Improving the Efficiency of Education in Developing Countries: Review of the Evidence

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May 1987

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Abstract

This paper defines education efficiency and reviews evidence from 15 empirical studies regarding the cost-effectiveness of several educational interventions: instructional materials (textbooks), teacher training, interactive radio, technical-vocational schools, peer tutoring and cooperative learning. On average, across several countries and a variety of student learning outcome measures, the more cost effective interventions are textbooks, interactive radio, peer tutoring and cooperative learning. Less cost-effective are teacher training and technical-vocational schools.
Introduction

The term "efficiency" is used in many ways, although the concept unifying all efficiency discussions is very simple. When there are limited resources--as there always are--those resources should be used to promote society's objectives as fully as possible.

Concern with efficiency in education, therefore, has to do with using the resources available to education to promote society's educational objectives--for example, basic literacy and numeracy, civic responsibility, religious piety. Efforts to improve educational efficiency are unique neither to the latter decades of this century nor to developing countries. At the turn of the century in the United States, John F. Bobbit--the father of the "scientific management" movement--argued that rapidly growing student enrollments would overtax resources available for education unless schools became more efficient (Bobbit, 1912). He presented two mechanisms that now, as well as then, are widely believed to improve efficiency: (a) reducing the costs of education by such policies as constructing substandard school buildings and reducing teacher salaries1 or (b) increasing
student learning through "scientific management" of schools, which included such policies as more intensive use of school buildings, tracking students according to ability, eliminating repetition, and teacher specialization.

Similar recommendations for cost reductions and better deployment of resources are currently under consideration for improving the efficiency of schools in developing countries. In this paper we contend, however, that only the second alternative is capable of affecting efficiency, since it includes reference to both resource management and student learning outcomes. Cost reduction by itself may be attractive in the face of budgetary pressures, but reducing costs alone is not necessarily related to efficiency, since efficiency is a term that relates resources to outcomes. Only when changes in resources are related to changes in outcomes is it possible to discuss effects on efficiency.

This paper (a) provides a conceptual framework for addressing the issue of efficiency in education, which distinguishes several types of efficiency, (b) considers alternative criteria for identifying efficiency, (c) discusses constraints on improving efficiency, and (d) presents evidence regarding the relative efficiency of several alternative educational inputs and practices.
Efficiency defined.

Efficiency refers to a ratio between inputs and outputs. A more efficient system obtains more output for a given set of resource inputs, or achieves comparable levels of output for fewer inputs, other things equal. The outputs of education refer to that portion of student growth or development that can be reasonably attributed to specific educational experiences. These include the development of literacy and numeracy skills, positive attitudes toward work, civic responsibility, and a myriad of other skills, attitudes and beliefs. In this paper, we depart sharply from the practice of considering the number of graduates the output of the education system, and focus attention directly on the net improvement in skills resulting from being educated. This approach is often referred to as a "value added" approach, which separates the effects of schooling (or other educational experiences) from parental and background effects.

The measurement of inputs and outputs, and hence the characteristic of the ratio employed, provides a convenient but unconventional way of classifying various forms of efficiency. The inputs of the system determine whether "efficiency" or a related "efficiency" or a related term, "effectiveness", is involved. When inputs are measured in monetary terms, the term "efficiency" is employed; when they are measured in non-monetary terms, "effectiveness", is used. The outputs of the system determine whether the descriptors "internal" or "external" are applied to efficiency and effectiveness. When outputs are
measured in monetary terms, the term "external" is used; when they are measured in non-monetary terms directly related to educational objectives, the term "internal" is employed.² In this section we briefly identify four commonly used but frequently confounded concepts: (a) internal effectiveness, (b) internal efficiency, (c) external effectiveness, and (d) external efficiency. Figure 1 provides a schematic representation of these distinctions.
How are outputs measured?

<table>
<thead>
<tr>
<th>How are inputs measured?</th>
<th>Non-Monetary terms (eg: learning)</th>
<th>Monetary terms (eg: earnings)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-monetary terms (#)</td>
<td>INTERNAL EFFECTIVENESS&lt;sup&gt;a&lt;/sup&gt;</td>
<td>EXTERNAL EFFECTIVENESS</td>
</tr>
<tr>
<td>(eg: number of textbooks, classroom organization)</td>
<td>technical efficiency: #/#)</td>
<td>(£/#)</td>
</tr>
<tr>
<td>Monetary terms ($)</td>
<td>INTERNAL EFFICIENCY&lt;sup&gt;b&lt;/sup&gt;</td>
<td>EXTERNAL EFFICIENCY</td>
</tr>
<tr>
<td>(eg: cost of textbooks, teacher salary)</td>
<td>(effectiveness-cost: #/§)</td>
<td>(£/§)</td>
</tr>
</tbody>
</table>

Note: All ratios refer to the ratio of outputs to inputs, expressed in either non-monetary (#) or monetary ($) terms.

