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COST ISSUES IN THE LIBERIAN

"IMPROVED EFFICIENCY OF LEARNING"

(IEL) PROJECT

Report No. 1 of the
IEL Cost Analysis Project

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COST ISSUES IN THE LIBERIAN "IMPROVED EFFICIENCY OF LEARNING" (IEL) PROJECT

Report No. 1

INTRODUCTION

Between November, 1981 and April, 1982 the IEL project underwent three separate reviews by external examiners. Dr. Robert Jacobs of Southern Illinois University produced a report entitled "Formative Evaluation of the Improved Efficiency of Learning Project." This was followed by "An Evaluation of the Improved Efficiency of Learning Project," prepared by Dr. Grant Harrison of Brigham Young University and Dr. Robert Morgan of Florida State University. These two reports concentrated upon the issues of materials development and project implementation within the IEL schools and, although there is a significant difference in the tone of the two reports, both were supportive of the goals of IEL and the current strategies for their achievement.

A third report, "Improved Efficiency of Learning Project: Mid-Term Evaluation Committee Report," was prepared by a panel consisting of Liberian government, USAID/Washington, and USAID/Liberia personnel. This report was again supportive of IEL (including the proposed extension of time and funds for the project). In addition to reviewing the materials and implementation activities, the Evaluation Committee concentrated upon the overall management of the project and future needs for consultation and evaluation. The committee noted that the "project now requires a more thorough and analytic study of both development and recurrent costs" and recommended that "a thorough cost study be conducted as soon as possible."

A decision was made to commission the present cost analysis project in response to this recommendation. The project is to have five major outcomes:

(1) The specification of a cost methodology to allow for comparison of IEL costs both in their present context and as they will be incurred during any planned implementation into additional schools;

(2) The collection, review, and analysis of existing reports and cost data on IEL and non-IEL instructional and administrative costs;

(3) The identification and elaboration of internal and external efficiencies as they exist in the present IEL system and as they would exist under implementation;

(4) The quantification of the cost-effectiveness of IEL instruction relative to that of two alternative models of the traditional Liberian primary school system; and

(5) The provision of estimates of the cost effects of alternative modes of IEL dissemination and implementation within the primary school system.

This initial report of the cost analysis deals with the first two of these outcomes. The present activity is not responsible for an analysis of past, present, or future IEL project costs except as they relate to the above outcomes.

The main product of this first report is to itemize the estimated costs for IEL and non-IEL schools in five main areas: teachers' salaries, materials costs, facilities and equipment costs, administrative and supervisory costs, and teacher training costs.

Because of the issue of textbook availability, alternative cost estimates of non-IEL schools will be made inclusive and exclusive of textbook costs. (Estimates have been made that as few as three percent of all primary school students possess textbooks.) The remaining three parts of the cost-analysis project will involve:

(1) The opportunities for, and the cost effects of, potential internal improvements in efficiency and external economies of scale within the IEL system;

(2) An initial and provisional cost-effectiveness comparison of IEL and non-IEL schools based on the summative evaluation work conducted by Dr. Klaus Galda; and

(3) An analysis of the cost impacts of alternative dissemination strategies.

As to this last activity, planning the actual design for implementation of dissemination will be the responsibility of Ministry of Education and IEL staff. The role of the cost-analysis project in this effort will be to provide estimates of the cost implications for the major alternative strategies to be identified. For example, both training and production/distribution costs are affected by the number of schools, their location, the existing quantity and quality of their teaching staff, equipment and facilities, the phasing of dissemination by grade level, and related characteristics.

The remainder of this report will discuss the framework for the cost determination and analysis as well as present the initial findings on the costs of IEL versus non-IEL schools in terms of types and level. Before proceeding to the estimates themselves, it is important to explain the economic concept of cost analysis which is used in the evaluation of alternative classroom methodologies.

THE ECONOMICS OF COST ANALYSIS

Two major types of economic analysis are appropriate for the present stage of IEL project activity. First, there is a need to compare the potential cost-effectiveness of the IEL experimental system to the conventional Liberian classroom methodology (consisting of teacher lectures with or without support from textbooks and related instructional materials). Second, the cost effects of a potential dissemination of IEL to the conventional Liberian schools is an important issue should the cost effectiveness results and other considerations of Liberian educational policy justify such action. In this section, the rationale

for use of a comparative cost analysis in both the cost-effectiveness and dissemination studies will be presented.

The choice faced by the researcher/planner in all cost analysis is between an analysis of total costs versus relative costs. In a total cost format, it is necessary to conduct a study of the full unit costs (per school or per student) for the following major components: facilities, equipment, materials, instructional and supervisory personnel, and requisite training. These costs would be estimated for both the experimental instructional system and for the traditional system. Such detail is necessary, however, only if school equalization rather than adaptation is the policy goal. Since the envisaged IEL project dissemination does not require that every school be made to approach some identical design in terms of all of the major resource components, it is possible to use the comparative cost format of analysis.

This is fortuitous since the Liberian primary educational system remains quite heterogenous especially in terms of available facilities and instructional quality. Also, there are serious methodological limitations in the unit cost estimation (e.g., calculation of the interest and depreciation values of facilities such as elementary schools, for which there are often no local alternative uses, is especially problematical).

The marginal or comparative cost format of analysis emphasizes the determination of the change in costs for a conventional Liberian school required to adapt to the IEL technology. These costs may be estimated in terms of the initial budget costs of dissemination (an important consideration for Ministry of Education budget planning) and in terms of the effect of the new program on recurrent costs (an important consideration given the present restrictions on the absorptive capacity of the Liberian National Budget). The first of these estimates will be emphasized in the subsequent report on cost-analysis issues for dissemination of IEL and the second will be a major issue for the report on the initial cost-effectiveness evaluation of IEL.

The first requirement for the marginal cost analysis has been to study the IEL programmed teaching (PT) and programmed learning (PL) systems to determine the requirements they will make on school resources. It is important to note at the outset that the IEL system as it exists in the laboratory school setting is not necessarily the appropriate model for estimating the instructional system's structure under the eventual dissemination plan. The daily teacher support and instruction provided by the IEL Instructional Supervisors, while necessary during the experimental stage of materials development and testing, would represent a prohibitive cost condition for immediate dissemination. It is planned that the new IEL experimental schools will operate with a level of supervision which approximates a more realistic assumption of available supervisory resources.

