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LEARNING RESOURCE CENTER
ECONOMIC ANALYSIS

A TRAINING MODULE

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OVERVIEW

This manual shows how and when to apply four common methods of economic analysis to the planning of learning resource centers for community based education in Latin America. The methods are:

- Benefit/Cost Comparison
- Cost-Effectiveness
- Cost-Efficiency and
- Cost-Utility Estimation

A workbook format is used for active participant response. Illustrative examples and exercises demonstrate the use of these economic analysis techniques in situations commonly faced by learning resource center field managers, cost analysts and Ministry of Education planners.

The purpose of applying these economic analysis techniques is to increase the impact of a given community learning resource center budget or to reduce the cost of community learning resource centers without lowering their outcomes.

It is assumed that instructors of this module will have been through it first and mastered its content and techniques.

I. INTRODUCTION

People like to get their money's worth. They invest in education when they think it will pay off for them. Educational planners are currently examining learning resource centers (LRC's) in community education to see if they are economically attractive. They want to know if and how much to invest in learning resource centers of various types and whether to expand existing LRC's or build new ones.

The purpose of economic analysis is to show decision makers "what you get" for "what you pay." Methodologies exist for doing this. Four common ones are reviewed here. They are: 1) benefit/cost comparison, 2) cost-effectiveness, 3) cost-efficiency and 4) cost utility estimations. The participant will learn how these techniques differ and what you need to use each.

The techniques then will be applied to sample studies of economic analysis of learning resource centers for community based education in Latin America. You will discover what each economic analysis technique can tell you specifically and how to pick the right one for the job. The limitations of the tools are compared, so you will know the restrictions when faced with making an economic analysis of LRC's on which important decisions may be based.

Although the economic analysis of LRC's for community based education in Latin America is not a perfect "science," it is not complete mysticism either. Armed with these techniques you can mix quantitative economic analysis with common sense, and recommend to decision makers appropriate learning delivery systems for improving community education.

The assistance of Martin Carnoy and Henry Levin of Stanford University in discussions and writings is gratefully acknowledged.[1/] Francisco Swett participated in the development of the illustrative examples and exercises in this and a Spanish version. Jack Crawford helped in the examples too. Gene Lamb and Jack Crawford of San Jose State University and AID/Washington administrators provided helpful guidance. Lucy Reyes did the typing.

Dollars are used for illustrative prices in the examples but may be translated into any local currency.

1/ For example, Henry Levin, "Cost-Effectiveness in Evaluation Research," in M. Guttentag, ed., Handbook for Evaluation Research, Society for The Psychological Study of Social Issues, 1975. Available in English.

II. LEARNING OBJECTIVES

After completing this module, you will be able to:

- Select an appropriate economic analysis tool for assessing community learning resource center plans from among:

  -- benefit/cost comparison
  -- cost-effectiveness
  -- cost-efficiency and
  -- cost-utility analysis

- Obtain the data you need to be able to use each method.

- Carry out the calculations of an economic analysis, leading to results and implications.

- Make recommendations to LRC decision makers, based on the results and implications of your analysis.

- Convey the limitations of your study and a sense of what is reasonably likely to occur if your recommendations are carried out.

- Transmit a sense of what difference it could make.

III. IDENTIFYING LRC PROJECT COSTS AND OUTPUT BENEFITS

A. INPUTS AND OUTPUTS OF EDUCATIONAL PROCESSES

We will start with the "input-output" notion. It explains a lot. All processes have "input" ingredients and "output" results. Each may be, and usually is, more than one. Let us refer to the schematic sketch in Figure 1.

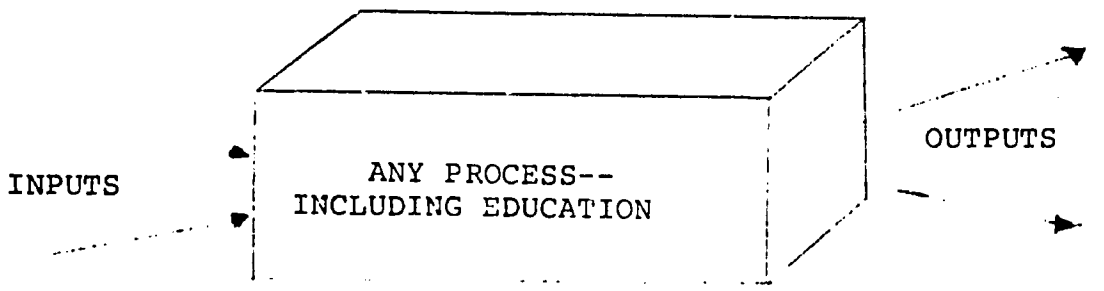

Figure 1
Processes Have Inputs and Outputs

Among recognized inputs to education processes are learners and institutions' time and money. Inputs people want to minimize are "costs."

