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# THE RELATIVE COST-EFFECTIVENESS OF THE LIBERIAN "IMPROVED EFFICIENCY OF LEARNING" (IEL) PROJECT

Report No. 3 of the

IEL Cost Analysis Project


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## Introduction

This analysis of the Increased Efficiency of Learning (IEL) Project will be based on the data and discussion presented in three earlier reports as well as on additional information collected specifically for this report. The cost data used here are from the first two reports of the IEL Cost Analysis Project: "Cost Issues in the Liberian IEL Project" and "Internal Economies in the Liberian IEL Project." The effectiveness data is derived from the Klaus Galda report "Improved Efficiency of Learning, Liberia: 1982 Achievement Test Results." The reader is referred to these original sources whenever questions of definition and means of calculation arise in regard to either cost or achievement data.

The ultimate measure of any project's or program's success is found in the comparison of costs and effects. Costs and effects are found in three forms: (1) those costs and effects that exist naturally in monetary measures (such as revenues and cash outlays); (2) those costs and effects that exist in a form which can be converted to a monetary equivalent (such as the use of existing land and equipment or the enhancement of one's employability through receipt of an educational degree); and (3) those costs and effects which cannot be transformed into monetary value in any collective manner

(subjective or psychic happiness or unhappiness).

In the first form, the comparison of costs and effectiveness is quite easy since the two measures are both in terms of the same numeraire, that is, the same unit of measurement (in this case, money). Where costs and effects both exist in monetary form a simple rate of return or present value of benefit/cost calculation will yield a statistic which will identify the project or program's success or failure.

The second form of costs and effects also allows for the use of the traditional models of investment anlaysis. However, in this case debate may exist over the proper values for transforming non-monetary effects (i.e., number of graduates) into monetary effects (i.e., increases in expected future national or personal income).

It is with the third form of costs and effects that the greatest difficulty arises in regard to interpretation of project or program success. It is impossible to create a simple summary statistic when the costs and effects are in dissimilar units of measurement. This "apples and oranges" dilemma is not resolved if, as in the case of the IEL project, costs remain in a monetary form while effects are measured in terms of an achievement test score.

The standard solution to this problem is to study a set of alternative projects or programs and to create a cost-effectiveness ratio. This is done by holding costs constant and identifying the alternative which shows the greatest effectiveness or by standardizing effectiveness and identifying the alternative with the lowest cost. This procedure requires similarity of costs among the alternatives and similarity of effects among the alternatives, but not that costs and effects be measured in the same way.

To appreciate why this approach to cost-effectiveness cannot be used in

the IEL evaluation, it is necessary to review the basic design of the evaluation structure. Three types of schools were identified for comparison and five schools of each type existed at the time of the 1982 evaluation. The first type of school included those which were identified as using the IEL programmed teaching (PT) materials for Grades One, Two, and the first half of Grade Three and the programmed learning (PL) materials in the remainder of Grade Three and Grade Four. The IEL system is being extended to the full six years of elementary school, but at the time of the evaluation the fifth and sixth grade materials were still undergoing development. The IEL schools also benefited from special systems of teacher training and supervision.

The second type of school selected was the status quo (SQ) school which is supposed to represent the "typical" non-metropolitan Liberian elementary school. No special teacher training or supervision was provided to these schools other than the administration of practice tests to familiarize the students with the type of test (but not content) to be used as the achievement examination.

The evaluation design, recognizing that the funds expended on IEL could be used for enrichment of the traditional teacher-oriented curriculum, suggested that a third type of school, the optimum conventional (OC) school, be included. These schools were to receive a full set of regular textbooks and teacher training and supervision equivalent to that provided to the IEL schools. Thus, the final design would allow for the use of SQ schools as a base line (untrained teachers, no or few textbooks, and no supervision) against which the alternatives of the IEL curricular strategy and of the OC enriched (training, textbooks, and supervision) traditional curricular

strategy could be compared.

Unfortunately, both for students and researchers, the OC schools did not receive the improvements they were supposed to receive. At the time of the 1982 evaluation, the only characteristic that distinguished the OC from the SQ schools was that the OC teachers had received a three-week training course in 1981.

From this description of the evaluation design, it may be seen that no ex post standardization of costs or effects can be achieved. One cannot compare $1 worth of IEL schooling with $1 worth of OC or SQ schooling or compare the cost of one percentage point of achievement of IEL with the cost of one percentage point of achievement of OC and SQ. What one can do is to compare cost differences with achievement differences. One might find, for example, that the IEL school costs more but also promotes greater achievement. (Note: if an alternative costs more and achieves less it is obviously an inferior choice and if it costs less and achieves more it is obviously a superior choice.) Where both costs and achievement are greater, the ultimate judgement involves a decision based on what is called cost-utility analysis. Someone - researcher, policymaker, or whoever - must decide, based on their own utility values of costs and achievement, whether the additional costs are justified by the additional achievement. Since it has been shown that the IEL project is not less expensive in most forms and scales of operation than the OC textbook alternative (and never less expensive than the SQ alternative), the only justification for IEL must be in terms of superior performance.