One of the advantages of the marginal cost approach is that it can be adapted to a variety of dissemination designs. If it should be decided that the dissemination plan will include less than full utilization of any part of the experimental IEL design, this change can be incorporated directly into the cost analysis. Similarly, for dissemination cost planning, any combination of phased grade-level or locational (by size of place, county, or other geographical determinant) dissemination plan can be costed directly from the effect of the particular design on existing school requirements.

The major cost components for Liberian primary education are the following:

(1) Teacher salaries;
(2) Materials costs;
(3) Facilities and equipment costs;
(4) Administrative and supervisory costs; and
(5) Teacher training costs.

Teacher Salaries: An important benefit claimed for IEL in its original planning documents was that the modularized curriculum approach and related instructional technology would compensate for the inadequacy

of preparation of most primary school teachers. Teachers with less than a high school education are classified in Liberia as "unqualified" and those with a high school education or more, but without formal teacher training, are classified as "underqualified." To the extent that the IEL system allows for the successful use of these teachers, it will have no effect on the salary requirements of dissemination schools.

However, it is important to remember that, because the IEL system requires much more effort and time-on-task than is the expectation (or at least the realized performance) of teachers in other primary schools, the IEL teachers have expressed dissatisfaction with their pay. In dissemination it will be important to test the proposition that new IEL teachers will be willing (or to discover what proportion will be willing) to adapt to the increased work demands of the IEL system without the receipt of additional salary payments. If they are not willing to do so, it may be necessary to require salary supplements or increases. This will become a factor in both the cost-effectiveness and the dissemination costs analysis.

A point underemphasized in much of the earlier project analysis is that an effect of the IEL approach will be not only to compensate for the inadequacy of unqualified or underqualified teachers, but also to complement the skills of Liberia's cadre of truly qualified teachers (who should not be assumed to be identical to those who are certified as "qualified"). The IEL modularized curriculum is designed to work with minimally qualified teachers, but it should work even better where teachers can combine administrative and pedagogical skills to employ the curriculum materials fully. If this supposition is correct, the increased efficiency of qualified teachers is a potential cost-offset within the evaluation of IEL dissemination costs.

Materials Costs: The single most dramatic effect of IEL instruction is the change in the amount and type of instructional materials used in the classroom. For the programmed teaching in Grades One and Two, and the first semester of Grade Three, five main types of

educational materials will be used: PT modules, reading booklets, review booklets, practice booklets, and semester tests. For the programmed learning system used in the second semester of Grade Three and in Grades Four to Six, the IEL materials consist of PL modules, student guides, module test booklets, module test answer keys, block and semester test booklets, and an arts and crafts manual.

While these materials theoretically may be viewed as replacing the use of textbooks, the fact is that, as was stated earlier, very few Liberian primary school students are estimated to have access to textbooks at the present time. The new Liberian-World Bank educational loan includes funds for acquisition and distribution of "economical" textbooks. The issue for the current cost analysis is to establish a base-line cost against which the IEL materials can be contrasted. The approach to be used is to parallel the summative evaluation design in which status quo (SQ) schools are defined as those with no textbooks (and unqualified or underqualified teachers) and optimal control (OC) schools are defined as those in which both qualified teachers and textbooks exist. Thus, a two-level cost comparison will exist between the IEL and SQ schools and the IEL and OC schools. Obviously, there will be an increase in costs from conversion of the SQ schools to the IEL system, but the relative costliness of IEL to OC schools will depend on the costs of IEL materials versus those of the required textbooks. Although final estimates will likely be unavailable by the time the cost-analysis project concludes in June, 1983, it will be important to consider IEL costs versus both current and projected textbook expenses (based on the World Bank reduced textbook cost activity).

Currently, however, most primary schools are closer to the SQ than to the OC end of the spectrum of resource availability. Thus, the policy issue for Liberia is two-fold: whether to increase the use of instructional materials in primary school classrooms and, if they are to be increased, whether the IEL or the low-cost textbook alternative is the most cost-effective. An important consideration in this regard is whether the technology for the production of low-cost textbooks can

be adapted to an even less expensive production of IEL materials than is projected from the present production methods.

Facilities and Equipment Costs: The IEL instructional system has been designed to operate with a minimal requirement for facilities modification or for additional equipment. The present IEL format requires only a lockable room at the school. (This would normally be for the principal's office where IEL materials would be stored when not in use.) The required equipment is for a 4' by 8' classroom blackboard; one group blackboard 2' by 4' for each 3-to-7 students in PT and one for each 4-to-7 students in PL; one lap board 9½" by 12" by 36". This box is designed to include all IEL materials required for a single semester of PT for 60 students or of PL for 70 students. The storage box and its IEL contents are collectively entitled a "semester package."

These equipment requirements will represent an increase in resources for most classrooms. While it is not unusual for schools to have some form of rudimentary blackboards, the requirements for group blackboards and individual lap boards will represent a marginal increase in costs from adoption of the IEL system. Similarly, the storage box is a new piece of equipment for primary schools.

Administrative and Supervisory Costs: An issue which remains to be resolved during the experimental stage of IEL is that of the requirement for administrative and supervisory assistance. These requirements exist at three levels: the classroom, the school, and the school system. At the classroom level, teachers will require some supervision and assistance if they are to implement the IEL instructional program properly. The IEL system is sufficiently complicated, and more importantly, sufficiently different from the traditional instructional system that the role of teacher supervision and assistance may prove crucial. Such activities would be required most intensively in the initial stages of implementation and could later be reduced or phased out depending upon the rate at which teachers adapt successfully to the

new system. The policy question ultimately will be how much supervision is required, if any, and who should provide it? As to the latter, the school principal is one alternative while the Ministry of Education district or regional personnel represent another.

At the school level, an initial constraint on the use of principals as instructional supervisors for teachers will be that the principals, being new to IEL, may themselves require supervision initially to see that the administrative and monitoring tasks required of them under IEL are handled properly. Supervision and assistance to principals should represent shorter and less time-extensive activities of the IEL dissemination system.