Outputs, or the useful results of educational processes

include greater labor productivity and earnings, more modern attitudes and increased self-esteem. Outputs judged desirable are "benefits," a term which also has a more restricted monetary meaning in Part IV.

A recent learning resource center provided vaccine for hoof and mouth disease in cattle, along with demonstrations on how to use the vaccine. Instruction was continued until half the farmers accepted it and vaccinated their cows. That took a year, and then the learning resource center discontinued the instruction, but kept a supply of the vaccine on hand. They figured that a 50 percent "take" of the new treatment was about all that could be exepected and that it would be too expensive, if not impossible, to "hook" all the other farmers. The idea might spread among the farmers themselves. The instructors' time and efforts were limited and besides they had to turn their attention to other worthwhile LRC activities that offered a greater chance of payoff. Everybody in the community thought this was a reasonable cut off point for the vaccine instruction. (illustration here — cow getting an injection)

Inputs to the process of learning about the new

vaccine were the vaccine itself, the time and interest of the community's cattle raisers, a place to meet, and the time and skills of the instructors who were other farmers from the region.

Recognizable outputs are, immediately, healthier cattle, and in the long run a better diet and more money for the community's cattle raisers and their families, which is just about everybody.

Isn't vaccinating cattle obvious common sense? Perhaps. But try to put a price tag on the desirable outcomes as well as the price of not introducing it. Try to sell the idea to community leaders. They'll want to know what they're going to get and what it is going to cost them. You will soon need the skills of economic analysis.

An economic analysis of any process must begin with being able to clearly distinguish the inputs to it from the outputs from it, as well as the inputs from each other and the outputs from each other. We will spend a lot time on costs and benefits because they are the heart of deciding if starting or expanding a learning resource center is worth investing in. Some-

times the benefits will be monetary and sometimes they will be measured in another ways.

There is no time like the present for you're taking an active role in economic analysis. How about trying your hand at recognizing costs and benefits in community education?

DISTINGUISHING COSTS AND BENEFITS

EXERCISE 1

Community based education using learning resource centers is a process having inputs and outputs. What are some of its desirable output benefits ? What are some of the costs? Just name them below; numerical exercises will come later on.

Extend the starter list below. A community resource center might be focused on improvement in plant production or family health. Select one of these topics or any other that seems appropriate to your own interest and fill in the table with your ideas of things that belong on the benefit side and things on the cost side. The purpose of this exercise is to stimulate your thinking on distinguishing costs from benefits in community education.

NOTE TO INSTRUCTOR:

This and other exercises are suggestive, but actual exercises for use will vary with your objectives, the time available and the learners' needs.

LRC's in COMMUNITY EDUCATION

List Benefit Items	List Cost Items
• Increased Earnings	• Additional travel cost
• Increased prestige (you add others to the list)	• Construction
•	• Sacrifice of income that could have been earned while learning
•	• (you add others)
•	•
•	•
•	•
•	•

The hard part is over and now the fun begins.

Are you ready to continue with costs and benefits?

B. Perceptions of Costs and Benefits

Learning Resource Centers (LRC's) are projects that aid in the process of community based education. Learning reource center planners, operators, potential and actual users, other competitors for scarce resources, and society as a whole all have their own perceived sets of benefits and costs. These perceptions are subjective, and can differ from one person or group to another. LRC planners should recognize this and allow for it in their planning.

For example, one person may "see" relatively small costs and relatively large benefits of a proposed LRC project, such as in family planning (Figure 2a). That person sees only bus fare as cost, and leisure and a better life for a smaller family as benefits. Another person may perceive the reverse relationship (Figure 2b). That second person may see the costs as bus fare and the loss of part-time employment when putting time into the learning resource center, as well as the possible "psychic" cost of not having many children.

