentations. Since the development cost of an hour of video instruction can run as high as $30,000, the high price of the life coping skills series reflects the high development cost of video presentations.

This range of prices per course hour reflects what Control Data now makes available to the market. The prices of computer-related products tend to decline quite rapidly over time. This phenomenon is partly due to great initial costs of development and relative low costs of production. The cost tends to decline when mass production is underway. In part, this phenomenon is due to the competitive nature of the computer industry and the fluid transfer of human resources among competitors. In other words, these prices for each course hour represent a ceiling price, since over time the market price of these course hours should decline dramatically.

In the next section, we compare the price per course hour provided by the Control Data Corporation with the development and production costs of per courseware hour suggested by the UCP proposal.

D. COMPARISONS

From the UCP proposal and additional information furnished by the Control Data Corporation, the development and production

costs of an hour of microcomputer-based courseware will range from $3,500 to $10,000. We believe that this cost range underestimates the actual costs of developing and producing an hour of courseware (see Chapter V). Thus the cost range for developing courseware represents a minimum floor level. The cost per course hour of purchasing courseware, the alternative approach we present for comparison purposes, represents the ceiling level. Therefore, it should be clearly understood that our comparisons reflect the best possible situation for the courseware development and production effort and the worst possible situation for the alternative of purchasing available courseware. The compared results will have a built-in bias in favor of the development and production efforts, and against the alternative of purchasing the available coursewares.

Table VII-1 compares the cost-effectiveness ratios of the two approaches.

Table VII-1

Cost Comparison of Courseware Development and Courseware Purchase

Development and Production Cost per Courseware Hour	Purchaseable Hours per Series*		
	Reading $9.4	Math $11.1	Life Coping $68.7
$3,500	372	315	51
$10,000	1,064	901	146

* Hourly cost of CDC courseware attained from Watson Memo.

The rows represent the development and production costs per courseware hour as suggested by the UCP, and the columns represent the purchasing costs of the available courseware per course hour. The numbers within each cell indicate how many sets of available courseware can be purchased for the development and production cost. In other words, instead of developing and producing an hour of courseware, what is the number of sets of an hour of similar course that we can purchase when they become available in the market?

For instance, instead of developing and producing one hour of a reading course which will cost $3,500, we can use that amount of money to purchase 372 sets of that hour of reading courseware. Assuming that on the average a CDC 110 requires a set a year, $3,500 will supply 372 terminals for a full year. As we go across the rows the numbers decrease because we are

interesting question is what the comparison will mean if we have 200 CDC 110 terminals. Table VII-2 attempts to answer this question.

The number in each cell of Table VII-2 represents the number of years an hour of courseware can be supplied by purchasing the available courseware instead of using comparable funds to develop and produce it in Jamaica. For instance, instead of developing and producing the reading series at a (underestimated) cost of $10,000 an hour, we can purchase enough courseware at the present market price to last 5.32 years. Even if the cost of development and production drops to $3,500 per hour of courseware, enough courseware can be purchased to equip the 200 terminals for 1.86 years. The extreme case is the life coping skills series. If the development and production cost is $3,500 per course hour, enough courseware can be purchased to equip 200 terminals for 5.1 years. If the cost is $10,000 per hour, we can supply the 200 terminals for 14.6 years.

E. CONCLUSION

In the last section, we tentatively developed some crude comparisons between developing and producing courseware in Jamaica and purchasing the needed courseware when they become available in the market. Remember that we are comparing the "floor" level cost of developing and producing the courseware in Jamaica with the "ceiling" level cost of purchasing available courseware in the market.

Table VII-2

Number of Years of Courseware to be Supplied by Development and Production Costs for 200 Terminals

	Reading[a]	Math	Life Coping[b]
Development and Production $3,500	1.86	1.58	5.1
Cost Per Course Hour $10,000	5.32	4.51	14.6

a. According to the Control Data Corporation, (Watson's Memop, October 25, 1982), five sets of reading and mathematics series are needed for a 10-terminal learning center. The average life of disks is estimated at half a year (UCP, p. IX-1). Thus ten sets of reading and mathemativecs courseware are needed annually per hour of courseware for a ten-terminal center. An amount of $1,800 ($9.4 x 200) will be needed to equip 200 terminals a year. The development and production costs of $3,500 is sufficient to supply the 200 terminals for 1.86 years. The development cost of $10,000 would supply 5.32 years of courseware if it were purchased.

b. It is estimated by the Control Data Corporation that one set of video tapes will be suffcient to equip a ten-terminal center (Watson's Memo, op. cit.). Since the life span of video tape averages two years (Watson's Memo, Nov 5, 1982), we will need on the average 0.5 tape to equip a ten-terminal center for a year. Since the life coping skills series relies heavily on video presentation, we will assume that the major portion of the price per course hour is for the high cost of video development and we will need (200 terminals x 0.5 sets/10 terminals) or 10 sets per year. Therefore it will cost ($68.7 x 10) or $687 per year to equip the 200 terminals. The cost of development and production of $10,000 per course hour would equip the 200 terminals for ($10,000/$687) or 14.6 years if the courseware were purchased.

Table VII-2 provides a rather simple measure by which to gauge the cost-effectiveness of these two different approaches. Although the reading and mathematics series are the most widely used courses, developing and producing even these courses would not be cost-effective. By utilizing an equal amount of money, we can buy enough of these two CBE courses to equip 200 CDC 110 terminals for 2 to 5 years. The estimation of 2 to 5 years, of course, depends on the full utilization of 200 terminals at all times. Even the most widely used courses would have a limited market in Jamaica. According to Taggart, unless it is absolutely necessary, new courseware should not be developed (Appendix A, p. 8). Thus there is no convincing evidence to support the development of even the most widely used courseware such as reading and mathematics courses.

It is even more difficult to justify courses which are not widely used and depend on the more expensive video presentation. Instead of developing and producing the life coping skills series, we can supply the 200 terminals for 5 to 14.6 years with similar courses purchased in the market. This assumes that these courseware will be quite widely used. In addition, if Jamaica develops and produces its own courseware, it sacrifices the ability to purchase the latest developments in the same subject area. In effect, Jamaica would be locked in for 5 to 15 years with courseware developed simply for local consumption.

We have compared two approaches to obtaining the needed courseware. The first approach develops and produces courseware as suggested by the UCP proposal. The second approach purchases courseware as they become available in the market. Even though the data is biased in favor of developing and producing the courseware, the evidence which we have examined thus far favors the purchase approach.

As we have discussed in Chapter V, there is no evidence to justify the proposed funding for the two courseware development centers. This chapter demonstrates that the development and production approach to the needed courses is not superior to the option of simply purchasing courseware as they become available in the market. Therefore, we conclude that establishing two courseware development centers is not economically justifiable.

NOTES FOR CHAPTER VII

1. The following table is provided by Control Data Corporation (Watson's Memo, October 25, 1982; November 11, 1982).

Reliable Coursewares	No. of Course Hours	Cost	Cost per Course Hours
Reading Series	223	$2,100	$9.4
Mathematics	147	$1,630	$11.1
Life Coping	48	$3,298	$68.7

VIII. IMPLEMENTATION ISSUES

Implementation is an important issue in all projects, but particularly so in projects of any appreciable size and complexity. A first concern is with the physical feasibility of the project. We found that the proposed project is physically feasible, given the precautions described below and which are included in the costs detailed in Chapter IV of this report.