Before proceeding to the data analysis, a point should be made concerning the definition of achievement in this evaluation. Any educational program

can be expected to have effects in terms of cognitive achievement, attitudinal change, and student behavioral adaptation. Only the first of these three effects have been measured in this evaluation and the reader should bear in mind that the "effects" discussed here are not exhaustive of the potential effects of the three school types. Also, the cognitive achievement results themselves are analyzable only in terms of two dimensions, differences in mean test scores and differences in the variation within the full distribution of test scores. The standard deviation measure will be used as a proxy for a learning "equality" standard while the difference in mean test scores among the three school type populations will be used as a learning "gain" standard.

## COST AND ACHIEVEMENT DATA

Table One presents the data on annual cost of IEL materials. These costs are based on the expense of producing a full year's package of modules and support materials. The "IEL" and "Conservative" estimates differ solely in terms of the expected life of the materials as they are used in the classroom. The figure 2* which appears under expected life for the PT modules in Grades One, Two, and Three denotes a ten percent increase in wastage over that assumed in the IEL estimate. All later analysis will be based on the IEL estimate and thus one must remember that actual cost-in-use may be higher than the figures presented indicate.

Report No. 1 of the IEL Cost Analysis Project identified several problems in the adaptation of the IEL curricular technology to the Liberian elementary school system. One of these problems was the quantity of materials used and the burden this factor imposed on the management skills of the untrained teachers. A second problem identified was the requirement for ex-

TABLE ONE

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 |

Source: Report No 1 - "Cost Issues in the Liberian IEL Project".

tensive supervision of teachers during the IEL process, The third problem, and the most critical, was the rigidity of IEL packaging of materials such that small classes of six to ten required the same quantity of materials as large classes of fifty to sixty students.

The reason for the severity of this problem is that, once beyond Grade One, the size of classes in most Liberian schools decreases dramatically and the Grade Five and Six classes often do not exceed ten or fifteen students. The result is that the per-student costs of IEL are greatest for exactly those size classes most common in the Liberian system. Textbook costs, on the other hand, are fixed per-student regardless of the number of students in a class. This makes textbook use more adaptable in terms of cost to small size classes.

Table Two indicates the present estimate of relative IEL materials and textbook costs by grade level and class size. The textbook costs are based upon the Mark Carroll report of March, 1981, on expenses required to supply a full set of texts for an individual student at each grade level and assume a three year textbook life. His estimates were:

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

The prices used are those for retail purchase at the Government Bookstore in Monrovia. The three alternative estimates used in Table Two are based on the following assumptions:

Textbook (A) - assumes current costs of textbooks and one textbook for each child;

Textbook (B) - assumes reduced price (50%) of textbooks (from the IBRD Fourth Education Project materials component) and one textbook for each child;

TABLE TWO

RELATIVE PER-STUDENT COSTS OF INSTRUCTIONAL MATERIALS

IEL versus Textbook Requirements
by Grade Level and Class Size

| Grade Level<br>Instructional Material | Number of Students in Class<br>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 |

Textbook (C) - identical to Textbook (B), but assumes students share books at rate of one textbook for every two children.

As indicated in Table Two, the IEL materials are always less expensive than the traditionally-priced textbooks and are less expensive than the reduced price textbooks at the middle-to-larger class sizes. Only in the vary largest classes, however, would the IEL materials be less expensive than the Textbook (C) alternative.

Table Three represents an update of the Table Two data. In Report No. 2 of the IEL Cost Analysis Project an attempt was made to derive alternative packaging arrangements of IEL materials so as to create greater flexibility of materials requirements to size of class. The "IEL Alternative" row in Table Three reflects the reduced costs at lower class sizes which repackaging allows. The IEL Alternative is much more economical at the lower class sizes than is the original IEL package and greatly enhances cost comparability between IEL and the textbook-based systems.

In the analysis which follows, only the materials component of IEL will be used as the measure of current cost differences between IEL and the OC and SQ schools. The justification for this is that the other costs associated with IEL - teacher training, equipment, and supervision - represent investments in the dissemination of IEL rather than in its ongoing day-to-day operation. These dissemination costs are of legitimate concern in terms of the decision to disseminate IEL or not, but are not appropriate costs to include in the evaluation of relative cost-effectiveness of the curricular technology. Report No. 4 of the IEL Cost Analysis Project will analyze the dissemination costs of IEL in terms both of their effect on the fiscal absorptive capacity of the Ministry of Education and their sensitivity to various proposed means of phasing in the IEL system.

TABLE THREE
RELATIVE ANNUAL PER-STUDENT COSTS OF INSTRUCTIONAL MATERIALS
IEL VERSUS TEXTBOOK REQUIREMENTS
(BY GRADE LEVEL AND CLASS SIZE)

| Grade Level and Instructional Material Alternative | Number of Students in Class | | |
|---|---|---|---|
| | 20 | 40 | 60 |
| GRADE ONE | | | |
| IEL - Original | $ 5.91 | $ 2.95 | $ 1.97* |
| IEL - Alternative | 4.13 | 2.51 | 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 - Original | 6.27 | 3.13 | 2.09* |
| IEL - Alternative | 4.25 | 2.63* | 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 - Original | 6.11 | 3.06 | 2.04* |
| IEL - Alternative | 3.86 | 2.19* | 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 - Original | 6.70 | 3.35 | 2.23* |
| IEL - Alternative | 2.02* | 1.95* | 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 - Original | 6.70 | 3.35 | 2.23* |
| IEL - Alternative | 2.02* | 1.95* | 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 - Original | 6.70 | 3.35 | 2.23* |
| IEL - Alternative | 2.02* | 1.95* | 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 |

*Least expensive alternative for grade level and size combination

The costs to be used in the combined cost/achievement analysis here will be the IEL original estimate and the Textbook (B) estimate since these appear to represent the most probable short-run costs of the two systems. In each case, it is assumed that the SQ schools operate with no current materials expenses relative to IEL and OC. ~~The IEL and OC costs will be adjusted to reflect the relative average size of class in the grade levels studied~~.