Finally, at the system level, there will be a need to supervise the system of materials distribution, teacher training, and related activities which will be an ongoing responsibility of the Ministry of Education as any projected IEL dissemination plan materializes. Both the construction of the dissemination system and its administrative/supervisory design will be a joint responsibility of the IEL project and the Ministry of Education.

For costs purposes, the issue of administration and supervision requirements is complex. If the supervisory personnel of the Ministry of Education were already performing in a highly effective manner (reflecting adequate training for their responsibilities and the availability of resources sufficient to fulfill their responsibilities), then there would be very little marginal cost related to conversion of schools to the IEL system. However, the present status is that both training and resource availability have been insufficient to allow for the full potential of the Liberian system of educational supervision to be realized. In fact, one of the anticipated supplementary benefits of IEL expansion is that it might provide a structure within which the supervisory system will itself be made more cost-effective.

For present purposes, the following compromise is proposed. For the cost-effective analysis, estimates will be made for IEL both

inclusive and exclusive of increased supervisory costs. For dissemination planning purposes, the cost requirements for supervision will be explicitly considered at each of the three levels of system, school, and classroom.

Teacher Training Costs: The implementation plan presently considered would require a three-to-four-week period of intensive teacher and principal training prior to the introduction to the concepts of programmed teaching, programmed instruction, and the use and administration of modularized curriculum materials. The major cost components of any teacher training program are: instructional fees, materials costs, room and board expenses for trainees, and transportation charges.

Currently, two teacher training exercises are being conducted related to the IEL project. The IEL Implementation Staff will offer a Training Workshop in February, 1983 for all principals and teachers of Grades One through Six from the eleven experimental IEL schools and the five IEL system schools. Because the current plan calls for teachers in IEL schools to share responsibilities for both PT and PL instruction, the training program will provide exposure to both systems for every teacher trainee.

A second teacher training activity is planned for the principals and teachers of the OC schools. The rationale for this is the desire to structure the eventual comparison between IEL and OC schools so that the OC schools represent the "best case" of what can be expected from rural schools under the conventional curriculum methodology. The OC teacher training will emphasize content and pedagogy based on the current Ministry of Education curriculum.

Again, the definition of expenses which should be assigned to IEL is problematical. The IEL teacher training expense obviously represents a cost addition compared to the alternative of no change in the present Liberian system. If one structures the comparison as being between IEL with teacher training and OC with teacher training the issue is reduced

to which teacher training format is more expensive (with the major residual differential being the relative effectiveness of the two systems as measured by student performance). For the present, the procedure used shall be to indicate the level of required teacher training costs for each of the three types of schools within the summative evaluation: IEL, SQ, and OC. The final decision as to the proper structure for comparison of the three school types will have to be made by the Ministry of Education based upon their teacher training plans, with or without the wide-scale implementation of IEL.

The IEL cost-effectiveness analysis, to be discussed in Report No. 3 of the cost-analysis project, will include teacher training costs only for IEL schools because 1983 is the first year in which the OC schools will receive in-service teacher training. However, it will be stressed within the cost-effectiveness report that if IEL can be shown to be equally or more effective, while requiring less total pre- and in-service teacher training, then this by itself represents a significant cost offset in favor of the IEL program.

In this section an attempt has been made to explain the rationale for use of a marginal cost approach to the analysis of the IEL program. In addition, the major cost components of the program have been discussed in terms of the structure of the proposed comparisons to be made. In the subsequent section attention will turn to the derivation of actual cost estimates for each of the IEL cost components.

COST ESTIMATES FOR IEL

In this section an attempt will be made, based upon the current design and plans for IEL, to derive cost estimates for implementing the IEL curriculum methodology in non-IEL schools. Because IEL remains in a developmental stage, these cost estimates, while they will represent the best available data, are preliminary estimates only. This is

especially true for concerns such as supervisory costs and teacher training costs where final design issues remain to be resolved. Nevertheless, these estimates can serve two useful purposes.

First, these estimates can be combined with the initial estimates of effectiveness to give a preliminary understanding of how well the IEL system compares with conventional primary schools. As noted elsewhere, both the cost and effectiveness measures are provisional (and neither will be derived without certain assumptions concerning definition and measurement) and should not be expected to measure project "success" or "failure." Rather, the estimates serve as an advance indicator of what the final summative results might be and will help clarify some of the debate over the proper structure of the final summative evaluation.

The second and possibly more important benefit of the cost-analysis exercise is to alert the IEL staff to areas of the IEL project where significant cost problems may occur in the implementation stage. This information will allow for reconsideration of these aspects of the IEL system to assure that internal efficiencies have been maximized and will allow for modification of implementation plans, if and when necessary, to adapt to these cost considerations.

Each of the cost components discussed earlier will be reviewed in turn. Because of the centrality of the materials component of IEL, the greatest emphasis will be on that topic. This section will conclude with a summary of the cost estimates and the inferences which may be drawn from them.

TEACHER SALARIES

The base salary for all primary teachers (regardless of qualifications) is $260 per month. Because of the recent announcement of an austerity reduction of 16½ percent in all government employees' salaries, primary school teachers will now be earning approximately $215 per month.

Although the IEL program is designed to allow for the use of less-qualified teachers, the fact that no pay differential exists by qualification level will mean that no immediate cost saving can be claimed for IEL. However, this would change if the Ministry of Education's "Handbook of Policies and Procedures for Certification of Educational Personnel" (March 1, 1982) were adopted as official government policy. In addition to establishing criteria for certification, this document proposes a revised salary schedule within which a Grade C teacher (high school graduate plus 18 hours of teacher training) would receive $300 per month. As the Grade C certificate holder is the most likely form of qualified primary school teacher, the difference between the $260 per month for an unqualified teacher and the $300 per month for a qualified primary school teacher represents a potential cost saving.