<sup>a</sup> A system is more internally effective (technically efficient) than another if, to produce the same level of output, fewer of at least one input are used.

<sup>b</sup> A system is more internally efficient than another if, to produce the same level of output, it is less costly.

<sup>c</sup> This box is the subject of this paper.
Internal effectiveness. We use the term "internal effectiveness" to refer to a ratio of learning (a non-monetary outcome of education) to specific inputs of the system. The inputs of education include both material and non-material resources, with the latter term used to encompass pedagogical practices and the organizational structure of schools and school systems, as well as such items as teacher time and ability. Material inputs include such items as textbooks, instructional materials, desks and classrooms. We do not restrict the term "inputs" to only those inputs which can be expressed as physical quantities or in monetary terms. In fact, we specifically include the complex interactions of students and teachers as elements of input, even though they are best expressed as processes rather than inputs. Internal effectiveness is also referred to as "technical efficiency": the organization of available resources in such a way that the maximum feasible output is produced (Levin, 1976).

Internal efficiency. Similarly, we use the term "internal efficiency" of education to refer to a ratio of learning (a non-monetary outcome of education) to the costs of educational inputs; the analysis typically employed is called cost-effectiveness analysis. Internal efficiency addresses the question of how funds within the educational sector should be best allocated. It is concerned with obtaining the greatest educational outputs for any given level of spending. Economists have a simple conceptual rule to determine how resources should be allocated among alternative educational activities: The
improvement in educational performance that results from the last amount of funds spent on an educational activity should be equal across each possible activity. For example, consider a school that is deciding between buying new workbooks for students and hiring a part-time teacher to tutor individual students. Clearly, the school should spend the funds on the one that increases performance the most--say workbooks in this example. In fact it should continue spending money on workbooks until the educational value of the two choices is the same. (After the initial purchase of workbooks, the value of added workbooks is probably lessened so that at some level of spending the appropriate decision is to purchase a tutor instead of more workbooks.) The same logic holds for all of the inputs that a school purchases, leading to the previously stated rule. Internal efficiency is also sometimes referred to as "allocative efficiency" or "price efficiency" (Levin, 1976).

External effectiveness. External effectiveness has to do with the relationship between non-monetary inputs and monetary outputs. In education, this could refer to the degree to which certain pedagogical practices or school tracks affect student post-graduate salaries, other things equal. Studies contrasting the earnings of technical-vocational track graduates with the earnings of students graduating from academic tracks are examples. Such analyses are usually conducted as a first step for "cost-benefit" analyses.
**External efficiency.** By external efficiency, we refer to what is often the topic of cost-benefit analyses: that is, the ratio of monetary outcomes to monetary inputs. Extensive consideration has been given to the issue of "external efficiency", or how the overall use of money for schooling compares to other potential public and private uses. If a country received $1 million, should it channel this to education or to some other expenditures? The answer depends crucially upon a comparison of the benefits of the alternatives. In perhaps the simplest consideration, one can calculate the rate of return to an investment in education and then compare this with an alternative investment. This is complicated—in large part because the calculation of benefits is frequently difficult—but it has proven to be a very useful approach for policy considerations.3

The analysis of external efficiency provides information that is useful in deciding upon the right level of educational spending for a country, or in deciding upon the allocation of funds across different subsectors such as primary education or vocational training. It does not, however, provide guidance about the specific policies that should be pursued within the educational sector. This guidance is provided through analysis of internal efficiency.

**Efficiency related to alternative criteria**

Before addressing the question of how to improve efficiency, we address some issues that are indirectly related to internal
efficiency. These are: the broader consequences of education, equity considerations, and specification of qualitative versus quantitative outputs.

**Broader consequences.** The rationale for investing in education often has to do with its indirect effects on desirable social goals—that is, it improves individual productivity, nutrition, and health; it aids in achieving other societal goals, such as fertility objectives; it relates to income distribution concerns; and so forth. These objectives are mediated by different direct outputs of the education system: cognitive skills, attitudes and behaviors. A direct implication of this is that different conclusions regarding efficiency will be drawn, according to the particular outcome criteria that is chosen.

It is not difficult to develop efficiency analyses when there are means of directly comparing benefits in different dimensions, such as by placing a monetary value on each output. The required weights for such alternative outputs as literacy, numeracy and civic responsibility, however, do not generally exist, and hence efficiency analyses typically address single outputs only.