The achievement data used here is based upon tests designed by Dr. Klaus Galda in cooperation with the West African Examinations Council (WAEC) Monrovia staff. The tests, by subject for each grade level from Grade One to Four, were keyed to the Ministry of Education's curriculum coverage for that grade. The tests were administered in November, 1982, about two weeks before the end of the school year.

Several problems arose in terms of test administration. Galda cites the following:

1) inadequate training of test administrators;
2) difficulty in use of tape recorded instructions;
3) incorrect packaging of test materials;
4) problems of English language comprehension on the part of the students;
5) a failure to collect the data on characteristics of the school and the students; and
6) lost or misplaced examinations for some students.

Even so, Galda notes that: "From the evidence I have seen it does not seem that in general the evaluation has been in any serious sense invalidated by the irregularities...."

However, since the time the Galda report was written, it has been discovered that the use of the IEL instructional materials in the IEL schools has followed a pattern that was not envisioned at the time the achievement tests were designed. Table Four presents a recent report from IEL staff concerning module utilization in the five IEL schools for 1982. Part I in-

TABLE FOUR

1982 MODULE COMPLETION REPORT

IEL SYSTEMS SCHOOLS

May 11, 1983

I. Target:

| Subject | Grade 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| Mathematics | 1 - 10 | 11- 20 | 21 - 25 PT<br>26 - 37 PL | 38 - 62 |
| Reading | 1 - 10 | 11 - 20 | 21 - 25 PT<br>26 - 37 PL | 38 - 62 |
| Language | 1 - 10 | 11 - 20 | 21 - 25 PT<br>26 - 37 PL | 38 - 62 |
| Social Studies | 1 - 5 | 6 - 10 | 11 - 15 PT<br>16 - 25 PL | 26 - 50 |
| Science | 1 - 5 | 6 - 10 | 11 - 25 PL | 26 - 50 |

II. Average Module Completed - All Systems Schools:

| | | | | |
|---|---|---|---|---|
| Mathematics | 5.2 | 9.0 | 17.8 | 30.75 |
| Reading | 5.0 | 9.25 | 17.8 | 31.3 |
| Language | 5.0 | 9.6 | 19.2 | 29.5 |
| Social Studies | 3.0 | 4.5 | 9.0 | 17.0 |
| Science | 2.75 | 4.0 | 9.25 | 19.25 |

III. Module Completion by School:

Dorothy Cooper

| | | | | |
|---|---|---|---|---|
| Mathematics | 7 | 10 | 17 | 25* |
| Reading | 6 | 9 | 17 | - |
| Language | 5 | 10 | 17 | 25* |
| Social Studies | 5 | 8* | - | 12* |
| Science | 4 | 8* | 9 | 20 |

* Data available not sufficiently current, and not included in average.

TABLE FOUR (CONTINUED)

| | Grades | | | |
|---|---|---|---|---|
| **Frelala School** | 1 | 2 | 3 | 4 |
| Mathematics | 5 | 9 | 17 | 31 |
| Reading | 5 | 6* | 15 | 34 |
| Language | 5 | 10 | 18 | 30 |
| Social Studies | 2 | 5 | 8 | 19 |
| Science | 2 | 4 | 9 | 20 |
| **Doloboi School** | | | | |
| Mathematics | 5 | 9 | 18 | 30 |
| Reading | 4 | 8 | 21 | 30 |
| Language | 5 | 9 | 21 | 29 |
| Social Studies | - | 3* | 9 | 16 |
| Science | - | 3* | 9 | 19 |
| **S.S. Collins School** | | | | |
| Mathematics | 4 | 7 | 19 | 32 |
| Reading | 5 | 10 | 18 | 29 |
| Language | 3* | 9 | 20 | 30 |
| Social Studies | 1 | 4* | 10 | 18 |
| Science | 2 | 4* | 10 | 20 |
| **J.S. Milton School** | | | | |
| Mathematics | 5 | 10 | 18 | 30 |
| Reading | 5 | 10 | 18 | 30 |
| Language | 5 | 10 | 20 | 29 |
| Social Studies | 2 | 4 | 8* | 15 |
| Science | 3 | 4 | 9* | -- |

dicates the total number of modules available for each grade level (all Grade One and Two modules are for PT and all Grade Four modules are for PL). Part II indicates the average module completed in the IEL schools in 1982 and Part III presents detailed data, by school, on module completion by subject.

The difficulty does not lie primarily in the inability of IEL teachers and students to cover all of the year's material in the given year. External observers have already noted the unrealistic expectations of the IEL system, especially given the actual number of days that an elementary school is likely to be in session during a given year. This is a problem - much like that of materials inflexibility - that the IEL staff must address if the IEL system is to be adapted to the Liberian environment.