However, the ultimate goal of the Ministry of Education is to upgrade all teachers. This process is severely constrained by the financial and training resources of the country, the scale of the task, and the time by which such a program would have to be instituted. The IEL system allows potentially (if its achievement goals are realized) for the transition to a fully-qualified teaching corps to be accomplished in the long run without requiring a continued short-run sacrifice in student learning.

An additional economizing function of the IEL system is its ability to increase the optimum student-teacher ratio. If the results of the evaluation of the experimental phase of IEL development indicate that PT teachers can indeed work effectively with sixty students and PL teachers with seventy students, this will allow for significantly low teacher costs per student. For example, for a teacher receiving an annual salary of $260 (for an unqualified teacher) or $300 (for a qualified teacher), the monthly per-student costs for a teacher are as follows for different class sizes.

Class Size	Unqualified Teacher	Qualified Teacher
10	$26.00	$30.00
20	13.00	15.00
30	8.67	10.00
40	6.50	7.50
50	5.20	6.00
60	4.33	5.00
70	3.71	4.29

Within the primary schools as they exist today, these savings will not be realized because the introduction of the IEL system of instruction will not, by itself, lead to a change in student-teacher ratios. Over time, however, adjustments can be made in per-student costs because the IEL system will not require the same rate of replacement for teachers lost through attrition and IEL will permit teacher reassignment for the staffing of new primary schools. Given the projections of a continuing increase in the primary school age cohort and of the probability of increasing primary school attendance, the capacity allowed by the IEL system for a higher student-teacher ratio (with the expectation of no sacrifice, and perhaps even a gain, in learning rates) is a major long-term benefit to be derived from wide-scale implementation.

MATERIALS COSTS

Table One represents a summary of the materials requirements for IEL introduction into a primary school. The numbers represent the contents of a "semester package." This package contains adequate supplies for up to 60 PT students and up to 70 PL students. Because of the shift from the PT to PL format in the middle of Grade Three, the first (I) and second (II) semester figures represent a change in both

TABLE ONE

MATERIALS REQUIREMENTS FOR IEL

(PER SEMESTER PACKAGE)

Item	Originals	Copies	Average No. of Pages	Total Pages
Programmed Teaching				
Grade One				
Modules	20	1	80	1,600
Review Booklets	4	15	74	4,440
Practice Booklets	14	5	20	1,400
Semester Test	1	1	5	5
Grade Two				
Modules	20	1	80	1,600
Reading Booklets	1	15	40	600
Review Booklets	4	15	74	4,440
Practice Booklets	14	5	20	1,400
Semester Test	1	1	5	5
Grade Three (I)				
Modules	20	1	80	1,600
Reading Booklets	1	15	80	1,200
Review Booklets	4	15	74	4,440
Practice Booklets	14	5	20	1,400
Semester Test	1	1	5	5
Programmed Learning				
Grade Three (III)				
Modules	50	7	24	8,400
Student Guides	1	10	2	20
Test Booklets	10	7	12	840
Test Answer Keys	1	1	48	48
Block & Semester Tests	1	1	78	78
Grades Four, Five and Six (per grade)				
Modules	60	7	24	10,080
Student Guides	1	10	2	20
Test Booklets	10	7	12	840
Test Answer Keys	1	1	48	48
Block & Semester Tests	1	1	78	78
Arts & Crafts Manual	1	1	100	100

quantity and type of materials used. Grades Four, Five, and Six use the same number of modules, etc. each semester so the numbers for these grades are presented collectively.

The following presents a brief definition of each type of instructional material used in the IEL system:

(1) PT module - used solely by the teacher for instruction.

(2) PL module - used by students for peer group and home study.

(3) Reading booklets - cover all subjects; are used only during some PT direct instruction lessons.

(4) Practice booklets - used by small groups (3-to-7 students) following direct instruction.

(5) PT semester test booklet - used solely by the teacher; includes instructions and scoring key.

(6) Student guides - provides instruction for students in appropriate behaviors for studying in peer groups.

(7) Module test booklet - used daily to test students on content of previous day's module lesson.

(8) Module test answer keys - for use by the teacher.

(9) PL block and semester test booklet - similar to PT semester test booklet, but includes test for block periods (first two six-week periods in each semester).

(10) Arts and crafts manual - used by teacher as basis for direct instruction of students.

The term "originals" in Table One refers to the number of separate and individual items of each type. For example, in Grade One, there are twenty separate modules on different topics. The term "copies" refers to how many duplicates of each original are required for a semester package.

The number of copies varies depending upon the manner in which a particular type of material is used. PT modules are used only by the teacher and so only one copy of each is used. Review booklets are used by students in direct instruction groups (ideally not exceeding fifteen

students per group). Thus fifteen copies are required to assure each child an individual booklet.

Obviously, the most dramatic characteristic is the number of original documents required. These vary from thirty-nine per semester in Grade One to seventy-four per semester in Grades Four, Five, and Six. The total number of originals required for all grades is 705 and, taking into account the multiple copies required of certain items, the total materials set exceeds 4,000 individual pieces of instructional material. These numbers have two important implications. First, they point to the need for improved classroom administration; this point has been carefully studied by the IEL staff and has led to consolidation of materials and to the formulation of the semester package concept. Second, these numbers are indicative of one of the important limitations on the exploitation of major economies of scale in printing. Since it normally requires a press run of 10,000 to 20,000 copies to achieve substantial savings from the printing process, the large number of originals but relatively small quantities of copies required for IEL work counter to the normal economies of scale that exist for traditional instructional materials (such as textbooks, for example). This issue will be dealt with in more detail in Report No. 2.

Table One concludes with a calculation of the total number of pages required in a semester package for each item of instructional material. These amounts are summarized in Table Two, which presents an initial estimate of the cost of production of a semester package for each grade level, with a separate estimate for two semesters of Grade Three.