**Equity.** A second and more fundamental issue in analyzing efficiency is the general neglect of any distributional matters. Efficiency considerations gloss over who benefits. If, however, there is a systematic distributional component that differs across policies, the "efficient" policy may not always be the optimal policy for society. (Typically, economic analysis would presume
that resources should be employed in their most productive use, maximizing the total amount of output. Then, if redistribution is a separate goal, other policies should be pursued to attack that area directly. Various political or cultural constraints might, however, make these latter policies difficult.)

Quantitative outcomes. Educational research and evaluations related to efficiency are highly dependent upon the output measures that are used. The most common measure used in research in developing countries is counts of students: enrollment rates by ages, grades, or level of schooling; continuation rates or dropout rates at specific ages or grades; and repetition or completion rates by grade or level. Each measures some aspect of the flow of students through schools.

None of these measures is appropriate for judging the internal efficiency of schools. Measures of the quantity of schooling received by children is most useful for making aggregate comparisons, say across countries or across regions within a country; they are much less useful within a country where the issue is differential performance by schools. Quantitative measures of participation or progress obscure differences in the achievement of children within the same grade of schooling, but these latter differences are more important for considerations of internal efficiency.

Moreover, it is very possible to develop policies that, for example, increase the continuation rates in schools but do so at
the expense of children's learning. The quantity of schooling is obviously related to the amount children learn, but the relationship is not consistent across children, schools, and countries. All available evidence suggests clearly that policies to increase the amount of primary schooling, and thereafter secondary schooling, are desirable. This does not, however, mean that all "improvements" in quantity mark "educational" improvement, since some might not be warranted if learning declines as a result. For example, repetition rates in primary grades can be changed by direct governmental policy; yet lowering repetition rates in a mechanical way might reduce the amount students learn.

The popularity of quantitative measures is clearly related to their availability, not their conceptual desirability. While they may be useful for aggregate and cross-national comparisons, they cannot provide real guidance to the efficiency discussions here. The important issue is the different kinds of policy discussions and deliberations that are being considered. For a country that does not have universal primary education, expanding exposure--almost regardless of quality considerations--is likely to be an appealing policy. But once general exposure, which can be justified on equity grounds, is reached, educational policies switch from purely quantity considerations to differential quality.

**Learning outcomes.** The most commonly used measures of school performance are scores on standardized achievement tests. By
standardized tests we refer to tests that are constructed, administered, scored, reported and interpreted in a consistent fashion to provide for the measurement of individual differences in as unambiguous ways as possible (Anderson, Ball & Murphy, 1975). Properly treated standardized tests provide consistent information across schools, as well as indications of performance differences among children within the same school. Although studies linking performance on standardized tests and subsequent outcomes are few, when tested, there is a strong positive relationship between test scores and subsequent labor market earnings (see Boissiere, Knight and Sabot 1985).

At primary levels, standardized tests provide good indicators regarding student attainment of principal educational objectives: functional literacy and numeracy. In later grades, where other objectives of schooling increase in importance, standardized tests covering the entire curriculum are more difficult to construct. In higher education there are very few cases in which learning outcomes have been successfully measured.

**Constraints on improving internal efficiency.**

Efficient use of resources is especially important in the case of education in developing countries. Most countries make education a priority spending item, and education tends to consume large portions of governmental budgets. Yet education must compete with other uses of funds, both public and private. In times of fiscal pressures on governmental budgets--whether these
arise from poor performance of the economy or from the competition of other governmental programs--education spending comes under intense scrutiny. If it appears that funds allocated to schooling are being wasted--inefficiently used--arguments for cutting back expenditures are strengthened.

Internal efficiency of education can be improved in two ways: (a) by reallocating resources from inputs that have smaller effects on learning to those than have larger effects on learning, that is, by increasing outputs associated with given levels of resources, and (b) by reducing overall resources while maintaining existing levels of learning.

Improving efficiency has obvious appeal, particularly in the face of the fiscal pressures facing most school systems. But there are many reasons why it might not be achieved; this discussion identifies three of the more important ones: (a) inadequate knowledge about internal effectiveness, (b) inadequate knowledge about costs in inputs, and (c) difficulty in obtaining appropriate information.

Effectiveness of Inputs. Informed policy making requires information about the effect on educational outcomes of adding (or subtracting) every possible educational input (that is, knowing the internal effectiveness of all resources). These informational requirements are obviously very large. Such information can come from many sources: educational experiments, research into scholastic performance, or experience and observation. Each source
has its advantages and disadvantages, but none is likely to provide a complete picture.