The problematical issue for this analysis, however, is not that of amount of coverage, but the sequence of coverage. The numbers in Table Four indicate that the average student beyond Grade One never studied in a module that covers the curriculum for their present grade level. An examination of the school module completion data reveals that in only a few isolated instances did <u>any child</u> study modules from their own grade level.

These figures, if accurately reflective of the IEL procedures, raise serious doubts about the meaningfulness of the achievement results. Because the tests are linked to the curriculum of a certain grade level, IEL students were asked to respond to questions based on instructional topics to which they were either never exposed or not exposed at the anticipated level of progress. Rather than the achievement test measuring the ability of students to learn from the IEL material, they measured this ability <u>plus</u> the degree of curriculum overlap from one grade to the next.

To explain, it is common, especially in mathematics and language arts, that there is a great deal of content overlap from one year to the next. The degree of this overlap varies from curriculum to curriculum, but a third grade student, for example, would not be expected to ~~totally~~ fail a fourth grade examination totally. One would expect, however, that the higher the grade level of the examination, the poorer the third grader would do. In the achievement test evaluation, the IEL students may have learned exceedingly well the material in the modules they covered. ~~exceedingly well~~. The third grade re-

sults, as will be discussed below, tend to confirm this. However, the IEL students are placed under an increasing disadvantage whenever the curriculum overlap between what they have studied and what the tests cover is reduced.

Two issues need to be resolved in terms of the question of IEL module completion rates. First, is the official Ministry of Education curriculum too ambitious for the time and other resources available at the elementary school level? Second, can the quantity and sequencing of IEL materials be modified so as to allow for greater coverage of the curriculum without unduly sacrificing the advantages of the present system of sequential learning? A third and separate question relates directly to the interpretation of the relative scores by IEL, SQ, and OC. To what extent did the SQ and OC schools cover the specific grade level curriculum material upon which the achievement tests were based?

Table Five presents a summary of the post-test scores, by grade level and subject, for each of the three school types. The interest in terms of cost effectiveness is only in those results which can be shown to be significantly different than what would occur in the SQ schools. In the parlance of experimental design, the SQ schools are the control group; they represent the level of achievement that would result if the government did nothing to change the elementary education system. The OC schools serve as an experimental group which was supposed to represent an enriched form of the SQ school. As was noted earlier, for the 1982 year from which these test results are taken, the OC schools did not have significantly different resource characteristics than the SQ schools. Finally, the IEL schools represent the second experimental group which differed from the SQ schools in terms of the type and availability of materials, teacher training, and supervision.

TABLE FIVE

POST-TEST SCORES

BY GRADE, SUBJECT, AND SCHOOL TYPE

| Grade<br>Subject<br>School Type | Mean % correct | Standard Deviation |
|---|---|---|
| Grade One - English | | |
| SQ | 44.0 | 16.8 |
| OC | 63.0*** | 27.0 |
| IEL | 46.2 | 19.0 |
| Grade One - Mathematics | | |
| SQ | 78.5 | 19.7 |
| OC | 79.1 | 21.2 |
| IEL | 64.4*** | 26.1 |
| Grade Two - English | | |
| SQ | 37.3 | 15.9 |
| OC | 58.2*** | 25.3 |
| IEL | 48.9*** | 14.9 |
| Grade Two-Mathematics | | |
| SQ | 51.6 | 19.3 |
| OC | 60.5*** | 18.7 |
| IEL | 55.9* | 17.2 |
| Grade Three - English | | |
| SQ | 53.0 | 17.4 |
| OC | 55.9 | 17.9 |
| IEL | 60.5*** | 17.1 |
| Grade Three - Mathematics | | |
| SQ | 52.3 | 15.5 |
| OC | 51.9 | 17.5 |
| IEL | 58.0** | 17.7 |
| Grade Three - Science | | |
| SQ | 42.9 | 11.6 |
| OC | 54.8*** | 16.0 |
| IEL | 55.2*** | 12.5 |

TABLE FIVE (CONTINUED)

| Grade<br>Subject<br>School Type | Mean % Correct | Standard Deviation |
|---|---|---|
| Grade Three - Social Studies | | |
| SQ | 47.7 | 12.7 |
| OC | 57.5*** | 13.9 |
| IEL | 50.3 | 13.9 |
| Grade Four - English | | |
| SQ | 51.2 | 18.4 |
| OC | 56.6 | 25.3 |
| IEL | 48.3 | 19.0 |
| Grade Four - Mathematics | | |
| SQ | 55.4 | 19.5 |
| OC | 59.4 | 21.9 |
| IEL | 40.4*** | 15.7 |
| Grade Four - Science | | |
| SQ | 49.6 | 16.1 |
| OC | 62.5*** | 18.2 |
| IEL | 44.0* | 16.8 |
| Grade Four - Social Studies | | |
| SQ | 45.9 | 11.7 |
| OC | 58.7*** | 19.9 |
| IEL | 37.3*** | 13.2 |

Note: OC and IEL school results are identified as significantly different from those of the SQ schools according to the following denotation:

* significant at .05 level
** significant at .01 level
*** significant at .001 level

The data presented here are based on the mean percent of correct responses of all students in each type of school on each of the achievement tests given. Galda has also reported the achievement tests results on the basis of the means of the school means. He has noted the weakness in the latter approach (a small school's average score counts the same as a large school's average score), but feels it is still useful data. For the purposes here, it is important to restrict the analysis to statistically significant results. With only five schools of each type, it is extremely unlikely that any but the most disparate results would be shown to be significantly different from zero in the school-based analysis. In fact, only three grade level tests were shown to represent significant mean achievement differences in the school-level analysis; all were for IEL schools. This was for the Grade Two English (+13.6), Grade Three English (+13.6), and Grade Three Science (+10.3).