Other organizational and management considerations are likely to have a greater impact on the project. The proposal does not describe how the project staff would be organized, managed, and scheduled. A closely related issue concerns Jamaica's ability to provide the necessary technical and management expertise for the proposed project without
jeopardizing existing education and training programs. In addition, procedures are needed for recruitment, selection, and placement of trainees in advanced training or jobs at the conclusion of training.

Since the project design defines the objectives against which the project should be evaluated, the chapter includes a brief discussion of project design considerations.

A. PHYSICAL FEASIBILITY

Task 2 of the Scope of Work for this assessment asked us to assess of the feasibility and costs of a number of aspects of the project: the additional or hidden costs of shipping and transport, required maintenance for the equipment required by the project, power requirements for the microcomputers, the type of physcial environment necessary for the learning centers, and security issues and costs. Although each of these considerations was included in the costing details provided in Chapter IV, a brief review of our findings in each of these areas is presented below.

1. <u>Additional or Hidden Costs of shipping and transport</u>. Detailed information about the costs of shipping and transporting all necessary equipment for the training component of the project are presented in Chapter IV. Since the UCP proposal provided very little information about the equipment needed for the courseware development portion of the proposal, we were unable to compute the shipping and transport costs for equipment to be used in software development.

2. Maintenance Requirements. We do not foresee unusual maintenance problems, since maintenance contracts will cover all CDC equipment. The costs of these contracts are included in the costing detail provided in Chapter IV, and users have reported good success with the CDC equipment. No maintenance contracts are available from manufacturers of related equipment, such as tape cassette and video players. However, the cost of this equipment represents a very small percentage of overall contract costs, and the maintenance costs should be comparatively insignificant.

3. Power Requirements. Jamaica has two power plants that supply the bulk of its electric power - the Old Harbour plant and the Hunt's Bay plant. Both of these are quite old. The Old Harbour Plant is being rebuilt presently, while some portion of the capacity of the plant at Hunt's Bay is being retired.

Power outages are a common feature in Jamaica, sometimes lasting several hours. We understand that over the last ten years, one outage lasted for a full twentyfour hours, while several have lasted from four hours to as long as twelve hours. This level of instability can be expected to continue for the next three years while the system modifications are underway. Circuit stability is quite low, circuit breakers do not function well, and severe voltage peaking is likely to result. Under such circumstances, it becomes necessary for systems which depend critically on constant power supply to install alternative backup power sypply. We have included the cost of voltage regulators to support each microcomputer in the project costs reported in Chapter IV.

4. Physical Environment Requirements. The team determined the space requirements for the proposed learning centers, and the cost of renovating the centers to accommodate computer equipment. This cost data is presented in Chapter IV.

There is some question whether the proposed mobile vans will hold up on the rough Jamaican highways. In addition, the "rough ride" may disturb delicate equipment. A review of Department of Agriculture experiences with their planned mobile van training services should provide more definitive information about the durability of the vans and their equipment under Jamaican conditions.

Because of the lack of detail about the equipment and space requirements of the courseware development centers, no cost detail was developed on the physcial space requirements for the courseware development centers.

5. Security Concerns. Our survey of PLATO users in the U.S. identified no security problems with PLATO equipment, even in situations in which other training equipment was vandalized. Our conversations indicate that existing security precautions in Jamaica should suffice when coupled with procedures such as physically separating the computer learning centers and keeping them locked at all times when center personnel are not present. In addition, all equipment should be insured. The costs of these measures--full personnel coverage of each center during all hours of center operation, locked physical facilities, and insurance--are included in the costing details presented in Chapter IV.

We did not assess security issues associated with the proposed software development centers.

B. ORGANIZATIONAL AND MANAGERIAL ISSUES

1. The Absence of a Management and Implementation Plan and Schedule

No project of this size can function without a detailed implementation schedule which explains the interrelationships of project tasks and procedures for managing the inevitable conflicts and delays that will occur. Without a doubt, delays will occur, as the experience of ETS/LAUSD shows. The period of shakedown involved the usual difficulties of getting a computer system functioning in a school system: (a) unclear responsibility as to who fixes what when breakdowns happen; (b) malfunctionings sufficient to call upon all the vendors; (c) interruption of the usual structure of the classroom as the machines began to undercut the traditional authority of the teacher.

Of even greater concern in the proposed UCP project is the absence of a project implementation schedule which takes into account the time required for courseware development. Despite the fact that much of the training to be provided is dependent upon courseware development, time to allow courseware development is not factored well into the project.

In addition, a detailed management plan is needed which details the relationships of all major actors in the project and their lines of responsibility. A project of this complexity will require a steering committee of high level officials to make policy decisions, and to solve any

conflicts which cannot be resolved at lower levels of the project organization. Our discussions with ministry officials indicate that very little thought has been given to how decision-making will occur among the three essentially equal ministries and the National Planning Agency which are to participate in this project.

2. Availability of Skilled Manpower to Implement the Project

Ministry officials were unable to demonstrate that the Island has available to it sufficient numbers of skilled personnel to manage the implementation of this project. We identified a number of individuals with appropriate backgrounds and training; however, there is some evidence that their use in this project might damage existing educational and training projects. In addition, to avoid relying completely on the JOBS project management team or on outside technical assistance for long periods of time, Jamaica needs to assemble a management team with capabilities in major areas of project concern: hardware; instructional technology; remedial, vocational, and higher education; financial management, and legal expertise. This team needs to be drawn from the local community, since Jamaica will need an institutional capability to manage the project and to obtain the necessary support and commmitment needed to implement it successfully.

3. Complexities of Distance, Size, Multiple Actors, and Implementation in a Developing Country

Pressman and Wildavsky (1973) described the problems encountered by a major project in the United States which involved the combined effort and work of many levels of government. They showed that the clear project outlines developed by Washington policy makers became increasingly vague as the project was implemented at the state and local agency levels. They documented common knowledge: distance increases complexity in program administration. The complexity created by distance is compounded by the uncertainty generated by democratic political decision-making at each level. The proposed project is very complex in this sense. Three different ministries and many different training institutions are involved, and learning centers are to be established in many locations throughout the country.

At yet another level, complexity results from sheer size, measured here by the number and interlocking nature of the

critical parts required to make the project "go". According to our cost analysis in the Chapter IV, the learning center training component under the proposed Unified Curriculum Project requires $4 million and the proposed courseware development requires at least $11 million, and probably a good deal more. The project will run for five years. By any measure, this is a most complex project.

The project proposes to introduce a major training innovation into the complex environment of a developing country. It assumes that an educational technology which works only to varying degrees in other circumstances will solve a number of problems in Jamaica. However, since U.S. environmental conditions cannot be duplicated in Jamaica, Jamacian social context adds a high degree of uncertainty to this project.

4. Top-down Planning

The team visited a number of institutions which would be involved in the implementation of the proposed project. Often the person in charge of these institutions either knew nothing or very little about the project. Top-down planning of this kind, in which the individuals who are to implement the project are shut out of the initial planning, can have a number of negative effects. First, the information on which the project is based may be inaccurate. For example, the number of individuals proposed as trainees was in some instances far removed from reality. Some institutions, such as the parish land authority offices, are not currently involved to any large extent in training activities. Second, the project needs the support of a wide number of institutions and individuals in order to succeed. This support will not be forthcoming if these institutions and individuals are not included in the planning stages of the project.