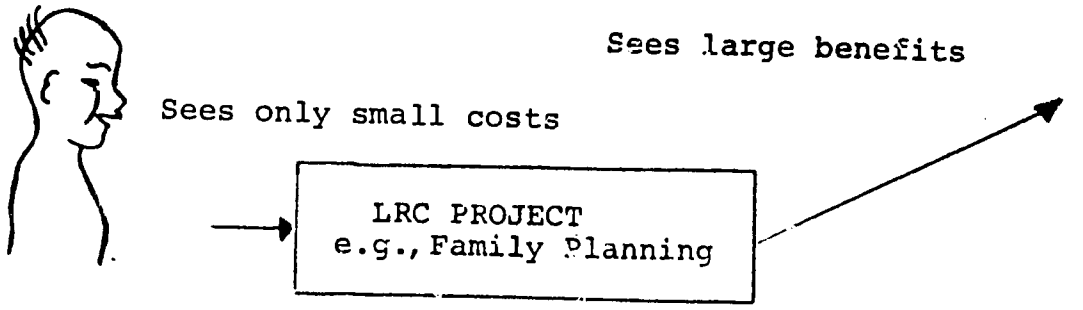

Figure 2 (a)

Perceeptions of Costs and Benefits can Differ

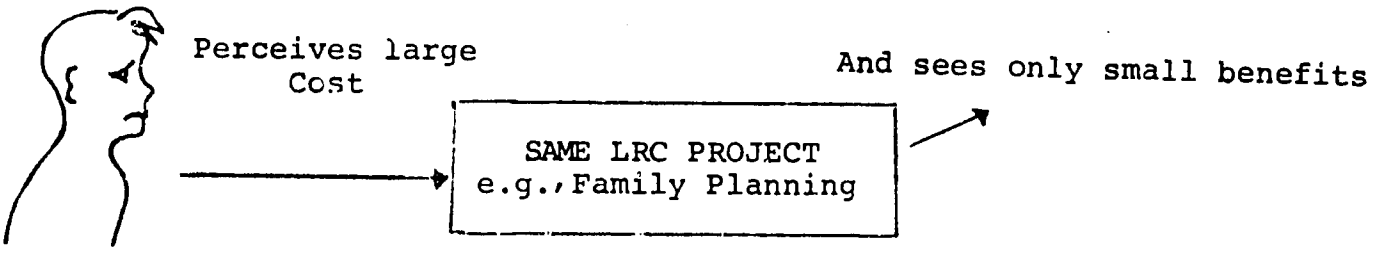

Figure 2 (b)
Perceptions of Costs and Benefits can Differ

Are you ready to try an exercise on people's different perceptions of costs and benefits of learning resource centers? This is to demonstrate that economic analysis is not a perfectly "scientific" endeavor.

PERCEIVED COSTS AND BENEFITS

EXERCISE 2

What are some of the costs and benefits in each of these proposed LRC projects that may be perceived differently by different constituents?

AN AGRICULTURAL LEARNING RESOURCE CENTER PROJECT

Suppose that many of the community's cattle have brucilosis. A vaccine has been developed that controls the disease. It has been proposed to expand activities within an existing learning resource center that would provide the vaccine as well as information on how to use it.

(1) List some items of cost and benefit as they might be perceived by a cattle farmer:

CATTLE VACCINE AND VACCINATION INFORMATION LRC

LIST BENEFITS SEEN BY CATTLE FARMER	LIST COSTS SEEN BY CATTLE FARMER
•	•
•	•
•	•
•	•
•	•

(2) List some cost and benefit items of this proposed LRC as may be perceived by another of the town's constituents (you identify): _____

LIST BENEFIT ITEMS	LIST COST ITEMS
•	•
•	•
•	•
•	•
•	•

MORE PERCEIVED COSTS AND BENEFITS

EXERCISE 3

WOMEN'S TRAINING LEARNING RESOURCE CENTER PROJECT

A learning resource center project has been proposed to train women for expanded roles in the community, some of which are not traditional.

(1) List some items of costs and benefits of this proposed LRC as they might be perceived by town women.

LIST BENEFITS ITEMS SEEN BY TOWN WOMEN	LIST COST ITEMS SEEN BY TOWN WOMEN
•	•
•	•
•	•
•	•
•	•
•	•

(2) Now, estimate how the same LRC project may be perceived by rural women.