Returning to Table Five, the relative achievement of the three school types can be assessed in terms of grade level and subject. In Grade One, the OC schools scored significantly higher than the SQ schools in English, while the IEL schools are significantly lower in Mathematics. Both sets of scores suggest a disappointing result for the IEL system.

In Grade Two IEL and OC schools are both higher than the SQ schools in both English and Mathematics. The OC schools, however, also scored significantly higher than the IEL schools in both subjects. It is in Grade Three that the most encouraging results are found for IEL. The IEL system schools are significantly higher than either of the SQ or OC types of school in both English and Mathematics. This pattern is modified in the Science test results where IEL and OC are superior to SQ but not significantly different from each other. The Social Studies results show IEL schools once again

equal to the SQ and lower than the OC scores.

The Grade Four results reveal no statistically significant differences in English, but IEL is lower than the other two school types in Mathematics. This pattern of IEL disappointment continues in the Science and Social Science results.

Cost and Achievement Analysis

Both the length of introduction to the analysis and the brevity of the analysis itself in this report is traceable to the same cause: the suspect and limited nature of the achievement data for the purposes of cost-effectiveness evaluation. The achievement data may be considered as inappropriate for a variety of reasons including the original selection criteria for OC and SQ, the sample size, the problem of test administration, the lact of concomitant data on teacher and student characteristics, and the lack of instructional process data (e.g. number of days actually taught, subject matter covered). What is known about the data is that for the IEL schools, at least, the achievement tests did not correspond to the subject matter covered in school during that year. It is impossible to know, however, what differences, other than in instructional technology, existed among the schools in the study and therefore, could have created a bias in the achievement results. For example, one school, the David Fejue School, accounts for much of the difference that exists between the OC schools and the other school types. The outstanding results for this school, if one can accept the evidence of the achievement tests, may be due to outstanding teachers, highly motivated students, or a variety of other unknown influences. In a small sample such as exists in this evaluation design, a single outlier in the distribution can have a dramatic effect on the average scores for the group.

If Galda had combined the SQ and OC schools, as appears justified by what is known of their minor differences in materials provision, teacher training, and supervision, the result would have been to reduce the effect of the single outstandlingly good or bad school on the overall group mean. Table Six presents the reconstructed group means for the combined SQ/OC control population and indicates the net difference in mean scores attained by the IEL system schools.

In summary, Table Six indicates serious weaknesses in achievement in IEL classrooms at Grades One and Four, no significant difference in achievement in IEL and non-IEL classrooms at Grade Two, and significant strengths in IEL performance in every subject in Grade Three except for Social Studies where no significant difference existed. While still not indicative of a consistent pattern, the results in Table Six are substantially less anomolous than those indicated in Table Five. This may be because the combined SQ/OC grouping more accurately resembles the proper experimental design categorization or could be a fortuitous and spurious mathematical result. Assuming the former, one can hypothesize as to why the pattern revealed in Table Six could occur.

The Grade One achievement problems are undoubtedly due in part (but there is no way to know how much) to the difficulty the students would face in adapting to the IEL curricular program. IEL's greater complexity suggests a need for a period of adjustment which may be expected to be greater than that necessary for the student in the traditional SQ/OC classroom. In Grade Two these adaptations appear to have been accomplished sufficiently that IEL and non-IEL achievement are equal. And finally, by Grade Three, even with the disadvantage noted earlier for IEL students because of still

TABLE SIX

MEAN ACHIEVEMENT DIFFERENCES

IEL VERSUS COMBINED SQ/OC CONTROL GROUP

| Grade and Subject | SQ/OC Mean Score (Percent correct) | IEL Mean Score (Percent correct) | IEL Advantage |
|---|---|---|---|
| Grade One | | | |
| English | 54.5 | 46.2 | -8.3* |
| Mathematics | 78.8 | 68.4 | -10.4* |
| Grade Two | | | |
| English | 49.8 | 48.9 | -0.9 |
| Mathematics | 56.5 | 55.9 | -0.6 |
| Grade Three | | | |
| English | 54.7 | 60.5 | +5.8* |
| Mathematics | 52.1 | 58.0 | +5.9* |
| Science | 49.9 | 55.2 | +5.3 |
| Social Studies | 53.3 | 50.3 | -3.0 |
| Grade Four | | | |
| English | 54.2 | 48.3 | -5.9* |
| Mathematics | 57.6 | 40.4 | -17.2* |
| Science | 56.9 | 44.0 | -12.9* |
| Social Studies | 53.3 | 37.3 | -16.0* |

* Indicates significance level of .05 or above.

working at Grade Two level modules, significant benefits appear.

The disappointing results for Grade Four are traceable to at least two causes. The first is the non-exposure to the Grade Four curriculum, an especially serious handicap in the non-English subjects. The second is the fact that this was the first year of IEL instruction and therefore the teachers were involved in IEL instruction for the first time. It was also the first year the Grade Four modules were used outside the IEL Laboratory School, but this is hardly relevant if few children ever advanced to these module levels.