Educational administrators, policy makers, and researchers must each be able to separate the influences of the different inputs to the educational process in order to judge their effectiveness. This is frequently very difficult to do because inputs tend to be related to each other. For example, well educated parents are likely to provide learning in the home and send their children to schools having more resources and better trained teachers. Similarly, illiterate parents in developing countries are likely to send their children to schools having few material resources and poorly educated teachers. In both cases, it is difficult to separate the influence of specific school inputs from each other or from that of parents. Other examples pointing to the difficulty in separating the distinct inputs to education are easy to develop.

Current knowledge of the educational process in developing countries is actually quite primitive (see Fuller, 1985, for a recent review). The effectiveness of some inputs is known, but the evidence is not very precise. The result is that inefficiency can be very large simply because there is insufficient information upon which to base policies.

Costs of inputs. A second element needed for policy and analysis into the internal efficiency of the educational system is the cost of separate inputs into the process. If there are
several inputs known to be beneficial to education, the efficiency criterion would dictate allocating resources in a way that also considered costs. Specifically, more expensive inputs should be more effective in order to compensate costs.

The estimation of costs of inputs, while apparently quite straightforward, can be very difficult. Costs must be directly linked to the inputs identified in the effectiveness discussion. If attempts are made to describe inputs in great detail—perhaps linking process choices of teachers and the like—the costs must relate to providing inputs of such a description. This rapidly exceeds our abilities, because little is known about the supply of many of the inputs. For example, the supply of teachers with a given level of schooling has been estimated as a function of salaries; the supply of teachers with a given schooling and verbal ability level, with a pedagogical style emphasizing student questioning, with a fluency in several languages, and so forth has never been systematically studied. Most cost estimates, therefore, are very general.

**Difficulty of obtaining information.** The difficulty in developing better information about the educational process reflects several factors. First, the complexity of the problem means that any research/information gathering effort must be quite sophisticated, utilizing multiple instruments to measure both inputs and outputs and employing complex research designs. To fully identify relationships, experimental designs with effects traced over several years are desirable. Such projects are rarely
undertaken anywhere, and are virtually unknown in educational research in developing countries.

Second, systematic analysis of the type needed to support large policy initiatives is costly, thereby making it an appealing target in times of fiscal stringency. It is noteworthy that, while the World Bank has invested over $10 billion in education projects, research necessary to answer questions about the internal efficiency of education has been conducted in fewer than half a dozen instances.

Third, and perhaps most fundamentally, the nature of schooling in the countries where studies have been undertaken may obscure any basic relationships. If identified inputs into the educational process do not have a consistent relationship with educational outcomes, observations of the inputs by different people at different times could yield mixed findings. Such could be the case if the educational system exhibited a noticeable degree of technical inefficiency (internal ineffectiveness); that is, if inputs were not used in such a manner as to achieve the maximum feasible output. For example, a textbook in the wrong language or a teacher improperly prepared for a specific subject would almost certainly be worse than if these were appropriately arranged. In some schools (those using the correct books) it might appear that textbooks were a very effective educational input, while the experiences of other schools (those using the wrong books) might suggest no impact of textbooks. Technical inefficiency, which is essentially the wastage of specific
resources, makes it difficult to predict or evaluate the potential advantages of different policies.

Technical inefficiency can exist for a wide variety of reasons. It might reflect historical but outdated policies; overt and knowing waste; or simple mismanagement.

But it might also reflect the complexity of the educational process and the difficulty of properly identifying effectiveness in both research and policy analysis. In the simple example above, it could be that properly measured inputs of textbooks (such as an appropriate arithmetic book in the correct language used immediately after the previous text in the same series) has a consistent effect on achievement, even though simply measuring the presence of any book in the school has no consistent effect. The case of teachers is much more complicated because the possible identifying characteristics make up a very long list--one far exceeding any available analysis.

The underlying requirement in measuring effectiveness and in evaluating potential policies is the identification of a given set of inputs that have a homogeneous relationship to student outcomes. Doing this might involve specifying complicated interactions among teachers, the various process choices they make in the classroom, and the environment of the schools and macro process choices. The more complicated this is, the less likely any research is to be successful and the less likely it is that fully articulated policies can be developed.
Evidence of internal efficiency in developing countries

Evidence related to internal efficiency comes from the combination of cost data with data on effectiveness. To ascertain the effects of different educational inputs and processes on educational outcomes requires two conditions: variation and comparison. Without variation, there can be no comparison, and hence no conclusions about relative effectiveness.