LIST BENEFIT ITEMS	LIST COST ITEMS
•	•
•	•
•	•
•	•
•	•
•	•

C. Monetary and Non-Monetary Costs and Benefits

People are motivated to action by both the purely "monetary" (dollar) benefits and costs as well as by those costs and benefits that can not be measured in purely monetary terms. The non-monetary costs and benefits are called "psychic costs " and "psychic benefits," respectively.

Each of the two persons shown in Figure 3 pays more attention (perhaps unconsciously)to the non-monetary ("psychic") costs and benefits of an illustrative proposed LRC project than to the purely monetary costs and benefits. Such psychic emphasis in motivation is not uncommon, and means that purely economic considerations form only part of a person's set of motivations. Simple dollar and cents questions often do not decide action, and tell only part of the story.

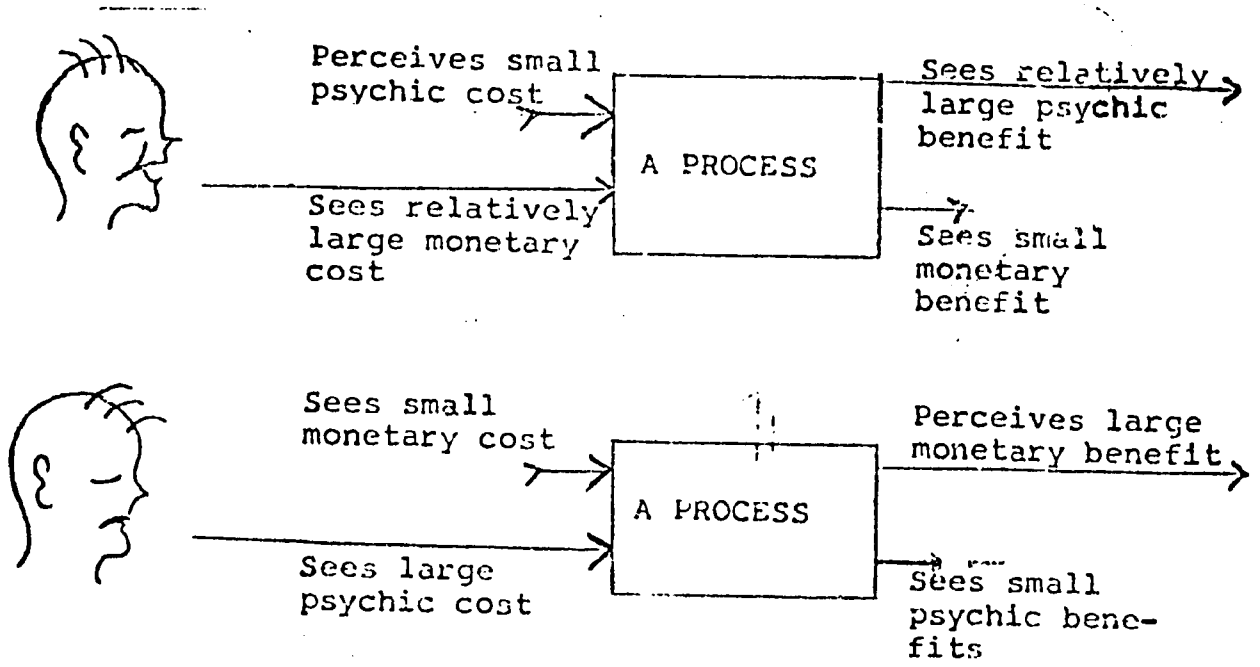

Figure 3
Perceived monetary and non-monetary psychic costs and benefits may differ between individuals

A simple "go" - "no go" economic decision rule states: if monetary benefits of a proposed project exceed the monetary costs, then the project is economically favorable -- "go." But if the monetary costs exceed the monetary benefits, the project is unfavorable --"no go." However, since this type of simple rule ignores the "psychic" benefit and cost side of projects, it cannot be relied on exclusively in trying to predict human behavior in community education.

Peer pressure can account for alot of "psychic" costs and benefits, if we "go" against or with the group.

How about doing an exercise distinguishing non-monetary costs from non-monetary benefits? We know you can do it.