Less benign interpretations could be made of the data in Table Six, but the fairest conclusion is that the data provides both comfort and confusion for those who are supportive of the IEL system of instruction. In Table Seven, the analysis of IEL is expanded to look simultaneously at the cost and the achievement differences. All cost and achievement differences are given relative to the SQ costs and scores. In addition, the achievement difference is divided into changes in mean scores and changes in the standard deviation. The latter measure can serve as an indicator of whether the changes in achievement are gained at the expense of increased inequality in achievement among the students. A purported advantage of the IEL system is an ability to increase achievement without the substantial increases in inequality commonly found in the traditional classroom.

For example, in Grade Two the OC schools' advantages in English are substantial, but so is the standard deviation. This means that the increase in average achievement of 20.9 points over the SQ scores was achieved not through a general increase but through the production of a smaller number of very high scores. The IEL increase, while less (+11.6 points), was achieved with less disparity in results than was the case for the SQ schools

TABLE SEVEN

COST AND ACHIEVEMENT DIFFERENCES

BY GRADE, SCHOOL TYPE, AND SUBJECT

| Grade - School Type | Cost Difference[1] (per student) | ENGLISH Mean difference | ENGLISH S.D. diff. | MATHEMATICS Mean Diff. | MATHEMATICS S.D. Diff. | SCIENCE Mean Diff. | SCIENCE S.D. Diff. | SOCIAL STUDIES Mean Diff. | SOCIAL STUDIES S.D. Diff. |
|---|---|---|---|---|---|---|---|---|---|
| Grade One | | | | | | | | | |
| OC | (a) | +19.0 | +10.2 | n.s | n.s. | - | - | - | - |
| IEL | 2.46 | n.s. | n.s. | -10.1 | +6.4 | - | - | - | - |
| Grade Two | | | | | | | | | |
| OC | (a) | +20.9 | +9.4 | +8.9 | -0.6 | - | - | - | - |
| IEL | 2.46 | +11.6 | -1.0 | +4.3 | -2.1 | - | - | - | - |
| Grade Three | | | | | | | | | |
| OC | (a) | n.s. | n.s. | n.s. | n.s. | +11.9 | +4.4 | +9.8 | +1.2 |
| IEL | 3.95 | +7.5 | -0.3 | +5.7 | +2.2 | +12.3 | +0.9 | n.s. | n.s. |
| Grade Four | | | | | | | | | |
| OC | (a) | n.s. | n.s. | n.s. | n.s. | +12.9 | +2.1 | +12.8 | +8.2 |
| IEL | 5.36 | n.s. | n.s. | -15.0 | -3.8 | -5.6 | +0.7 | -8.6 | +1.5 |

1. IEL costs were determined by dividing total materials cost by the average size of IEL classes.

(a) No cost difference is shown for OC schools as textbooks were not provided for 1982.

or the OC schools.

In every case but one in Table Six, the OC advantages in test scores was concomitant with a larger standard deviation than existed in the SQ schools. In contrast, in three of the six cells in which IEL shows a test score advantage over the SQ schools, there is a decline in the relative standard deviation. Too much should not be made of these relationships given the earlier warnings concerning the problems of interpretation of the achievement data, but no final decision on the IEL system should be made simply on the basis of mean scores. If the interest is in the total distribution of achievement, the IEL instructional approach may have important advantages which should not be overlooked by an excessive concentration on differences in mean achievement levels.

Can a final judgement be made on the value of the IEL system from these results? It would seem not. A positive decision for IEL dissemination is not justified even when the data is given the most favorable structure and interpretation. There are simply too many questions which remain unanswered concerning the relative efficacy of the IEL instructional system. However, there is enough encouragement in these results to argue against a negative decision as well. The IEL system continues to indicate a potential for relatively economical costs when compared to the textbook alternative. This economy would be reinforced if IEL staff would take more seriously the suggestions for reductions in module numbers and the quantity of related materials and the need to seek flexibility in adaptation to smaller classes.

The solution to this decision-making impasse cannot be simply to recommend further analysis. Steps must be taken to assure that the next evaluation will lead to complete and reliable data and that this data will

permit conclusive decision making. No evaluation process can answer all questions, but the research design can control for the most important considerations. Therefore, the concluding section of this paper will discuss the design factors which must be incorporated into the 1983 IEL evaluation so that a final judgement on cost efficiency will be possible by Spring, 1984.

Summary and Recommendations

In terms of cost, four major conclusions may be made in regard to the IEL system:

1) While obviously more expensive than the present SQ-type school, the IEL system of instruction should be no more costly, at class sizes of approximately forty or more students, than would be the most probable form of textbook based system (Textbook alternative "B" shown in Table Two);

2) At class sizes below forty students, the IEL system will be increasingly expensive relative to the textbook alternative, and will be more expensive than textbook use at class sizes below the following levels --

| | |
|---|---|
| Grade One: | 25 |
| Grade Two: | 23 |
| Grade Three: | 23 |
| Grade Four: | 28 |
| Grade Five: | 23 |
| Grade Six: | 30; |

3) similarly, at smaller class sizes, the IEL system would be more expensive to disseminate even if one assumes, as is unlikely, that teacher training, supervision, distribution and dissemination costs are no more expensive for the IEL than for the textbook dissemination system; and

4) several potential internal economies remain to be exploited in the IEL system in terms of the total quantity of materials required and usable and in terms of the organization of materials for use in small classes and/or

with teachers who have multi-classroom, multi-subject responsibilities.