5. Participation of the Private Sector.

The organizational and institutional structure of parts of the UCP project such as the Fair Break centers should be reconsidered. Many of the successful training projects which we reviewed involved private contractors who provide CBE-PLATO training services. They were required to meet established objectives for trainee performance at fixed costs, since they were reimbursed a flat sum for each trainee who received instruction. In some instances the contractor was not reimbursed unless a pre-established percentage of trainees (for instance, 80 percent) met the

established training and/or job placement objectives. Often the contractor was responsible for both training and job placement.

We feel that the private operation of training centers would be the most appropriate and cost-effective method of carrying out the project. A "performance contract" would help assure that US AID and Jamaica obtain the level of desired training at designated costs.

6. Classroom Management and Training Implications

Careful observers indicate that Jamaican schools are hierarchically ordered and create a comparatively rigid and authoritarian social climate. This pattern has developed out of the long history of Jamaican society, and is consistent with the broader plantation social framework which Beckford (See for example Beckford, George and Michael Witter, 1982) used in his study of Jamaican society.

As described by Beckford, plantation society is characterized by hierarcy, privilege, and differential access. There are large numbers of unskilled workers, organization is authoritarian with centralized decision-making; and workers and bosses are separated by wide social and cultural differences. Society is rigidly stratified, and race and color are important contingent factors in the stratification system.

To some extent the culture and organization of Jamaican schools are consistent with the plantation system. This means top-down decision-making and instructional methods which are characterized by lecturing, memorization, and group instruction rather than individualized instructional models. Within the classroom, the teacher has superordinate authority. Within the school, the principal enjoys that special position.

The lecture method can be regarded as one teaching methodology. More technologically based-education could fundamentally upset the social norms and received patterns of relationships in Jamaican training institutions. Teachers might struggle against a technology which determines classroom organization and could be perceived as limiting their authority.

We posed this potential problem to a past president of the Jamaica Teachers Union and to a number of persons who had been teachers in the public school system in Jamaica. They did not see the computer as a potential threat. On the contrary, we discovererd that Jamaican teachers have initiated informational sessions on the nature of computer based education on the assumption that sooner or later CBE would come to Jamaica. Apparently Jamaican teachers feel that the computer could greatly facilitiate classroom management and could generally help teachers to make better use of class time.

The proposed project is not likely to impact the length and breadth of schooling in Jamaica since it is confined to selected areas within the three ministries involved. Under these circumstances, general resistance to CBE may not develop, despite the nature of the existing training system. However, all teacher training institutions should focus heavily on how a teacher functions in a system which provides individualized instruction, since this approach would require a different classroom orientation than that traditionally used in Jamaica.

7. Selection/Recruitment/Placement of Trainees

Although the UCP approach holds promise for upgrading basic skills generally, the proposal does not indicate how trainees will be recruited for basic skills training. Although selection procedures may be straightforward for many applications, they are likely to be more complex for the proposed Fair Break Centers. For example, how will students be identified and encouraged to "stay the course?

Persons in the Ministry of Education describe a " natural demand" for education. They cite a strong desire on the part of students who have been "left out" to complete their schooling, and assume that a ready pool of learners exists. We find this view somewhat optimistic, since learning basic skills, even when computer-assisted, is hard work and students who would come regularly to learning centers would reduce their present employment opportunities, no matter how poor. Incentives, such as transportation and free lunches, should be offered, as well as assistance for job placement.

The recruitment of farmers to participate in training in land authority offices is even more difficult to envisage, since the existing offices offer very few training services. We have been told that many Jamaican farmers have poor reading and math skills, and that many are in their sixties.

In addition, since farmers must work in their fields during the daylight hours, their willingness to go to town to participate in the proposed training appears highly unlikely.

We also think it highly unlikely that employees will make use of the single-terminal learning centers proposed for placement in the ministries unless some specific learning objectives are written into their job requirements. Therefore, we conclude that the proposed project should have a program component which recruits appropriate students for training and provides learning incentives.

The proposed training would be much more attractive to trainees if it were tied more tightly to the employment goals of the government. The prospect of a better job following training would greatly enhance the attractiveness of training. Job placement does not just happen, it requires a separate and detailed program component. This concern leads to a general concern about the design of the proposed project.

C. PROJECT DESIGN

Most training projects begin with an articulation of project objectives. They are revised and refined as the project designers consider the full range of training objectives, available funding, and the relative importance of each objective. Basically, this describes a project response to a problem. The proposed UCP project presents us with a product--the CDC 110 microcomputer which can deliver CBE courseware--as a solution to a number of problems which have not been carefully articulated. However, since portions of the proposed project have considerable promise, the minimal steps in a coherent project design are briefly outlined below.

Jamaica needs to create more jobs and to provide Jamaicans with the skills they need to fill those jobs. If this project is to respond to the need for a better match between employee skills and the skill needs of employers, the following steps should be followed in developing a training project:

1. Identify areas in which demand for skilled employees exist, and determine, as precisely as possible, the number of trained personnel that are needed and the type and level of skills that employers are demanding. Typically this assessment involves a detailed survey of employers to determine both demand and required skill levels.

2. Develop training program objectives which respond directly to employer needs. Determine the most cost-effective method of providing that training, and develop evaluation criteria and measures (testing procedures) to assure that trainees in fact obtain the skills required by employers.

3. Develop a training program which responds to these objectives in the most cost-effective way. Often the specification of objectives almost dictates the type of training to be provided.

4. Be sure that the entire training program is directed toward meeting the program objectives. In the case of Jamaica, the only desirable outcome is trainees who are placed in jobs and employers who are satisfied with the trainees they hire. Since this satisfaction does not just happen, continual evaluation and feedback on how well the program is meeting employer needs should be factored into the ongoing revision and development of the training program.

5. Develop appropriate institutional structures to assure the success of the program. Include employers on the project steering and advisory committees, and be sure that outside experts in the major fields of expertise required by the project are available on an advisory basis to project management. Create a project steering committee of high level policy makers who can resolve policy issues and major conflicts among project participants.

6. Develop a simple project evaluation plan which can also serve as a management tool. A first objective is assuring that the planned events occur as scheduled. A second is that when the planned events occur, they produce the desired results. Continual evaluation is the only way the project can be assured of its ongoing relevance and usefulness to the community.

None of the above steps were apparent in the design of the proposed project.

D. CONCLUSIONS

The project is physically feasible, and the costs associated with the physical implementation of the project are included in our cost calculations. However, the UCP proposal neglects basic project design, organizational, and managerial elements.

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IX. SOCIAL AND ECONOMIC IMPLICATIONS

The conclusions and recommendations of this assessment are directly related to and grow out of the social and economic policy implications of the project. Although the proposed Unified Curriculum Project has a clear private sector bias, it deals with issues such as Jamaica's projected need for trained labor, and should be firmly based on data which indicates employer demand for specific categories and levels of skills.
Training projects should show good promise for resolving the national problems they address, such as the recurrent teacher shortages on the Island. The UCP program also ought to be tied into Jamaica's existing training resources, and the social implications of the new technolgy should be carefully considered so that they can be addressed throughout project implementation.