NON-MONETARY BENEFITS AND COSTS

EXERCISE 4

Consider non-formal education. Let's define this to mean "out of school" education. List what you perceive to be some of the psychic (non-monetary) benefits and psychic costs of non-formal education for the learner:

NON-MONETARY BENEFITS OF NON-FORMAL EDUCATION	NON-MONETARY COSTS OF NON-FORMAL EDUCATION
• Feeling of accomplishment	• Loss of leisure
• (You add others)	• (Add others)
•	•
•	•
•	•
•	•
•	•

D. LEARNING RESOURCE CENTERS IN NON-FORMAL EDUCATION

Now let's consider LRC's within non-formal education

Let's see the monetary and psychic cost and benefit balance sheet to a user.

LRC USER'S COSTS AND BENEFITS

EXERCISE 5

Learning resource centers offer a possibly attractive delivery mode of non-formal education. List, and calculate where possible, some of the costs and benefits (to a potential user) of his or her attending a learning resource center. Extend the starter list below, building on Exercise 1 through 4. Notice that we have reached a four-way split of cost and benefit categories.

BENEFITS	COSTS
1) Monetary Benefits	1) Monetary Costs
• Greater earnings	• Extra travel cost
• (List others, and evaluate if possible)	• Sacrifice of "moon-lighting" opportunities (earnings foregone)
•	• (List others and evaluate if possible)
•	•
•	•
•	•
•	•

BENEFITS	COSTS
2) Non- Monetary (psychic) Benefits	2) Non-Monetary (psychic) Costs
• Feeling of accomplishment	• Loss of leisure
• (You add to list)	• (You add to list)
•	•
•	•
•	•
•	•
•	•

Let's see what an LRC's benefits and costs are to the different kinds of sponsoring agencies. Community learning resource centers could be indigenously based, sponsored by a regional or provincial government or by the national Education Ministry, or a religious or lay group.

LRC SPONSOR'S COSTS AND BENEFITS

EXERCISE 6

We have just looked at what an LRC could mean to a user.

Now make the same kind of cost and benefit list as in Exercise 5, but this time take the perspective of a potential learning resource center sponsoring agency, such as the Non-formal Education branch of the Ministry of Education. Extend the starter list below.

BENEFITS	COSTS
1) Monetary Benefits	1) Monetary Costs
• Additional community production due to more productive labor force.	• Higher budget needed for staff salaries
• (List others)	• (List others)
•	•
•	•
•	•
•	•
•	•

BENEFITS	COSTS
2) Non-Monetary ("psychic") Benefits • More prestige due to greater number of administrators hired. • (List others) • • • • •	2) Non-Monetary Costs • Loss of informal atmosphere as agency grows: "growing pains" • (List others) • • • • • •

You are on the way to making economic analyses. Congratulations.

E. Benefit/Cost Relation and Scale of Operation

There is one more notion before turning to specific Learning Resource Center cases. In many educational projects, increasing (incrementing) the input costs leads to an increase, or increment, in the output benefits. That is, "the more you pay, the more you get" (Figure 4). The "leaning-over S shape" in the figure is typical of many processes. We have to have data in order to plot it.