In terms of IEL effectiveness the conclusions which may be drawn from the recent achievement evaluation are less certain. The IEL system remains intuitively attractive because of its ability to structure the use of teacher and student time. Also, its systematic progression through the subject matter of the curriculum should promote greater understanding and retention. The achievement results, however, are largely disappointing, except at Grade Three, even when IEL is compared to the combined SQ/OC control population. The low scores of IEL students at Grades One and Four may be due to delayed student and teacher adaptation respectively, but the data available is inadequate to confirm this. The Grade Two results, where no significant differences in achievement were found, were hardly more encouraging given the additional costs of the IEL program.

The residual uncertainty over IEL efficacy and the ability of the system to justify its costs cannot be allowed to become a permanent condition. The 1983 evaluation design should allow for much greater control of non-curricular technology differences among the school populations. While the expansion to forty-five schools (fifteen of each type) should have reduced the small sample size problem, it did not achieve this because of problems of non-standardization which will be discussed below. However, the new schools do pose a methodological problem. The

IEL population will consist of five schools where students have used IEL materials for one year or more (except of course, at Grade One) and ten schools where students will be using the IEL system for the first time at all grades. It will be necessary to divide the IEL group into two parts, both for comparison with one another and for comparison separately with the SQ and OC populations.

The major areas of attention for research design for the 1983 evaluation are:

1) pretesting requirements;
2) improved data on student characteristics;
3) improved data on teacher characteristics; and
4) measures of curriculum coverage.

Each will be detailed below.

1) Pretesting Requirements: The attempts in the Galda report to conduct longitudinal analysis of IEL and non-IEL learning are highly suspect given, as Galda makes quite clear, the change in the nature of the test population. Because of attrition, repetition, and absenteeism (none of which are necessarily random) there is little chance that the students taking a post-test in one year are the same students who took an earlier pretest or post-test at the same school. Galda notes that the overlap could be less than 50 percent.

However, without pretest data, it is impossible to ascertain the value added of a year of instruction within any of the three school types or to control for existing differences in prior achievement among schools. Students in all grades in the thirty new schools added to the evaluation in 1983 and first grade in the

original fifteen schools have been administered pretests designed by the IEL project staff. If the reliability of these tests may be accepted, the residual problem is the failure to test the second, third, and fourth grade students at the original fifteen schools. Thus, there will be no opportunity to control for ability differences in any analysis which includes the population of five IEL, five OC, and five SQ schools that were the bases for the 1982 evaluation.

In consultation with the evaluation specialist, Dr. Gelda, it has been decided to recommend that the previous year's post-test scores be used as controls on prior achievement for the second, third, and fourth grade students at the original fifteen schools. All students in the forty-five 1983 evaluation schools are being assigned identification numbers. It will be necessary to have the present students (except for first grade) in the original IEL, OC, and SQ schools matched with the post-test scores from 1982. This can be done through matching of names and test scores and then recording all data in terms of the new identity numbers. The use of identity numbers will allow much more detailed student-level analysis than was practical in the previous year's evaluation.

The result will be an experimental design in which the following analysis, with control for prior achievement, may be made:

1) New IEL versus new OC and SQ schools, by grade level and subject;

2) Old IEL versus old OC and SQ schools, by grade level and

subject;

3) Old and new IEL combined versus old and new OC and SQ schools, for grade level one only, in English and Mathematics; and

4) Old IEL versus new IEL, grade one only, for English and Mathematics; and

Because the pretest and the post-test control variables for prior achievement are not equivalent, it is not possible to compare students in the second, third, and fourth grade classes in the original set of fifteen IEL, OC, and SQ schools with the students in the new set of thirty IEL, OC, and SQ schools. This could be done if one decides to delete the control on prior achievement but the result would be to produce the same type of uncertainty concerning causality of achievement which plagued the 1982 evaluation.

The purpose of the comparisons (numbers 1, 2, and 3 above) between IEL and the two control populations is one of establishing the relative effectiveness of the IEL curricular strategy versus the traditional alternatives. Comparison number 4, between old and new IEL classrooms, will test the hypothesis that teacher familiarity with IEL materials increases the overall instructional effectiveness Unfortunately, another important hypothesis, that student familiarity with IEL materials also increases instructional effectiveness, cannot be tested except in the absence of a control on prior achievement. As the second, third, and fourth graders at the five original IEL schools were not given pretests for 1983, but the ones at the ten new IEL schools were, there will be no comparable measure of prior achievement to control for when studying variation

in 1983 achievement.

2) Improved Data on Student Characteristics: It is vital that more adequate data be collected on student characteristics. With a lack of pretest equivalency, the collection of information on student (and teacher) characteristics is even more mandatory. All of the data should be coded so as to create a student-specific file of characteristics which can be linked to the teacher, curricular technology, and test results variables.

The main student characteristics needed are: age, sex, years in school, repeater status in present grade, and rate or days of absenteeism. For the IEL students there should also be information on the years of previous IEL material use. Years of pre-Grade One schooling is an additional variable that may be considered although the 1982 data did not indicate that it had a significantly differentiating effect.