A. JAMAICA'S ECONOMY.

The Jamaican policy context must be considered when assessing a training project of this size and scope. The Jamaican economy is characterized by an essentially dualistic structure: an advanced sector consisting of bauxite, tourism and agribusiness, and a peasant agricultural sector. The former has traditionally been capital intensive, while the latter has been characterized by more labor intensive technologies.

During the 1950's and 1960's, Jamaica enjoyed sustained and rapid economic growth. The bauxite industry, the leading edge of this economic performance, was a catalyst for both growth and fundamental structural changes in the economy. This was also a period of great expansion in foreign investment. Real economic growth per capita during the period was averaged of 4 - 5 percent per year.

Economic growth far outstripped social progress. Unemployment grew from 13 percent to 23 percent between 1960 and 1972. By 1972, almost 70 percent of the employed labor force was earning less that $20.00 per week. The share of income of the bottom 40 percent declined between 1958 and 1969 from 7.2 percent to 5.4 percent, signalling a worsening in the distribution of income.

Despite the fact that exports expanded rapidly during this period, imports also grew, so that by 1970 imports exceeded exports by a staggering factor of two to one.

Just as exports had been a major factor in the growth of the economy in the 1950-1960 decade, their decline characterized the 1970's. Bauxite production fell in 1975/1976 and other export earners like sugar and tourism also saw sharp declines due to worldwide recessions. The period also saw dramatic increases in oil prices and chaotic terms of trade for exporters of primary commodities. As a consequence, after 1975 imports plummeted as export earnings and rising import prices combined to severely restrict the pace of import expansion. Between 1972 and 1976, investment fell sharply and GDP contracted by 7 percent.

The employment implications of this are puzzling. During the period of rapid growth in the twelve years from 1960 to 1972, employment grew by only 0.45% per year, while GNP growth in real terms was just under 6% per year. The critical factor explaining this unusual lag in the expansion of employment was the high capital intensity of the expanding sectors of the economy. Although economic activity expanded quite rapidly, the same could not be said concerning employment.

Later growth in employment during a period of contraction in total economic activity reflected fundamental structural changes. Foremost was the growth of public sector employment and the expansion of self-employment. Agriculture grew during the 1970's from 7.5% of GDP in 1970 to about 10% in 1978, in response to substantial growth in consumer demand. Export agriculture actually declined during the decade, although production for domestic consumption increased 75%.

Of an annual average employed population in 1981 of 752,500 persons, the productive sectors accounted for 392,500; agriculture, forestry and fishing employed 82,200; and mining, quarrying and refining employed only 8,000.

Unemployment figures for 1981 suggest that 262,500 persons were out of work for an unemployment rate of 25.9%. This figure, though lower than unemployment rates in 1980 (270,800, 27.3%), and 1979 (264,700, 27.8%), is higher than corresponding figures for 1978. The way in which Jamaica counts unemployment could account for some upward bias in these statistics. Despite this general downward trend of unemployment, we are not convinced that a pattern has set in. Consequently, the task of reducing excessively high levels of unemployment remains a major concern of the Jamaican government.

Women and youth are particularly at risk in the volatile labor market situation in Jamaica. The rate of unemployment for women is much higher than that for men, and extremely severe for younger workers. Actual rates show the following orders of magnitude: for 14-29 year olds, the unemployment rate was 41 percent in late 1981 while the overall rate was 25.6 percent during the same period, women had overall rate of 38.7 percent against 14.2 percent for men; and young women, experiencing the double disadvantage of age and sex, had a staggering 60 percent unemployment rate in late 1981.

Women and youth thus appear to be the obvious targets of any comprehensive employment program. New training initiatives should single out these groups and the industries of their relative concentration for corrective treatment, providing that these policies are consistent with the Government's macroeconomic policy thrusts.

The comparative sizes of the major employing sectors provide some perspective on possibilities for the expansion of employment. By far the greatest concentration of female labor is in commerce, the public sector, and service and agriculture. The manufacturing sector accounts for a fairly small portion of the total employment, 8.1%. For men, 42% are employed in agriculture, forestry and fishing, 11.2% in public administration, 14% in manufacturing industry, and 1.6% in mining. Cutting across this distribution is the sector comprising the self-employed, some 41% of the total Jamaican labor force. These are mostly in agriculture, but they are found also in commerce, in some services and also in manufacturing.

B. PROJECTED NEED FOR TRAINED LABOR

Long term forecasts of needs for labor of different types and skill levels were generated by the MPTE project at the National Planning Agency. The following represent our distillation from this most recent survey of labor needs for the Jamaican economy. Sectors expecting to show the greatest employment growth up to 1987 include construction (66.1%), manufacturing (32.2%), wholesale and retail trade (33.4%), mining (28.2%), and agriculture (30.2%). Since these are not sectors of relatively strong female representation, they cannot be expected to impact strongly on female unemployment. However, the sector "all other services" is expected to grow by some 47.6 percent during the period. In terms of occupation, "self-employed and independant" will grow some 42 percent, while the next most rapidly expanding occupation group consists of unskilled, manual and general workers.

If women and youth suffer the highest incidence of unemployment, it is quite likely that they will experience long job-search periods, particularly when labor markets are slack. The data suggest that women and youth will continue to be significantly at risk in the employment situation in Jamaica.

A very small number of private sector jobs are available as compared to the number of new entrants to the labor market. The ratio of new entrants to the labor market to the availability of new jobs is approximately of two-to-one. Jamaican employment policy must be concerned about job creation. Although there could always be a better match between demand and supply, appropriate policies to stiumulate the demand side of the equation are perhaps now more critical.

Demand for labor is a derived demand, reflecting employers' assessment of their need for labor imputs into the production process. Employment policy requires the joint determination of the demand and supply of labor and the optimal matching of the two. In the Jamaican case, this is particularly true given the recent slack in almost all sectors of economic activity.

The thrust of the UCP proposal is clearly on the supply side, presumably on the assumption that high levels of unemployment in Jamaica are a function solely of the skill levels of the labor force in relation to the demand for those skills in the mrket. This is clearly incorrect, given the slow economic activity occasioned by a world wide recession and its impact on major export earners and other producers in Jamaica. The UCP proposal must be assessed in terms of a broader macroeconomic policy having both demand and supply side interventions.

C. DERIVING DEMAND DATA

In any training project both specific training outcomes and skill requirements must be clearly specified. The UCP proposal identified outputs in global quantitative terms, such as the number of students in agriculture or in training schools to be trained. If an input-output model were disaggregated enough to allow for industries of interest to be isolated, specific skill requirements could be simulated, based on a range of assumptions which could affect the demand for specific skills. Although the UCP project did not emerge from considerations like these, such a focus would considerably narrow the large margin of error associated with pure supply-side interventions. We understand that a fairly detailed input-output model is

now available to the government. We could not secure this model, and so could not derive insights about the training needs of Jamaica.