Evidence regarding the effectiveness of alternative educational inputs or processes on student learning is drawn from three sources: (a) experiments, in which variations are controlled by the experimenter, (b) surveys, in which variations occur naturally, or (c) descriptive reports from more anecdotal sources. Although the firmest conclusions about effectiveness come from experiments, very few true educational experiments have been undertaken in developing countries, particularly on a large scale. Many of what are described as "experiments" are actually changes in national policy, which, by being implemented uniformly, lack variation. The impact of these "experiments" on student learning, moreover, are seldom evaluated.

Most evidence on school effectiveness in developing countries is derived from surveys. Data are collected on student, teacher and school variables, and relationships between independent variables (inputs and processes) and the dependent variable (student achievement) are estimated through statistical methods.
Findings from research in developing countries differ from those in industrialized countries in two important ways. First, the effect of school resources (material inputs) on student achievement in developing countries is much more pronounced than in more developed ones. Second, few studies of non-material inputs and processes have been conducted in developing countries, even though these have been found to contribute significantly to student achievement in developed countries.

Studies in which the cost-effectiveness of alternative educational policies have been assessed are extremely rare. Since internal efficiency is our primary concern here, we review these in some detail. Only a few educational inputs have been subject to systematic studies of cost-effectiveness in developing countries; cost-effectiveness studies of educational processes are entirely limited to developed countries. In these studies, comparison have typically been made between the cost-effectiveness of using some input (for example, textbooks) and the cost-effectiveness of not using the input. Occasionally the cost-effectiveness of one or more inputs are compared. In reporting these studies, we use student learning as the numerator in a ratio in which the denominator is a unit of cost, typically $1 in developing countries and $100 in developed countries (thus, the ratio is properly an effectiveness-cost ratio). A summary of the results of these studies appears in Table 1.
### Table 1: Efficiency of Six Educational Policies

<table>
<thead>
<tr>
<th>Policy</th>
<th>Effect Size</th>
<th>Cost</th>
<th>Per-Student Efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Textbooks</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brazil</td>
<td>.34</td>
<td>$1.65</td>
<td>.21/$1</td>
</tr>
<tr>
<td>Nicaragua</td>
<td>.36</td>
<td>$1.75</td>
<td>.21/$1</td>
</tr>
<tr>
<td>Philippines</td>
<td>.36</td>
<td>$ .27</td>
<td>1.26/$1</td>
</tr>
<tr>
<td>Thailand</td>
<td>.06</td>
<td>$ .25</td>
<td>.24/$1</td>
</tr>
<tr>
<td><strong>Radio Education</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kenya</td>
<td>.53</td>
<td>$ .40</td>
<td>1.33/$1</td>
</tr>
<tr>
<td>Nicaragua</td>
<td>.55</td>
<td>$1.80</td>
<td>.31/$1</td>
</tr>
<tr>
<td>Thailand (Northeast)</td>
<td>.58</td>
<td>$ .44</td>
<td>1.31/$1</td>
</tr>
<tr>
<td><strong>Teacher Education</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brazil (4 yrs. primary)</td>
<td>.21</td>
<td>$2.21</td>
<td>.09/$1</td>
</tr>
<tr>
<td>Brazil (Logos II)</td>
<td>.09</td>
<td>$1.84</td>
<td>.05/$1</td>
</tr>
<tr>
<td>Brazil (3 yrs. secondary)</td>
<td>.16</td>
<td>$5.55</td>
<td>.03/$1</td>
</tr>
<tr>
<td>Thailand (additional semester</td>
<td>&lt;.01</td>
<td>$ .09</td>
<td>.06/$1</td>
</tr>
<tr>
<td>postsecondary)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Technical-Vocational Secondary</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Colombia (INEM)</td>
<td>.39</td>
<td>$98.00</td>
<td>.40/$100</td>
</tr>
<tr>
<td>Colombia (tech-voc.)</td>
<td>.33</td>
<td>$376.00</td>
<td>.09/$100</td>
</tr>
<tr>
<td>Tanzania (commercial)</td>
<td>.50</td>
<td>$272.00</td>
<td>.18/$100</td>
</tr>
<tr>
<td>Tanzania (technical)</td>
<td>-.37</td>
<td>$561.00</td>
<td>-.07/$100</td>
</tr>
<tr>
<td>Tanzania (agricultural)</td>
<td>-.20</td>
<td>$375.00</td>
<td>-.05/$100</td>
</tr>
<tr>
<td><strong>Cross-Age Peer Tutoring</strong></td>
<td>.73</td>
<td>$212.00</td>
<td>.34/$100</td>
</tr>
<tr>
<td>United States</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Cooperative Learning</strong></td>
<td>1.40</td>
<td>$85.00</td>
<td>1.65/$100</td>
</tr>
<tr>
<td>Israel</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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a/ The effect size is the average score difference between treatment and control groups divided by the standard deviation of the control group (Glass, McGaw & Smith, 1981).