3) Improved Data on Teacher Characteristics: Because of the central role played by the teacher as the primary intervening variable between the curricular technology and the student, it is necessary that detailed information be collected so that achievement results are credited appropriately to the teacher and to the instructional approach. Even in the expanded sample of forty-five schools a spurious correlation between technology and achievement could occur if highly motivated and able teachers are not randomly distributed among the three school types.

The most useful measure of teacher quality would be to have estimates of teacher verbal and mathematical ability. It has

been suggested by the Ministry of Education personnel that the teacher could be given the national 9th or 12th grade examinations which have verbal and mathematical components. Previous research on classroom effects have shown that these characteristics of teachers are the ones most often correlated significantly with student achievement.

Additional teacher data which would be valuable would include: age, sex, years of teaching experience, highest education level attained, possession of teacher training credentials, rate or days of absenteeism, single or multi-grade level responsibility, and class size. Teachers in the IEL schools should be identified in terms of years of IEL experience. All teacher data should be coded so as to be matchable to the specific students in the teacher's class.

A special problem in regard to matching teacher characteristics to student achievement is the practice of having subject-specialized teachers in the elementary school. Thus, one teacher may teach mathematics for two or more grade levels while others will do the same for English, reading, etc. Thus, to match teacher to student is a more complicated process than where a single teacher is responsible for all subjects at a given grade level. For most schools, Grades One and Two are taught by a single teacher but, for Grades Three and Four, subject-specialization is the common practice.

This pattern will require that the teacher survey identify teachers by grade level and subject taught. Where more than

one class exists at a grade level the survey will have to collect the names of all students in each teacher's classes. This will allow matching of the teacher's characteristics to the specific identification numbers of students in his or her classes.

A special problem exists in regard to the English achievement test. At certain schools, separate teachers have responsibility for reading. language, arts, and spelling. In these cases a combined teacher characteristic variable must be created. While simple enough to do mathematically, there are obvious methodological problems of interpreting the meaning of a variable based on an average of characteristics over such a small number of individuals. In any case, the inclusion of the teacher data, especially that on math and verbal ability, will greatly enhance the analysts potential to interpret the results in terms of the relative effectiveness of the curricular alternatives.

4) Measures of Curriculum Coverage: It is absolutely essential in an evaluation of alternative curricular technologies that information on how much of the curriculum was actually covered by a particular classroom of students be collected. The importance of this was highlighted in the current analysis because of the incongruence between IEL materials use and the national grade level curriculum. For the 1983 evaluation, it will be important to ascertain exactly what textbooks the OC schools obtained and what amount of the material was covered. Because all OC schools did not receive all textbooks it is necessary to incorporate into the final analysis a measure of

curriculum coverage for each of the subject areas tested for on the achievement examination.

In addition to the above data requirements, two areas of research design remain to be addressed: the structure for data collection and the format of data analysis. Three major parties should be involved in the data collection. The primary responbilility for final design and overall implementation should rest with the external evaluator. The actual data collection responsibilities should be divided between IEL project staff and Ministry of Education personnel.

The IEL staff should be assigned the task of collecting data on student characteristics, teacher characteristics (except verbal and math test scores), IEL module use, and textbook availability and use in the non-IEL schools. The Ministry of Education, in cooperation with the WAEC, should be responsible for teacher verbal and math skill testing and data on teacher and student absenteeism. The work of both groups should be coordinated so that all data is coded in a student-specific manner. Variables such as teacher characteristics and classroom curriculum coverage should be coded for matching to each student in the particular classroom.

The external consultant should be on site during the full period of data collection in November and again to monitor problems in the coding process. The analysis and description of results should be solely the responsiblity of the external consultant, but provisions should be made for a full review of the evaluation draft by Ministry of Education, IEL, and USAID personnel before

the report is finalized. The external consultant should be in Liberia during the time of draft revision so the comments and suggestions of all parties can be incorporated, as appropriate, into the final draft.

The data collection recommended here will allow for more detailed analysis than the simple mean, standard deviation, frequency distribution, and contingency analysis to which the 1982 evaluation results are restricted. A simplified production function model of school results can be used to elicit the effect of the curricular technology under ceteris paribus (all other things equal) conditions. The function would take the form of

$$X = X\ (S,T,C,e)$$

where "S" represents a set of student characteristics, "T" a set of teacher characteristics, "C" a set of measures of the curriculum alternative and of the degree of coverage, and "e" represents an error term. The output "X" can be defined in terms similar to that used in the 1983 achievement results. An additive form of the production function would be most appropriate given the level of data aggregation. A separate function would be estimated for each grade level-subject combination.

This analysis, combined with updated IEL and textbook cost data (to the extent costs are anticipated to have changed) would provide the most complete evaluation of the IEL system's appropriateness for general dissemination. The full analysis, including review, should be complete by June, 1984.

This evaluation design recommendation may seem especially demanding and, in terms of the 1982 design, it does represent

a substantially more complex approach. There will also be concomitant increases in expense. However, economizing on evaluation should never be assumed to imply doing the least expensive evaluation. Given the scale of Liberian govermment funds that would be involved in an IEL dissemination, and the potential effect of the change in curricular technology on the lives of students, it would be extremely short-sighted not to assure that the best possible data is collected within the limits of resource availability. Of course, cost effectiveness evaluation is subject to its own analysis in terms of cost and effects. The research design proposed here should prove to be a good investment and allow for a conclusive decision concerning the IEL system's future status.