However, we were able to extract two important tables from Juan Buttari's recent paper (Buttari, 1982). Tables IX-1 and IX-2 show employment for main sectors of economic activity. These data are later used to construct projections for specific occupational groups. Whether, and how the UCP project will impact these explicit training needs is not specified in the document. However, we feel that the proposed training must be related to these micro aspects of the larger problem.
*(NPA, 1982)

D TEACHER SUPPLY IMPLICATIONS

We are skeptical about the usefulness of this CBE Project for reducing teaching shortages by speeding the training of new teachers in Jamaica. The teaching profession in Jamaica suffers from a bewildering variety of ills, none of which would be fundamentally affected by UCP/CBE. In our discussions, we identified the following problems: (a) teachers are disgruntled about teaching conditions generally in the schools; (b) teachers are poorly compensated for their efforts, especially in relation to remuneration in the private sector or in statutory bodies; (c) chances for mobility are infinitely greater outside the profession than in it; (d) teaching provides good training for certain occupations in the private sector, such as insurance sales persons, and teachers use the profession as a stepping stone to other professions. The teaching profession has low status and meaning. As long as this remains the common perception, efforts to maintain, let alone increase, the size of the qualified pool of teachers in the profession are likely to fail.

Computer based education is not likely to have much positive impact on teacher shortages under such conditions. On the contrary, programs such as UCP/CBE may simply speed the migration of teachers out of the profession. There are no hard estimates of this migration out of the teaching profession, but casual observation places such migration at a minimum of about 5 percent per year. This figure is a modest estimate, given that we base it on the assumption that the typical teacher stays twenty years before

Table IX-1

Project Employment by Occupation

OCCUPATION	Base Year 1980			
	Nos. Employed ('000)	Percent of total	Nos. Employed ('000)	Percent of Total
Professional, Technical & Related	52.5	7.5%	63.0	6.7%
Administrative, Executive/Managerial	11.5	1.6%	15.0	1.6%
Clerical & Sales	87.1	12.0%	110.2	11.8%
Self-Employed & Independent	293.6	40.3%	387.9	41.5%
Service, Sports & Recreation	89.2	12.8%	119.8	12.8%
Craftsmen, Production Process & Operating	84.4	11.9%	112.4	12.0%
Unskilled, Manual & General	100.4	13.8%	127.3	13.6%
Not Specified	2.0	...	...	...
TOTAL	720.4	100.0%	935.6	100.0%

Source: NPA, 1982

Table IX-2

Projected Employment by Sector

SECTOR	Base Yr. 1980 No. Employed ('000)	Projection Yr. 1987 No. Employed ('000)	Percent Change 1980-1987
Agriculture	263.5	343.0	30.2%
Mining	7.8	10.0	28.2%
Manufacture	76.7	101.4	32.2%
Electricity & Water	4.7	5.7	21.3%
Construction	25.4	42.2	66.1%
Wholesale & Retail Trade	75.7	101.0	33.4%
Transport Storage & Communication	29.6	35.9	21.2%
Public Administration	108.7	113.9	4.8%
All Other Services	123.6	182.4	47.6%
Sub-Total	715.7	935.6	...
Industry not Specified	4.7 (9)	...	...
GRAND TOTAL	720.4	935.6	29.9%

Discrepancies due to rounding

Note (1) TThe numbers employed whose industry were not specified were distributed pro rata across teh Sectors for the projection exercise.

Source: NPA, 1982

departing. Newer teachers certainly do not intend to spend twenty years in the profession. The rate of exit is greater for men than for women because men have greater job opportunities in the private sector. Thus a weighted estimate of teacher migration would place it closer to 10 percent. The most promising policy option is to upgrade teacher salaries and the real income of the teaching profession. Serious erosion of confidence in the profession is likely to continue in the absence of policy designed to raise the real wages of teachers.

E. EXISTING TRAINING RESOURCES

A large number of training programs have been developed in Jamaica in recent years. Formal sector training is responsive to the demand for skilled labor from the bauxite and other new industries. Informal training largely provides labor-market access for workers coming from lower socio-economic groups. Tables IX-3 and IX-4 provide a listing of existing skill training programs and the projected outputs for occupations requiring different levels of formal schooling. Tables IX-5 and IX-6 show the outputs from institutions for the period since 1977.

The output of skilled labor has declined in recent years, in some cases quite sharply. Because high unemployment constitutes a social problem of massive proportions, the government has embarked upon a major program to rationalize its training programs. This effort, called the HEART program, is still under development.

The objective of the government is to train 10,000 young people per year under the HEART program with two basic objectives in view: (a) to impact the unemployment crisis among youth and women; and (b) to fill manpower resource gaps. In addition, a variety of industry groups are targeted, including food industry, garment and sewn products, business and secretarial, construction, repair and maintenance, and footwear and leather. We feel that the proposed UCP should be considered in the context of this broader employment policy. To the best of our understanding, HEART has not included the UCP proposal in its overall planning.

F. IMPLICATIONS OF THE NEW TECHNOLOGY

There are additional dimensions to the potential impact of advanced technology on social structure. Jamaica's Five Year Plan (1978-1983) provides objectives to support a radically new educational technology. These objectives include:

TABLE IX-3

Skill Up-Grading Programmes: Number in Attendance 1980-1981

Areas of Training	NUMBER IN ATTENDANCE					
		1980			1981	
	Public Sector	Private Sector	Total	Public Sector	Private Sector	TOTAL
Management and Administration	429	408	837	389	1,976	2,365
Financial Management and Accounting	637	287	924	585	164	749
Supervisory and General Foreman	205	240	445	151	556	707
Teaching	1,158	26	1,184	49	...	49
Secretaries, Stenographers, Typists, Reporters	281	66	347	463	451	914
Telecommunications and Satellite Communication Technicians	6	...	6	5	...	5
Telephone Operating	220	27	247	49	100	149
Engineering	868	72	940	...	520	520
Building and Metal Trades	...	...	...	...	115	115
Motor Vehicle Driving, Conducting, Inspecting	...	58	58	...	...	...
Motor Vehicle and Mechanical Maintenance	...	61	61	...	...	...
Other	1,302	707	2,009	86	307	393
TOTAL	5,106	1,952	7,058	1,777	4,189	5,966

Source: Economic and Social Survey, Jamaica, 1981.

TABLE IX-4

Output of Skilled and Semi-Skilled Manpower by Occupational Group: 1977-1981

Occupational Groups	Output				
	1977	1978	1979	1980	1981
Agricultural Workers	241	466	408	326	276
Community Health Aides	60	95	...	...	...
Cooks, Waiters and other Hotel Workers	589	265	601	573	455
Craftsmen Production Process and Operating Workers	1,873	1,824	1,287	1,172	1,799
Police	494	120	308	186	337
Post and Telegraph Workers	136	121	64	128	94
Secretarial and Other Commercial Workers	1,629	836	1,136	1,133	1,205
Miscellaneous Groups	207	51	69	372	229
TOTAL	5,229	3,828	3,873	3,890	4,395

Source: Economic and Social Survey, Jamaica, 1981

Table IX-5

Projected Output for Occupations Requiring Tertiary Level Education

Institutions	Projected Average Annual Output
Univerity of the West Indies	1,000
College of Arts, Science & Technology	635
West Indies College	299
Sch. of Radiography	10
Nurse Practitioner Sch.	22
Schs. of Nursing	479
Sch. of Physiotheraphy	20
Dental Auxiliary Sch.	30
W.I. Sch. of Public Health	55
Teachers' College	1,255
Excelsior Education Centre	82
Vocational Training Development Institute	56
In-Service Teacher Education Thrust	47
Maritime Tr. School	16
Sch. of Agriculture	40
Ja. Theological Sem.	20