TABLE TWO

INITIAL MATERIALS COSTS FOR IEL DISSEMINATION

Grade Level	Total Pages in Semester Package	Number of Semesters	Subtotal	Cost per Page	Total
Grade One	7,445	2	14,890	$.03	$ 446.70
Grade Two	8,045	2	16,090	.03	482.70
Grade Three (I)	8,645	1	8,645	.03	259.35
Grade Three (II)	9,386	1	9,386	.03	281.58
Grades Four, Five, and Six	11,166	6	66,996	.03	2,009.88
Total	44,687		116,007		$3,480.21

Using the IEL estimate of $.03* per page as the total cost of paper, reproduction, and binding, the last column of Table Two presents the total cost of IEL materials for the grade levels as presented. The cost increases from $446.70 for a semester package for Grade One to $669.96 for each of Grades Four to Six. The total initial cost of providing a set of semester packages (one semester package per semester per grade) to an elementary school is $3,480.21.

Two major considerations must be introduced before this last figure can be compared meaningfully to the textbook alternative currently available in Liberia. The annual recurrent cost of IEL materials will depend upon the number of years a set of original materials may be used and on the number of students served by each set. Table Three presents two estimates for the annual costs of IEL materials based upon two sets of assumptions concerning the rate of replacement of IEL materials.

*The appropriate rate to be charged for IEL production will be analyzed in detail in Report No. 2.

TABLE THREE

ANNUAL COST OF IEL MATERIALS

Item	Total Pages	Original Cost	IEL Estimate Expected Life	IEL Estimate Annual Cost	Conservative Est. Expected Life	Conservative Est. Annual Cost
GRADE ONE						
Modules	3,200	$ 96.00	2	$ 48.00	2*	$ 52.80
Other Mat.	11,690	350.70	5	70.14	4	87.68
Total	14,890	446.70		118.14		140.48
GRADE TWO						
Modules	3,200	96.00	2	48.00	2*	52.80
Other Mat.	12,890	368.70	5	77.34	4	96.68
Total	16,090	482.70		125.34		149.24
GRADE THREE (I)						
Modules	1,600	48.00	2	24.00	2*	26.40
Other Mat.	7,045	211.35	5	42.27	4	52.84
Total	8,645	259.35		66.27		79.24
GRADE THREE (II)						
All Materials	9,386	281.58	5	56.32	4	70.40
GRADE FOUR						
All Materials	22,332	669.96	5	133.99	4	167.49
GRADE FIVE						
All Materials	22,332	669.96	5	133.99	4	167.49
GRADE SIX						
All	22,332	669.96	5	133.99	4	167.49
GRAND TOTAL	166,007	$3,480.21		$768.04		$942.07

Based upon an examination of the frequency of use, the quality of materials*, and the probability of loss, the IEL project team has estimated a life of five years for all materials except PT modules, which are expected to need replacement every two years. Because of the nature of materials maintenance in rural schools and the initial familiarity of students and teachers with such materials, the five-year estimate may be unduly optimistic. This is especially the case for items such as PT review booklets which leave the classroom and are thus subject to less control and a higher incidence of loss.

To examine the significance of the assumption about material life, a more conservative set of figures is also used in Table Three to test the sensitivity of the dollar estimates to a variation in realized length of material use from that anticipated by the IEL staff. The replacement rate for PT modules has been increased by ten percent from the original assumed life of two years (the revised estimate is indicated in the table as "2*"). The assumed life of materials has been reduced from five to four years.

The annual cost estimates vary from $118.14 for Grade One to $133.99 for each of Grades Four to Six for the IEL assumptions and from $140.48 to $167.49 for the alternative assumptions. The total annual cost of using IEL materials in a primary school with one class at each grade would be $768.04 for the IEL estimate and $942.07 for the alternative estimate.

As noted earlier, the IEL system is designed to operate with a class size of sixty students for PT and seventy for PL. Because of the requirements for individual and group use, the semester packages represent the minimum level of materials for any class size up to these optimal sizes. While sizes slightly in excess of sixty for PT or seventy for PL can be accommodated, the rigidity of the material requirements leads to a "step-function" in terms of the average cost (cost per student) of IEL materials. This means that a two-semester package for Grade One purchased at the IEL annual cost figure of $118.14 would

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*All IEL materials are to be of 20-lb. paper with cardstock covers and are stapled.

decline in average cost up to the sixtieth student and would then suddenly increase again as a second full set is required. Table Four presents the average cost figures per grade level for different quantities of students in a hypothetical school.

The lowest average cost figures occur at multiples of sixty for PT and of seventy for PL classes. It is important to remember, therefore, that these amounts are the minimum, not the average or anticipated values of per-student costs. As schools increase in size with multiple classrooms of IEL instruction, the per-student cost will rise with the addition of each new semester package, but then begin to decline again until a new multiple of the optimum class size is reached.

In economic terminology, there are positive scale effects (reductions in average cost as number of students increases) for the use of a single semester package. There are negative scale effects for introduction of an additional semester package and then a re-establishment of positive scale effects until the multiple of the optimum size is reached once again. The relevance of this is in the consideration of the probable class size of the schools to which IEL will be disseminated. The reality of the Liberian primary school system is that there is a great variation in class size with enrollments in the upper primary grades often being well below the IEL optimum. This will be the case especially in the rural primary schools which are the focus of the IEL project. While it may be possible to take advantage of the positive scale effects at the first- or second-grade level, the rate of attrition is such that the smallest class sizes are always at the higher grades.

School consolidation is not an alternative except in the cities and larger towns, and even there the expense and availability of transportation often represents a prohibitive restraint on this alternative. Multi-grade teaching, while a means of lowering average teacher costs, has no effect on average materials cost. In fact, the conditions which force multi-level teaching in the present system (small numbers of students at each grade level) will represent the source of a significant cost-increasing effect for average material expense.

TABLE FOUR

PER STUDENT COSTS OF IEL MATERIALS

by Grade and by Class Size

Grade Level	Annual Cost*	Number of Students										
		20	40	60	70	80	100	120	140	160	180	200
GRADE ONE	$118.14	$5.91	$2.95	$1.97	$----	$2.95	$2.36	$1.97	$2.53	$2.22	$1.97	$----
GRADE TWO	125.34	6.27	3.13	2.09	----	3.13	2.51	2.09	2.69	2.35	2.09	----
GRADE THREE (I)	66.27	3.31	1.66	1.10	----	1.67	1.33	1.10	1.42	1.24	1.10	----
GRADE THREE (II)	56.32	2.80	1.41	.94	.80	1.41	1.13	.94	.80	1.06	.94	.80
GRADE FOUR	133.99	6.70	3.35	2.23	1.91	3.35	2.68	2.23	1.91	2.51	2.23	1.91
GRADE FIVE	133.99	6.70	3.35	2.23	1.91	3.35	2.68	2.23	1.91	2.51	2.23	1.91
GRADE SIX	133.99	6.70	3.35	2.23	1.91	3.35	2.68	2.23	1.91	2.51	2.23	1.91

*Annual cost of pair of semester packages required for one year except for Grade Three where each semester package is considered separately.