b/ Efficiency is the effect size divided by the per-student cost.

c/ Source for Brazil: Armitage and others (1986).

d/ Source: Jamison and others (1981) for effect; Wells & Klees (1978) for cost.

e/ Source: Heyneman and others (1985) for effect; Searle (personal communication) for cost.

f/ Source: Lockheed and others (1987).


h/ Source: Searle (1979) for effect; Wells and Klees (1978) for cost.

i/ Source: Friend and others (1986) for effect; Galda (1985) for cost.


k/ Source: Levin and others (1986).

l/ Source: Sharan and Shacher (1986).
In all but two cases, the effect of the intervention on student achievement was positive, and—for most cases—meaningful, with a median effect size of .36 (Cohen, 1969). Per-student costs varied widely, however, ranging from an additional $561 for lower-secondary agricultural training in Tanzania to $.25 for textbooks in Thailand. The consequence of this is that investment decisions based on effectiveness alone would differ substantially from investment decisions based on effectiveness-cost. In general, investments in textbooks, radio, cross-age peer tutoring and cooperative learning appear more cost-effective than investments in teacher education or technical-vocational training in secondary school. In Brazil, Nicaragua and Thailand, where the cost-effectiveness of two types of investments have been evaluated, this point is most clearly demonstrated.

In Brazil, textbooks are more than twice as cost-effective as primary teacher training, four times as cost-effective as inservice teacher training (Logos II), and seven times as cost effective as secondary teacher training. In Nicaragua, radio is half again as cost-effective as textbooks. In Thailand, textbooks are nearly five times as cost effective as each semester of postsecondary education for teachers. Thus, investing in textbooks instead of teacher training in Brazil could improve the efficiency of Brazilian education, while investing in radio education instead of textbooks in Nicaragua could increase the efficiency of Nicaraguan education.
The following sections provide details on the studies that are summarized in Table 1. Only a very few possible educational investments have been subject to analysis containing both effectiveness indicators and cost indicators, and these studies only provide examples of how decisions could be informed by such evidence.

**Instructional materials.** Most research on instructional materials has focused on textbooks, and their cost-effectiveness has been examined in several studies. Textbooks have been found more cost-effective than (a) not having textbooks in Nicaragua and the Philippines, (b) teacher education in Thailand and Brazil, and (c) a variety of other educational infrastructure and "software" inputs in Brazil.

In Nicaragua, the mathematics achievement of students in classrooms randomly assigned textbook was compared with the achievement of students in classrooms with no supplementary materials (Jamison, Searle, Galda & Heyneman, 1981). Overall textbook effects were significant, with an effect size of .36. Assuming the cost of a textbook to be $1.75 per copy (Wells & Klees, 1978), the effectiveness-cost ratio for textbooks in Nicaragua was .21.

The Philippines national textbook experiment involved supplying first and second grade children with textbooks under two different conditions: a student to textbook ratio of 2:1 and a student to textbook ratio of 1:1; a comparison group was drawn
from students in school the previous year when textbooks were not available (Heyneman, Jamison & Montenegro, 1983). The effects of textbooks were substantial, with an average effect size (over two grades and three subjects—science, math and Pilipino) of .36; no difference was observed between the effects of the two textbook conditions. The cost of the books was estimated at $.55, for a per-pupil cost of $.27 (assuming two students to one textbook) and an average effectiveness-cost ratio of 1.26.

As part of the IEA Second Mathematics Study in Thailand, data were gathered on frequency of textbook use by teachers. Students in classes in which textbooks were used "frequently" scored significantly higher on the posttest (controlling for pretest) than did students in classes in which textbooks were not used frequently (Lockheed, Vail & Fuller, 1986). The effect size was .06; the per-student cost of the textbook was estimated at $.25, for an effectiveness-cost ratio of .24. Although the effect size was small, it was equivalent to one-sixth of the average gain for the entire school year, or the same as 1.6 more months of school. In the same study, the effectiveness-cost ratio of one additional semester of post-secondary teacher training was estimated to be .06.

In Brazil, the effects on student learning of adding various "school quality" elements to poor rural schools is being examined in a longitudinal study (Armitage, Batista, Harbison, Holsinger & Leite, Leite, 1986). The results of the first two years of data collection permit comparison of several school quality elements
for their cost-effectiveness. On average for second and fourth grade students in 1981 and 1982, the effect size for textbooks was .34; the per-student cost of the textbooks was estimated to be $1.65, and the effectiveness-cost ratio was .21.