Source: NPA, Jamaica, 1982

Table IX-6

Projected Output for Occupations Requiring Up To Secondary Level Education

Insitutions	Projected Average Annual Output
College of Arts, Science & Technology	177
Business & Commercial Schools	2,888
Technical Schools	1,522
Community Colleges	380
Cultural Training Centre	20
Vocational Schools	75
Jamaica German Automotive School	40
Garment Industry Training School	75
West Indies College	30
Housecraft Training Centre	360
G.C. Foster School	100
Toolmaker's Institute	10
Apprenticeship Scheme	20
Other	12
Social Development Commission	1,000
TOTAL	6,709

Source: NPA, Jamaica, 1982

1. The production of individuals who can cope with economic, social, political, technological, and cultural changes;

2. The formation of positive attidues in students and the society at large toward purposeful physical work; and

3. The improvement of teacher and pupil relationships which ensure a less authoritarian approach and a more democratic and positive acceptance of increased student autonomy.

These objectives are consistent with the type of training offered by the proposed project and would establish the kind of environment needed for the successful introduction of computer based instruction.

However, we cannot assume that benefits which technology confers on developed countries will be equally beneficial in less developed countries. In the first place, balance of payment problems may develop as foreign exchange is expended to acquire new technology. Secondly, a comparatively small cadre of persons will have access to the new technology in a developing country, which could exacerbate an already difficult income distribution situation.

Some work quoted by Turner and Persand (1978) suggests that when educational television was introduced to the island, some teachers became passive and some audiovisual materials were not used. They gave the following explanation of these findings: a) objectives were not "always socially relevant with respect to people's needs; b) content was borrowed without adaptation, and c) technical problems occurred. While the adaptation question is addressed by the large software development component, there is a strong general sense that any new educational technology should be introduced slowly into developing countries.

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X. CONCLUSIONS AND RECOMMENDATIONS

The primary purpose of the proposed Unified Curriculum Project (UCP) is to improve the employability and productivity of Jamaicans (I-2). This purpose has meaning for individual Jamaicans--and is worth the high cost of an investment in training--only if trainees can obtain economic benefit from improved skills or can satisfy the skill needs of their employers.

A. REVIEW OF THE PROPOSAL

The UCP Project provides two basic strategies for improving Jamaicans' employability. The first provides various types of computer based education (CBE) training for Jamaicans of working age by using Control Data Equipment and software training programs. Training in basic academic skills using Control Data's CBE remedial education materials is heavily emphasized. The second strategy develops CBE courseware in Jamaica for use by Jamaicans on CDC equipment and for possible sale throughout the English speaking Caribbean and other developing countries.

A brief review of the proposal and the team's assessment of its suitability for resolving Jamaica's employment and economic development objectives follows.

1. Review of Proposed Training Applications

The computer-based educational approach proposed by the Unified Curriculum Project is a training tool or technique. It does not represent and should not be considered as a comprehensive training solution to Jamaica's many and varied educational needs. Although the UCP document cited a number of objectives which are generally relevant to the development of the Jamaican economy and increased employment, it appears that the proposal did not evolve out of a rigorous assessment of the nature of Jamaica's educational and economic development problems and the identification of the best approaches for meeting those problems. The proposal's estimates of numbers of students to be trained are based on machine capacity rather than documented demand for training, and it does not cite job placement--employment--as the expected outcome of any of the training activities.

In the Ministry of Education, two CBE learning centers are proposed for installation in two teachers colleges. Their primary purpose is to upgrade the academic skills of first year students so that they can matriculate into a college of education. The teachers colleges would then produce more teachers, which would help to resolve teacher shortages on the island. There is an implicit assumption that teacher shortages are a function of indequate training. But teacher shortages in Jamaica result from high turnover, which is a function of low salaries and poor working conditions. An increase in the number of teachers trained should not greatly affect teacher shortages, and the use of CBE instruction cannot be justified for these reasons.

A CBE learning center was also proposed for the College of Agriculture. Its primary purpose is to upgrade the basic academic skills of some trainees (number unknown), and to provide other trainees with CBE training in agricultural topics. However, CBE courseware in agricultural topics currently are not available on diskette, with the exception of bee keeping. Since, in addition, we have no information about the extent of demand for improved or expanded agricultural training which could be met by CBE courseware in the College of Agriculture, we see no basis for this use of limited training resources.

Six CBE learning centers are proposed to provide basic skill instruction to street kids, young people between the ages of 16 and 21 who left the traditional school system with minimal academic skill levels (third or fourth grade). Under the proposal, these young people would be trained in Fair Break Centers. These centers, which are modeled after similar centers in the U.S. which have successfully upgraded the academic skills of disadvantaged young people, would provide basic training in academic skills and the attitudes and skills these youth need to function in the world of work. Expected outcomes would be either employment in entry level jobs or additional skill training. In this case, available data suggests that large numbers of young people possess few of the skills needed to function successfully in the job market. Therefore, providing training in Fair Break-type centers appears to be a plausible solution to the problem.

However, the Fair Break Center is a training strategy. It is not described as part of a system or program which would recruit and select trainees, or assist with their placement into additional training or jobs when they complete their training in Fair Break centers. We do not see how these Centers could help these young people to reach the ultimate

objective--finding jobs--unless the training strategy is part of a complete program which is designed to assure their placement in jobs.

We have similar problems with all of the proposed applications in the Ministry of Agriculture. A total of 17 CBE training centers is proposed for placement in regional centers and land authority offices. In addition, mobile vans are proposed to provide traditional (non-CBE) training to farmers. However, the UCP proposal gives no indication of what the proposed training is to accomplish in terms of learning objectives or increased productivity, it is not clear how the proposed CBE center could be effectively integrated into the existing agricultural extention services. It appears that massive amounts of CBE training are proposed for the Island's 1,796 extension workers, but no agricultural courseware currently is available on diskette and there is no indication of the agricultural topics for which training is most needed. When those topics are identified, CBE may not be the most effective training approach. Since extension workers are already employed, as are the farmers who are expected to be recipients of training, careful specifications of expected training outcomes are needed before any training can be justified.

The situation is much the same for the CBE training applications proposed under the jurisdiction of the Ministry of Youth and Community Development. In general, additional CBE training is proposed for use in training institutions or youth camps which already have training facilities. The UCP gives no indication of existing deficiencies in these training institutions which can be resolved by CBE instruction. Training objectives for youth camp enrollees are unclear. In general, CBE training figures appear to be somewhat inflated and unrelated to actual or projected numbers of students, since the UCP document indicates summer school and/or part time applications which appear to be inappropriate given the structure of the training institutions.

In the absence of detailed data on the number of trainees in these institutions who need basic skills training and identified topics for CBE courseware, and the almost total absence of vocational and agricultural CBE courseware on diskette, we find it difficult to justify any funding for CBE training in facilities under the Ministries of Agriculture and Youth and Community Development.