This topic will be discussed again in the cost-effectiveness analysis and in the cost formulation for the dissemination planning. The topic of immediate importance is an estimate of the comparable costs of textbook materials. In a report prepared in March, 1981, Mr. Mark S. Carroll provided the following estimate of per-student textbook costs by grade:

Grade One	$28.15
Grade Two	32.65
Grade Three	32.20
Grade Four	28.25
Grade Five	34.95
Grade Six	27.05

These figures are based upon the provision of the Ministry of Education recommended textbooks at each level (there are seven of these for each of Grades One to Three and five for each of Grades Four to Six). The costs are based on the retail prices at the Government Bookstore.

The Fourth Education Project materials component has as its goal the achievement of significant reductions in textbook cost. Originally, there were plans to do this through increased printing of materials in Liberia, but the thrust of the materials project has shifted toward capturing the economies of scale available from bulk purchases of textbooks. In Table Five, a comparison has been made, by grade level, of the per-student costs at class sizes of twenty, forty, and sixty students of IEL materials, textbooks at current prices (A), textbooks at the reduced price (fifty percent of current charges) which is the goal of the educational materials project (B), and reduced priced textbooks used on a shared basis of one textbook to every two children (C).

The numbers in Table Five indicate the dramatic effect which class sizes have on the relative costs of the different types of instructional

material. It is obvious that the alternative of a traditionally priced textbook for every child is by far the most expensive; this is true for any class size above twenty. For smaller classes (those with 10-12 students or less), the textbook alternative "A" may have some comparative advantage. However, both of the other textbook alternatives presented in Table Five are less expensive than is the IEL curriculum for the class sizes up to approximately twenty-five to thirty students. Beyond that size only the reduced-cost textbooks shared by students remains less expensive. Finally, at the sixty to seventy class size, the IEL alternative becomes less expensive than any of the three versions of the textbook alternative.

In reviewing Table Five it should be remembered that, while the textbook costs are subject to little variability except among the three alternatives, the IEL figures used are highly sensitive to the earlier assumptions concerning marginal production costs and materials life. If marginal printing costs should vary from 3 cents a page or the replacement rate from the two- and five-year cycles estimated by IEL staff, the costs of IEL materials could vary considerably. One task for the IEL project over the implementation planning period is to verify or, if necessary, refine these estimates so that they may be used with greater confidence.

The discussion to this point has dealt largely with an abstract analysis of IEL comparative costs. There is a need now to consider IEL implementation and its effect on costs in terms of the realities of the Liberian primary education system.

Primary school enrollment in 1983 is expected to total 105,265 of which an estimated 70,528 will be in government schools. There will be approximately 2,275 primary school teachers in these government primary schools, assuming a maintenance of the 31:1 student-teacher ratio which has prevailed in recent years. Historically, statistics have indicated that only 31 percent of <u>all</u> Liberian teachers are qualified; however, the qualified teachers tend to be concentrated in

TABLE FIVE

RELATIVE PER-STUDENT COSTS OF INSTRUCTIONAL MATERIALS

IEL versus Textbook Requirements
by Grade Level and Class Size

Grade Level Instructional Material	Number of Students in Class 20	40	60
GRADE ONE			
IEL	$ 5.91	$ 2.95	$ 1.97
Textbook (A)	9.38	9.38	9.38
Textbook (B)	4.69	4.69	4.69
Textbook (C)	2.35	2.35	2.35
GRADE TWO			
IEL	6.27	3.13	2.09
Textbook (A)	10.88	10.88	10.88
Textbook (B)	5.44	5.44	5.44
Textbook (C)	2.72	2.72	2.72
GRADE THREE			
IEL	6.11	3.07	2.04
Textbook (A)	10.73	10.73	10.73
Textbook (B)	5.37	5.37	5.37
Textbook (C)	2.68	2.68	2.68
GRADE FOUR			
IEL	6.70	3.35	2.23
Textbook (A)	9.42	9.42	9.42
Textbook (B)	4.71	4.71	4.71
Textbook (C)	2.36	2.36	2.36
GRADE FIVE			
IEL	6.70	3.35	2.23
Textbook (A)	11.65	11.65	11.65
Textbook (B)	5.83	5.83	5.83
Textbook (C)	2.91	2.91	2.91
GRADE SIX			
IEL	6.70	3.35	2.23
Textbook (A)	9.02	9.02	9.02
Textbook (B)	4.51	4.51	4.51
Textbook (C)	2.26	2.26	2.26

the high school programs so that current estimates of the percent of unqualified teachers at the primary level are as high as 80 to 85 percent.

The most detailed data on the Liberian educational system comes from the National Education Survey of 1978. The stability of the Liberian educational structure in recent years allows use of certain proportions from these data with a degree of confidence. Of importance to the IEL context is the fact that the 748 government elementary schools in the survey reported a total enrollment of 85,475 students for an average enrollment per school of 114 students. Since all but a small number of these schools had a full six-year cycle of primary classes, this indicates an estimated average class size only slightly in excess of 19 students. This is well below the class sizes which the earlier discussion revealed to be optimal for IEL materials use. When one considers the fact that these figures include the bimodal national pattern of large primary schools in urban areas and extremely small primary schools in rural areas, the issue of the fit of the IEL cost pattern to the reality of school and class size becomes even more important.

In Bong County, the initial site of the IEL experiment, the survey reveals even more useful information concerning the pattern of class sizes to which IEL will have to be adapted. Table Six depicts the distribution of class sizes by grade for the 42 government elementary schools in Bong County (four of the schools had no Grade Six class but all others reported data for all six grades of the elementary school cycle).