Interactive radio. The positive effect of interactive radio education for learning mathematics and foreign or national languages has been demonstrated in Nicaragua, Kenya, and Thailand. Radio has been found more cost-effective than conventional instructional methods relying on teachers alone.

The Nicaragua Radio Mathematics Project (Suppes, Searle & Friend, 1978) has been extensively evaluated. Using effectiveness figures from Searle (1979) and cost figures from Wells and Klees (1978), it is possible to estimate its cost-effectiveness. Other cost-effectiveness estimates have been calculated, but they are not expressed in effect size per $1, the standard term used in this paper. From these data, we compute an average effect size of .55 for radio mathematics project students in grades 1-4. Using a per-pupil cost of $1.80 (1976 $), the average per-pupil cost for students in grades 1-4 calculated by Klees and Wells, we calculated an effectiveness-cost ratio of .31 for radio.

From 1979 to 1985, the Radio Language Arts Program in Kenya used "interactive radio" to teach English as a second language to lower-primary students (Standards 1-3). An evaluation of this project has recently been completed (Oxford, Clark, Hermansen, Christensen & Imhoff, 1986) and per-student costs estimated
(Kemmerer & Friend, 1985). From these reports, it is possible to construct cost-effectiveness estimates for interactive radio in Kenya. Overall, radio was effective in increasing students' English language reading and listening skills; on average, for students in Standards 1-3, the effect size was .53. The per-student cost of the program was estimated at $.40, for a effectiveness-cost ratio of 1.33.

In Thailand, radio was used to broadcast radio mathematics to students in first, second and third grades. An evaluation of the effects of radio on grade two mathematics achievement reported an effect size of .58 for radio in Northeast Thailand (Friend, Galda and Searle, 1986). The cost of the radio mathematics project was estimated at $.44 per student (Galda, 1985), for an effectiveness-cost ratio of 1.31 for radio in Northeast Thailand.

**Technical-vocational training in secondary school.** The cost-effectiveness of technical-vocational programs in comparison with general academic secondary education has been evaluated in Colombia and Tanzania, with somewhat inconsistent results (Psacharopoulos & Loxley, 1985).

In Colombia, secondary vocational schools and comprehensive secondary schools offering both academic and vocational curricula (INEM schools) were compared with general academic schools. On average, students in INEM schools outperformed students in general academic schools on tests of verbal and mathematical achievement, with an average effect size of .39. The per-student cost for INEM
schools was estimated at $98 more than for general academic schools, for an effectiveness-cost ratio of .40 per $100 spent in INEM schools. Students in technical-vocational schools also outperformed students in general academic programs, with an average effect size across four programs (agricultural, commercial, industrial and social services) of .33. The average per-student cost for technical-vocational schools was estimated at $376 more than for general academic schools, for an effectiveness-cost ratio of .09 per $100 spent on technical-vocational programs.

In Tanzania, students were tracked into either technical-vocational lower secondary schools or into academic lower secondary schools. Three types of technical-vocational schools (commercial, agricultural and technical) were compared with academic schools for their effects on student academic and vocationally relevant achievement. The results differed between programs, with commercial schools being more cost-effective than general academic schools, and agricultural and technical schools being less cost-effective.

Students in commercial schools outperformed students in general academic schools on tests of mathematics, English and vocational achievement for an average effect size of .50. The annual per-student cost for commercial schools was $272 more than for academic schools, for an effectiveness-cost ratio of .18 per $100 spent on commercial programs. Students in technical schools performed less well on academic and vocational tests than did
students in academic schools, with an average effect size of -.20; since the costs of technical schools exceeded those of academic schools by $375, the cost effectiveness ratio was -.05 for each $100 spent on lower secondary technical training. Students in agricultural schools also performed less well on academic and vocational tests than did students in academic schools, with an average effect size of -.37 and an incremental $561 per-student cost, for an average effectiveness-cost ratio of -.07 for each $100 spent on agricultural training in lower secondary schools.

**Teacher training.** The evidence regarding teacher training suggests that training that emphasizes basic skills is more cost-effective (vis-a-vis student learning) than training that refines skills at a higher level.