2. Review of Proposed Software Development

The proposed training applications depend to a large extent on the development of CBE agricultural and vocational software in Jamaica. However, the UCP document did not indicate the particular topic areas in which CBE software development would be most productive for Jamaica, nor did it indicate a time schedule for the development of CBE courseware which could be tied to the implementation of the training component of the project. No indication was provided of the expected quantity or quality of software which would be produced, beyond the rough estimate of 1,000 CBE hours for the $10 million invested (IX-6). Although the proposal indicated that CBE software developed in Jamaica could be sold to other countries, no marketing data supported that assumption, and little information was provided about how this possible return on Jamaica's investment in software development might be realized.

Software development would use over half of the proposed project resources, but very little attention was given in the proposal to the software development process or its management, and costing details were too limited to allow us to make a detailed assessment of full costs. These problems, combined with the limited success of software development in the United States (the literature review indicated that most educational software is of little instructicnal value), led us to conclude that there is little justification for a major investment in software development in Jamaica at this time.

B. REVISED COST ESTIMATES OF THE PROPOSED UNIFIED CURRICULUM PROJECT

In the analysis of the cost of the Unified Curriculum Project, we divided the proposal into two major components: the learning centers and the courseware development centers. Total annualized costs were derived for each type of center. We divided the cost of each center according to the following categories: facilities and equipment, training, administration, personnel, curriculum, maintenance and miscellaneous.

Even though over half of the requested $20 million funding is for the two courseware development centers, little attention and care were devoted to estimating their actual cost. Therefore we had no basis on which to develop more detailed cost estimates, and could only conclude that the proposed costs were probably underestimated.

When we compared the relative costs and benefits of purchasing CBE courseware as compared to developing it in Jamaica, we found little economic justification to support its development. This factor, combined with the limited information provided in the proposal about specific courseware development objectives, costs, schedules, or marketing potential, lead us to recommend that U.S. AID not consider funding this portion of the proposal.

We conclude that U.S. $4.0 million would be required annually to run all of the learning centers. This is 135 per cent more than the annual amount suggested in the UCP proposal. If the project were to be fully funded as requested, the Government of Jamaica would have to provide an additional $2.3 million annually to operate the learning centers.

Our crude cost comparisons between a ten terminal Fair Break Center (which provides remedial education) and the traditional educational system indicate that computerized instruction is substantially more expensive than traditional instruction. According to our cost estimates, it would cost $236 to raise one student one (remedial) grade level using CBE. It would cost $67 to raise one student one grade level in the traditional Jamaican educational system, according to cost estimates provided in the UCP proposal. However, since the Fair Break centers used for this cost comparison provide job readiness training and counseling in addition to remedial instruction in basic skills, realistic cost comparisons cannot be made since programs with quite different objectives are being compared.

There is very limited data in the literature on either the comparative cost or the effectiveness of CBE instruction for vocational and agricultural instruction; apparently comparatively little CBE instruction has been attempted in these fields. The absence of information about the comparative costs or effectiveness of these applications, combined with the lack of clearly specified objectives in the UCP proposal for these applications, leads us to conclude that U.S. AID should not consider funding the proposed CBE instruction in these areas at this time.

The proposed project does not involve any substantive transfer of technology and does not propose to develop computer literacy among Jamaican students. As a result of project funding, Jamaican students and instructors will not become educated consumers of computer technology, nor will Jamaicans develop a capability to design, build or program computers. Except for a limited number of people who would

be trained at great cost in the software development centers, Jamaica would not develop a substantive courseware development capability. Even this limited number of Jamaicans would not be trained to develop commercial applications. The availability of a computer is necessary but not sufficient to establish computer literacy, any more than a stove in a kitchen guarantees edible meals. Specialized instruction in computer-related topics such as programming is needed if computer literacy is a training objective.

C. RECOMMENDATIONS

In the previous section we stated that we do not recommend that AID consider funding the vocational and agricultural CBE applications or the software development component of the Unified Curriculum Project. We do feel that CBE remedial academic skills training, which was costed out in Chapter IV of this report in the context of a ten terminal Fair Break-type Center, effectively provides remedial instruction for many students who in the United States have previously failed in academic settings. The costs are considered high by our respondents, but not unreasonable or beyond "tolerable costs," given established instructional and training costs in the United States.

Our review of the literature and our survey of users of Control Data equipment and software programs indicate that these are good products, that the Control Data Corporation is responsive to its clients, and that many persons who have failed in traditional educational systems learn basic skills using computer technology. Since many of these individuals were previously considered academically hopeless, there is no real basis for comparing the costs of using computerized instruction with these individuals with other approaches.

We conclude that CBE instruction may be an effective means of providing remedial instruction in Jamaica. However, decisions about funding CBE remedial education must be decided by determining tolerable or acceptable costs of remedial education in Jamaica. Simply put, the Government of Jamaica/USAID will have to decide whether they are able and willing to fund computerized remedial education programs at the cost levels described in this report. They must decide whether it is likely that a successful demonstration project using CBE instruction would lead to continued and increased funding for CBE remedial training. Based on the limited information available to us, we question the wisdom

of spending large amounts of money on remedial education, given the full range of Jamaica's ecucational needs.

If extensive funding of CBE remedial skills training appears to be warranted, we recommend that a demonstration project be developed in which basic skills are taught in individualized education centers which are separate and distinct from existing academic institutions. The project should include at a minimum two centers, each of which would provide basic skills instruction from approximately grade 3 through the CXC. One center should provide paper and pencil instruction, the other CBE instruction. The two centers should be evaluated in terms of effectiveness and cost by an outside contractor who participates in the design of the demonstration project so that major variables such as differences in the student body, teaching staff, and learning environment can be controlled.

Since we could not determine specific learning objectives for job readiness training, we do not recommend that PLATO's life skills training be used unless a comparable paper-and-pencil based curriculum can be identified for use in a paper-and-pencil center. If life skills-type training is desired, we recommend that expected outcome measures be developed for the training and that it be offered by two additional centers so that the effects of the job readiness training can be separated out from the effects of the remedial skills training.

Exhibit X-1 provides rough cost estimates for a demonstration project with two individualized learning centers. The CBE center costs are those calculated for a 10 terminal Fair Break Center in Chapter IV; costs would be reduced slightly by deleting the counselor if the life skills training is eliminated. The cost of the paper and pencil center is a very rough estimate derived from CBE center costs.

Estimated first year operating costs for a single paper and pencil individualized learning center are $179,364; second year costs are $98,527. Over a two year period, the cost per grade level increment is $232 (assuming an achievement rate of 60%, see Note j, Exhibit X-1).

Estimated first year operating costs for a single CBE learning center are $332,765; second year costs are $133,157. Over a two year period, the cost per grade level increment would be $388 (assuming an achievement rate of 60%, see Note j, Exhibit X-1).