The data in Table Six present a very dramatic picture of the rate of attrition in the Liberian primary school system accentuated by the higher rates characteristic of a more rural county such as Bong. There is a dramatic decline between the size distribution of first- and second-year classes and a continuing significant decline from grade to grade thereafter. The 1978 survey data's continued relevance is supported

by the 1982 educational statistics for the national enrollment pattern in government schools:

Grade One	29,067
Grade Two	21,144
Grade Three	17,710
Grade Four	14,383
Grade Five	12,060
Grade Six	9,865

Accepting a class size of sixty as the optimum for both PT and PL and ignoring the Grade One classes which exceed this, 81 percent of all Grade One classes shown in Table Six are below this optimum size. For Grade Two the proportion below the optimum reaches 93 percent and all classes of all other grades are smaller than the IEL optimum level. Remembering that a class size of thirty students represented an important transition point for the IEL materials-textbook comparison presented earlier, it is useful to see the proportions of classes which fall above and below that threshold.

For Bong County, forty percent or more of the Grade One and Grade Two classes are above this minimum size. However, from Grade Three onward, the distribution shifts significantly toward more small classes as indicated by the average class sizes of 22.4, 19.0, 15.6, and 15.1. The conclusion which must be drawn is that, at least for a rural county such as Bong, the IEL scale effects will not be realized in most classrooms and will have a marked cost advantage only in the earliest grades. Such a situation has very important implications for the analysis of IEL cost-effectiveness by grade level and should also be a factor in planning the dissemination. An example of the latter implication is that the priority for dissemination of IEL materials, in a case where only partial dissemination is affordable or where a phased dissemination is preferred, would be to start in those grades where the greatest cost

TABLE SIX

DISTRIBUTION OF CLASS SIZES, BY GRADE

BONG COUNTY, 1979

Grade Level	0-10	11-20	21-30	31-40	41-50	51-60	61-75	76-100	101-125	125+	Average Enroll-ment	% of Classes Below 60 Stud.	% of Classes Below 30 Stud.
GRADE ONE (42)	0	7	9	8	5	5	2	3	2	1	44.7	81	36
GRADE TWO (42)	5	16	4	8	6	-	3	-	-	-	26.8	83	60
GRADE THREE (42)	9	12	8	7	6	-	-	-	-	-	22.4	100	69
GRADE FOUR (42)	15	11	7	6	2	1	-	-	-	-	19.0	100	79
GRADE FIVE (42)	17	13	7	3	2	-	-	-	-	-	15.6	100	8
GRADE SIX (38)	17	12	5	3	1	-	-	-	-	-	15.1	100	8

advantages exist for IEL materials. An analysis, similar to that done here for Bong County, should be done for each of the counties of Liberia as well as a separate one for the Monrovia Consolidated School System.

To what extent do these figures relate to the ultimate benefits of extending IEL to conventional primary schools? This question cannot be answered definitively based on the above data because the benefits of IEL have never been stated as primarily of a cost-saving nature. Although such cost-savings may exist (for optimal size classes and from long-run readjustments in the student-teacher ratio), the major cost-offsets are of two types: learning enhancement and improved efficiency in the use of existing resources.

The improved achievement of children under IEL instruction, as anticipated by the IEL project, would represent a major increase in the effective use of the resources already being invested in primary education. A second effect of IEL could be a better utilization of staff and facilities at secondary schools as better prepared students graduate from primary school programs.* Finally, it should be recognized that the IEL program, if successful, will create enrollment patterns in the future which are more complementary to the comparative cost advantages of IEL materials. For example, improved learning in earlier grades should increase retention and reduce grade repetition with the result that class sizes at the higher grades will increase and thus approximate more closely the optimal class sizes where IEL materials costs compare most favorably with those of the textbook alternatives.

A final issue is the aggregate cost of IEL materials for initial distribution and in annual recurrent costs. Using the Bong County data as approximations of a national average, it is possible to estimate the

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*A possible negative effect could occur if IEL or any other improvement in primary education should accelerate social demand for secondary education beyond the level which the government can afford and what the demand of the labor market can justify.

cost of IEL materials distribution to all government elementary schools based upon the 1982 enrollment statistics. This is an extremely conservative assumption of the national distribution pattern, but helps offset the possibly optimistic assumptions made earlier about marginal printing costs and material life, as well as the effect of the skewness of the enrollment pattern toward smaller class sizes. Table Seven presents the results of these calculations.

A cost per student of IEL materials is derived from the cost data originally presented in Table Three, divided by the average class sizes given in Table Six. The result is multiplied by the total enrollment at each grade level to give a total IEL materials cost for each grade level. The sum of these amounts for original publication cost and for annual recurrent cost (under the IEL assumptions of material life) are $2,561,500 and $565,063 respectively. These are marginal costs only. They do not include the cost of any distribution expense and they are exclusive of any on-going revision/adaption work in terms of the materials' subject matter.

Similar calculations can be made for the annual recurrent costs of the three textbook options discussed earlier. The figures, as shown in Table Eight, are $1,057,838, $528,919, and $264,460. The most important implication to be drawn from Table Eight is, however, the pattern of relative advantage for the IEL material. Using the data as adjusted for the realities of the class size distribution and the current enrollment levels, the IEL materials are seen to have an advantage at earlier grades, but to lose their comparative advantage (especially relative to the low-cost textbook/multi-use alternatives) at the higher grades.