In Brazil, a study of the effectiveness of various "quality" inputs included teacher education as one of the inputs (Armitage et al, 1986). Three types of teacher educational background were identified: inservice training (Logos II), four years of primary education and three years of secondary education. Differences in performance for students having teachers with each type of educational background were assessed for grades 2 and 4, in 1981 and 1983; the comparison group comprised students of teachers lacking completed primary education. Overall, the average effect sizes for the three types of teacher education programs were: .09 for Logos II, .21 for four years of primary, and .16 for three years of secondary. The costs for each type of training were, respectively, $1.84, $2.21 and $5.55. The cost-effectiveness,
therefore, for each teacher education program was .05, .09 and .03, with four years of primary education the most cost-effective.

In Thailand, the cost-effectiveness of additional semesters of teacher training in mathematics was assessed vis-a-vis student learning of eighth grade mathematics (Lockheed, Vail & Fuller, 1986). The effect size for each additional semester of public postsecondary mathematics education was estimated to be less than .01 at a per-student cost of $.09. The effectiveness-cost ratio, therefore, was computed to be .06 for each semester of mathematics education.

Packages of inputs. The empirical literature provides little rigorous guidance with respect to effective packages of inputs and processes. However, it is believed that providing teachers with textbooks but no training in their use will be less cost-effective than providing training along with the textbooks. Similarly, the effectiveness of radio mathematics classes will be enhanced when students are also provided opportunities (blackboards, paper and pencils, workbooks) with which to practice skills taught in the radio lesson.

Efficiency of alternative educational processes

Although there is no evidence regarding the efficiency of alternative educational processes in developing countries, some evidence is available from studies conducted in the United States and Israel. Even in developed countries, however, costs
associated with pedagogical practices and alternative organizational structures have rarely been computed. Instead, costs associated with changing teacher behavior from one set of pedagogical practices to another have been assessed. Some pedagogical practices, such as using higher order questioning strategies, have never been analyzed from a cost perspective, even though they are known to be effective in increasing student learning. The following paragraphs present some information regarding the cost-effectiveness of selected educational processes and organizational forms. In this section, the effectiveness-cost ratio is expressed as effectiveness per $100.

**Cross-age peer tutoring.** This pedagogical practice has been most closely investigated relative to its cost-effectiveness (Levin, Glass & Meister, 1984). It entails the use of older students as tutors of younger students; comparable learning gains were found for both tutors and tutees. Overall tutoring effects were substantial, with average effect sizes of .97 and .48 for mathematics and reading, respectively. Costs of the peer tutoring intervention were estimated at $212 per student participant. The effectiveness-cost ratio for peer tutoring was estimated as .34 (the effect size for each $100 of cost per pupil).

**Group investigative method.** In the cooperative learning classrooms, each student was a member of a four-person group that served as the social unit for learning purposes Sharan & Shachar, 1986). Classes were assigned randomly to control (whole class) and experimental (group investigative) conditions. Overall, the
effects of cooperative learning were substantial, with effect sizes of 1.30 for geography and 1.50 for history. Preliminary analysis suggests a per pupil cost of approximately $85; since this study was conducted in Israel, costs are not comparable to the peer tutoring costs presented above. The preliminary effectiveness-cost ratio was estimated at 1.65.

Summary

This paper has defined internal efficiency and has presented evidence regarding the relative cost-effectiveness of several educational interventions: instructional materials (textbooks), teacher training, interactive radio, technical-vocational schools, peer tutoring and cooperative learning. On average, across several countries and a variety of student learning outcome measures, the more cost effective interventions are textbooks, interactive radio, peer tutoring and cooperative learning. Less cost-effective are teacher training and technical-vocational schools.
Footnotes

1. To reduce costs, Bobbit suggested that it would be necessary "to build inferior buildings, omit playgrounds, school gardens, laboratories, workrooms, and assembly halls, to employ cheap teachers, to increase the size of classes, to cut down the yearly term to eight months, or to accommodate two shifts of children in the same building each day by doing half time work" (Callahan, 1962, p. 131)

2. We tend to concentrate on directly observable effects like literacy or numeracy, rather than on a broad range of indirect effects such as health, nutrition, or fertility, since these effects are hard to trace. When these are identified as objectives of educational programs, such as nutrition educational programs, then they are properly classified as "internal".

3. Benefits in terms of increased productivity in the labor market are both easiest to measure and most common; benefits in terms of health, nutrition, fertility, and social behavior are on the other hand difficult to measure and much less frequently considered in any formal analysis of external efficiency.

4. Effect size is defined as the average score difference between treatment and control groups divided by the standard deviation of the control group (Glass, McGaw & Smith, 1981).
References


Sharan, S. & Shachar, C. (1986). Cooperative learning effects on students' academic achievement and verbal behavior in multi-ethnic junior high-school classrooms in Israel. Tel Aviv: Tel Aviv University School of Education.