EXHIBIT X-1

CBE AND PAPER AND PENCIL CENTERS

Start-up and Additional Annual Costs (US)[a]

Resource Elements	CBE CENTER Start-up	CBE CENTER Annual	PAPER & PENCIL CENTER Start-up	PAPER & PENCIL CENTER Annual
Facilities Construction[b]	$78,786	$ ---	$50,786	$ ---
Equipment[c]	90,771	---	---	---
Training	30,051	---	30,051	---
Administration[e]	---	14,337	---	14,337
Personnel[f]	---	54,242	---	54,242
Curricula[g]	---	46,181	---	23,091
Maintenance[h]	---	10,440	---	---
Miscellaneous[i]	---	7,957	---	6,857
TOTAL	$199,608	$133,157	$80,837	$98,527

First and Second Year Cost Comparisons

	First Year	Second Year	Total
CBE Center	$332,765	$133,157	$465,922
Paper & Pencil Center	179,364	98,527	277,891
TOTAL	$512,129	$231,684	$743,813

Cost per Grade Level Increment (60%)[j]

CBE Center	$555	$222	$388
Paper & Pencil Center	$299	$164	$232

Notes to Exhibit X-1

a. Exchange rate: US $11 = J $1.75

b. The CBE Center assumes a 10 terminal center which would use CDC equipment and programs. Costs are based on those developed in Chapter IV of this report. At 100 percent utilization, 250 students would gain four grade levels of improvement per year from 30,000 hours of CBE instruction (assumes Center operation 60 hours per week, 50 weeks per year, and one grade level improvement per 30 hours of CBE instruction). For comparative purposes, we have arbitrarily assumed that approximately the same number of students could receive paper and pencil-based programmed remedial instruction for the same learning objectives in centers with similar staffing patterns.

New construction costs are assumed as needed for both types of centers. We assume that no renovation costs will be required for the paper and pencil center.

c. We assume no unusual equipment costs for the paper and pencil center.

d. We assume that training costs will be similar for both centers, since individualized instruction requires a quite different technique than that traditionally used in Jamaica.

e. We assume that administrative costs would be halved for each center, since contracting out the centers should reduce administrative overhead for the ministry.

f. We assume that personnel requirements will be equal in both centers. Costing assumptions assure that a teacher, counselor, clerical person and secretary will be on duty during all hours of center operation.

g. We assume that curricula costs in the paper and pencil center will be one half those in the Fair Break Center.

h. We assume that there will be no unusual maintenance costs in the paper and pencil center.

i. We assume that no insurance premiums and minimal power will be needed in paper and pencil centers.

j. Although the UCP proposal uses an 80 percent effective utilization rate (UCP III- 21), we apply a more conservative 60 percent to account for the probable power failures and other difficulties inherent in introducing any new technology and educational approach. The projected number of terminal hours is obtained by multiplying .6 by the projected number of terminal hours, 30,000, to obtain 18,000 effective hours. This number is divided by 30, the average number of terminal hours, to gain one grade increment. Thus 600 grade increments should be obtained from one year of center operation. We obtained the cost per grade level increment by dividing the total cost for each year of center operation by 600. We have arbitrarily assumed that similar numbers of students can be served and that similar results will be obtained from the paper and pencil center.

Total first year costs for the two centers are $512,129; second year costs are estimated at $231,684. The total cost for the two centers for the two year period would be $743,813, excluding evaluation costs. Over the two year period, this investment would provide remedial training for 1,000 students in the two centers. We would expect 600 of those students to progress four years in remedial reading and/or mathematics for a total of 2400 grade level advancements. Costs could be somewhat reduced by using existing facilities and by making adjustments in staffing patterns. We recommend that such a demonstration be run at least two years so that the costs and effectiveness of the two programs can be assessed over time.

Since we are recommending that the demonstration be assessed by AID and Jamaica in terms of tolerable costs for remedial education, we think it is reasonable to compare these costs with the training investment Jamaica currently makes in its secondary level students. Using the traditional instruction costs cited in the UCP proposal, traditional instruction is provided in Jamaica at the (underestimated) cost of $67 per student for one academic year of instruction in a single topic. The Jamaican system now trains 1,000 secondary students in four subjects at a cost of $269 each, for a total cost of $269,000. Assuming a 60 percent effectiveness rate, this training would result in 2400 grade level advancements.

Contrary to the impression given by the proposal, which suggested that students would use the centers on a walk-in basis and during the evening hours, remedial learning is difficult and tedious, even if a machine makes it easier. Learning is a discipline which, when successfully mastered, can translate into good work habits. However, students must be motivated to learn--CETA students in the U.S., for instance, are paid stipends while learning, and prisoners face few better alternatives. Incentives to learn might include transportation to and from the centers and hot lunches. A job or training placement service would also help.

The centers cannot operate without a supporting structure, although they probably would be incompatible with a traditional educational setting. A sponsoring agency must recruit and select students, establish procedures to help assure that students will be committed to completing the coursework, and reinforce learning center rules about absences, tardiness, etc. An important aspect of any remedial training program is the development of good work habits, and CBE learning centers are no exception.

Very efficient scheduling will be needed to keep costs down. Center staff will need incentives to achieve optimal scheduling and to encourage their clients to successfully complete their coursework. This appears to be best accomplished in the U.S. when remedial work is contracted out to the center, and the center is paid or its contract is renewed only when it meets established criteria. The sponsoring agency conducts both pre- and post-testing to assure that appropriate learning objectives are established and achieved. We recommend that a similar approach be used in Jamaica.

The contracting approach should help ameliorate some of the uncertainties associated with the introduction of a new technology into a developing country. This is particularly true of CBE, which as an individualized instructional approach implies fairly substantial changes in the relationship between instructors and trainees from those traditionally observed in Jamaica. When using CBE, students direct their own learning and instructors provide motivation and assistance with specific problems rather than didactic instruction. Since a private center will tie contract renewal, and therefore instructor retention to performance criteria, instructors will have a built-in incentive to adopt the most productive instructional style.

Although this approach is consistent with Jamaica's educational objectives (Five Year Plan 1978-83), authoritarian methods still dominate the current teaching environment and the work place in Jamaica. Very careful training and continual monitoring and reinforcement will be needed to assure that appropriate teaching and counseling procedures reinforce the individualized instruction.

If successful, the paper and pencil-based center could serve as a prototype for other, similar centers on the Island. Access to appropriate paper and pencil materials could be obtained by contacting Robert Taggart. Such a center also could serve as a laboratory for developing and pretesting the individualized paper and pencil materials which should precede the development of CBE programs.

At the same time, the PLATO prototype could demonstrate the comparative effectiveness of CBE instruction under the best of conditions. Our survey respondents described PLATO as the "Cadillac" of CBE training programs, and the Control Data Corporation has a proven ability to establish and manage such training centers. No other arrangement could be installed as easily or as quickly. Jamaican personnel could

learn effective CBE implementation and management techniques by observing the development of PLATO training centers, and this expertise could be used to develop other CBE prototypes if experience with the PLATO center suggest their feasibility. If the PLATO remedial training centers appear to be worth the cost, JOBS could be urged to offer other PLATO training services such as secretarial training.

This approach would provide an incremental strategy for the introduction of a new educational technology to Jamaica. It would provide data on the relative costs and effectiveness in Jamaica of two different individualized educational approaches with similar remedial training objectives. In addition, the demonstration could provide a resource base for the development of additional paper and pencil materials, for use either as is or as the basis for further CBE software development; and for the training of personnel in the implementation and management of individualized instruction and CBE learning centers.

A demonstration of this kind could serve as a model for private industry cooperation with government. By contracting out for these training services, the Jamaican Government can establish and enforce performance and cost limits for the project. The private sector push for profits could then support the government's efforts to increase employment and productivity.