Another reality of the Liberian context which has not been discussed adequately to this point is the absorptive capacity of the Ministry of Education for any new recurrent costs. Both the textbook and IEL alternatives represent an increase from a current base of materials cost which is close to zero in many schools. The recent USAID/Government

TABLE SEVEN

IEL MATERIALS COST, ORIGINAL AND ANNUAL RECURRENT

Adjusted for Class Size and Total Enrollments, 1982

Grade Level	1 Original Cost	2 Average Class Size	3 Original Cost per Student (1 ÷ 2)	4 Enrollment	5 Total Original Cost (3 x 4)	6 Annual Cost	7 Annual Cost per Student (6 ÷ 2)	8 Total Annual Cost (7 x 4)
GRADE ONE	$446.70	44.7	$ 9.99	29,067	$ 290,379	$118.14	$2.64	$ 76,737
GRADE TWO	482.70	26.8	18.00	21,144	380,592	125.34	4.68	98,954
GRADE THREE (I)	259.35	22.4	24.15	17,710	427,697	66.27	5.47	96,874
GRADE THREE (II)	281.58					56.32		
GRADE FOUR	669.96	19.0	35.26	14,388	507,145	133.99	7.05	101,400
GRADE FIVE	669.96	15.6	42.95	12,060	517,971	133.99	8.59	103,595
GRADE SIX	669.96	15.1	44.37	9,865	437,710	133.99	8.87	87,503
TOTAL					$2,561,500			$565,063

TABLE EIGHT

IEL VERSUS TEXTBOOK MATERIAL COSTS, BY GRADE LEVEL

Adjusted for Class Size and Total Enrollments, 1982

Grade Level	Original Cost*				Recurrent Cost*			
	Total IEL	TEXTBOOK "A"	TEXTBOOK "B"	TEXTBOOK "C"	Annual IEL	TEXTBOOK "A"	TEXTBOOK "B"	TEXTBOOK "C"
GRADE ONE	$ 290,379	$ 818,236	$ 409,118	$204,559	$ 76,737	$ 272,745	$136,373	$ 68,186
GRADE TWO	380,592	690,352	345,176	172,588	98,954	230,117	115,059	57,529
GRADE THREE	427,697	570,262	285,131	142,566	96,874	190,087	95,044	47,522
GRADE FOUR	507,145	406,320	203,160	101,580	101,400	135,440	67,720	33,860
GRADE FIVE	517,977	421,497	210,749	105,374	103,595	140,499	70,250	35,123
GRADE SIX	437,710	266,848	133,424	66,712	87,503	88,949	44,475	22,237
TOTAL	$2,561,500	$3,173,515	$1,586,758	$793,379	$565,063	$1,057,838	$528,919	$264,460

NOTE: Textbook Alternatives "A" - Current Ministry of Education Bookstore prices.
"B" - Half-price textbook goal of World Bank Loan project.
"C" - "B" with added assumption of one book for every two students.

*Sums may not equal totals because of rounding.

of Liberia educational sector assessment stressed the need for extreme caution in terms of assumptions concerning Liberian capacity to absorb incremental project costs. The Fourth Education Project educational materials component will be testing the idea of parentally-financed textbooks during the next year. Whether such marketing of educational materials will work remains to be seen, but it is an attractive alternative and is being considered for IEL as well. However, the IEL system imposes an additional marketing disadvantage in that parents, rather than buying a book, will be asked to pay an instructional materials fee because of the multi-year use of materials. School fees are an extremely sensitive issue in Liberia and the initial introduction of the materials fee undoubtedly will face some "consumer resistance."

As has been indicated throughout this section, the materials cost component of IEL, while not representing the sole impact of IEL on educational costs, is certainly the major issue in considering its potential cost effectiveness. The data presented here have indicated that the IEL system is designed to minimize per-student costs at fairly large class sizes. Because class sizes in Liberian primary schools tend to approximate these optimal dimensions only at the lower grades, the cost-advantage of IEL materials declines as the grade level increases. While these initial results are provisional and will be expanded upon in future reports, three key questions can be identified. First, will the cost of materials - IEL materials or textbooks - be sufficiently effective in terms of student learning to justify their costs? Second, even if effective, should IEL be disseminated only (or at first) to those schools and/or grade levels where an obvious cost advantage exists? And third, can the IEL system be restructured to allow for greater cost flexibility (without an offsetting decline in learning effectiveness) so that in those schools and/or classes where total enrollment is low, the IEL system can still be instituted in a comparatively inexpensive manner?

FACILITIES AND EQUIPMENT COSTS

As noted earlier, the only facilities and equipment items which will represent a marginal cost of the IEL program over the conventional primary system of instruction are the "semester package" box, the group blackboard, and the individual lap boards. The expenses for a lockable room and for the class blackboard are not assigned to IEL under the assumption that these or equivalent facilities already exist in most schools. The unit costs of these items are $26.50 for the "semester package" box (based on a contract with the LOIC for an initial order of 250); $3.44 for the group blackboard at current prices; and $.20 per lap board (based on 40 lap boards cut from a $7.50 plank plus an additional charge for labor and equipment).

To estimate the quantity required one must consider the ratios of item use to student numbers. The "semester package" box is used at a rate of one per class per semester for any student number between 1 and 60 or 70 (depending on PT or PL level). One group blackboard is used in each PT and PL class for at most every 7 students. One lap board is required for each student in each class. Using the Bong County distribution of class size once again, the following quantities may be derived as the required number of each item at each grade in an average school:

Grade	"Semester Package" Boxes	Group Blackboards	Lap Boards
One	2	7	45
Two	2	4	27
Three	2	4	23
Four	2	3	19
Five	2	3	16
Six	2	3	15

Multiplying the quantities of each item by its original cost gives the following distribution of costs by grade level:

Grade	"Semester Package" Boxes	Group Blackboards	Lap Boards	Total
One	$ 53.00	$24.08	$ 9.00	$ 86.08
Two	53.00	13.76	5.40	72.16
Three	53.00	13.76	4.60	71.36
Four	53.00	10.32	3.80	67.12
Five	53.00	10.32	3.20	66.52
Six	53.00	10.32	3.00	66.32
Total	$318.00	$82.56	$29.00	$429.56

Assuming a five-year life for these items and using the earlier enrollment figures for the calculation of a per-student cost for each grade, the following original and annual recurrent cost of these materials can be derived:

Grade	Original Cost Per Student	Annual Recurrent Cost Per Student	Total Original Cost	Total Recurrent Annual Costs
One	$1.93	.39	$ 56,099	$11,220
Two	2.69	.54	56,877	11,375
Three	3.19	.64	56,495	11,299
Four	3.53	.71	50,772	10,154
Five	4.26	.85	51,376	10,275
Six	4.39	.88	43,307	8,661
Total			$314,926	$62,984