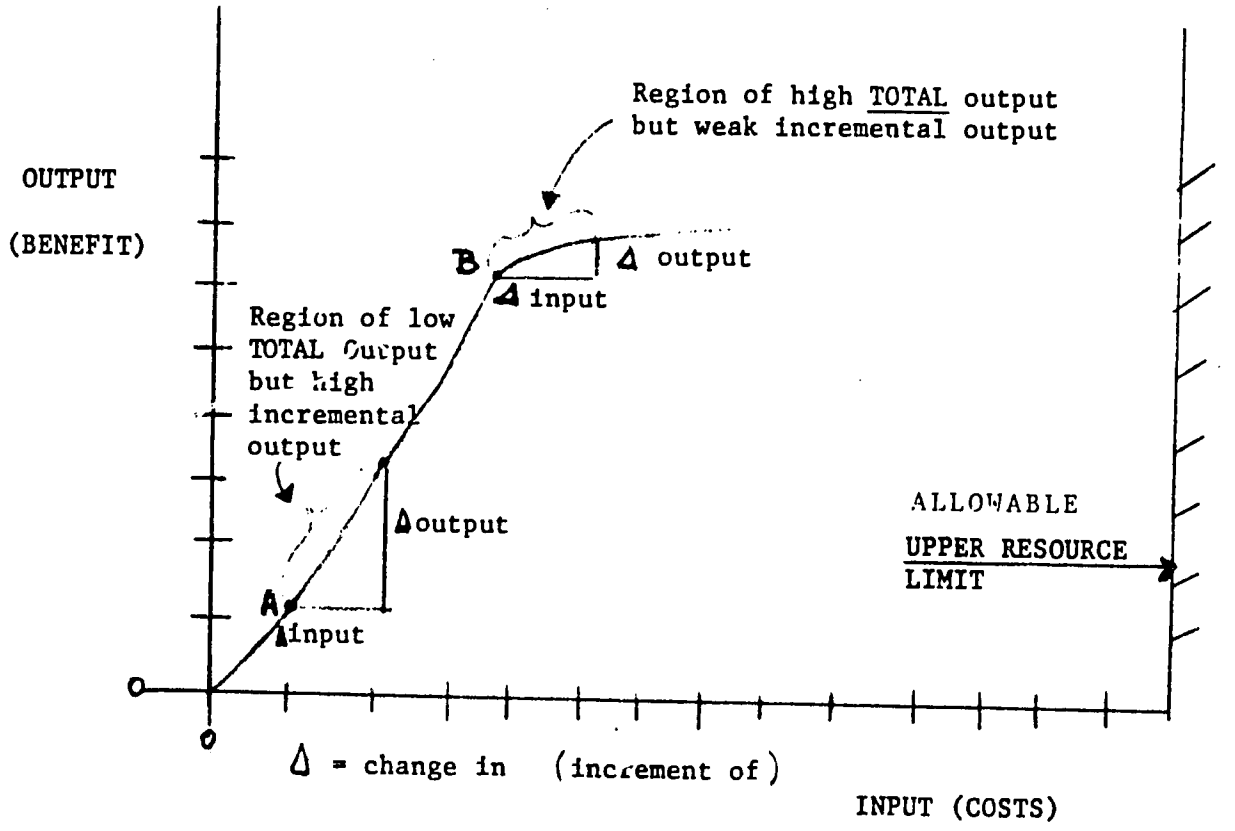

Figure 4
Positive Input-Output Response Curve

Note: Δ = change in (increment of) some quantity

Now suppose we know the shape and numerical values along the input-output curve. The curve tell us "what you get" at different levels of "what you pay." This knowledge is a valuable part of planners needed financial data.

This illustrative curve is steeper near point A, and levels off beyond B. LRC expansion projects following these data would thus be more attractive near point A than near B. This is because a given additional cost input (Δ input)[1/] yields a bigger vertical rise along the output curve near A than near B.

A practical example would be that of converting a town's primary water purification treatment plant to a second level of treatment if the change would provide substantially increased benefit to the community at only a modest additional cost.

On the other hand, converting a secondary water treatment plant to a tertiary one (near point B) would be very expensive and would probably not provide sufficient additional benefit to the town to be worth the extra investment. Educational questions of scale have a similar reasoning.

Large scale operations are not necessarily more efficient than small scale ones. Where a proposed expansion in community education does pay off and where it doesn't is an important theme in the economic analysis of learning resource centers.

1/ The symbol Δ (delta) is used to indicate a change or increment of some quantity.

An expansion project should be analyzed on an incremental cost and benefit basis, while a brand new project needs to take the total costs and benefits into account. In any viable project the upper total cost limit (the vertical "wall" in Figure 4) can not be exceeded. Next we will move into the particular tools of economic analysis.

FINDING THE RIGHT SCALE OF OPERATIONS

EXERCISE 6-A

First, how about trying a participation exercise?

Refer to Figure 5. It shows the community's estimated sales earnings annually that are associated with different levels of annual expenses of a furniture making activity in a learning resource center.

Put the correct number from 1 to 6 next to each of these concepts.

$1,000 extra cost with little extra payoff to show for it _____

A large payoff to $1,000 extra cost _____

A good point to run the learning resource center at _____

$1,000 extra cost yielding a good payoff _____

A poor operating point for this furniture making LRC activity, since there are other important places that the community can put its extra money_____

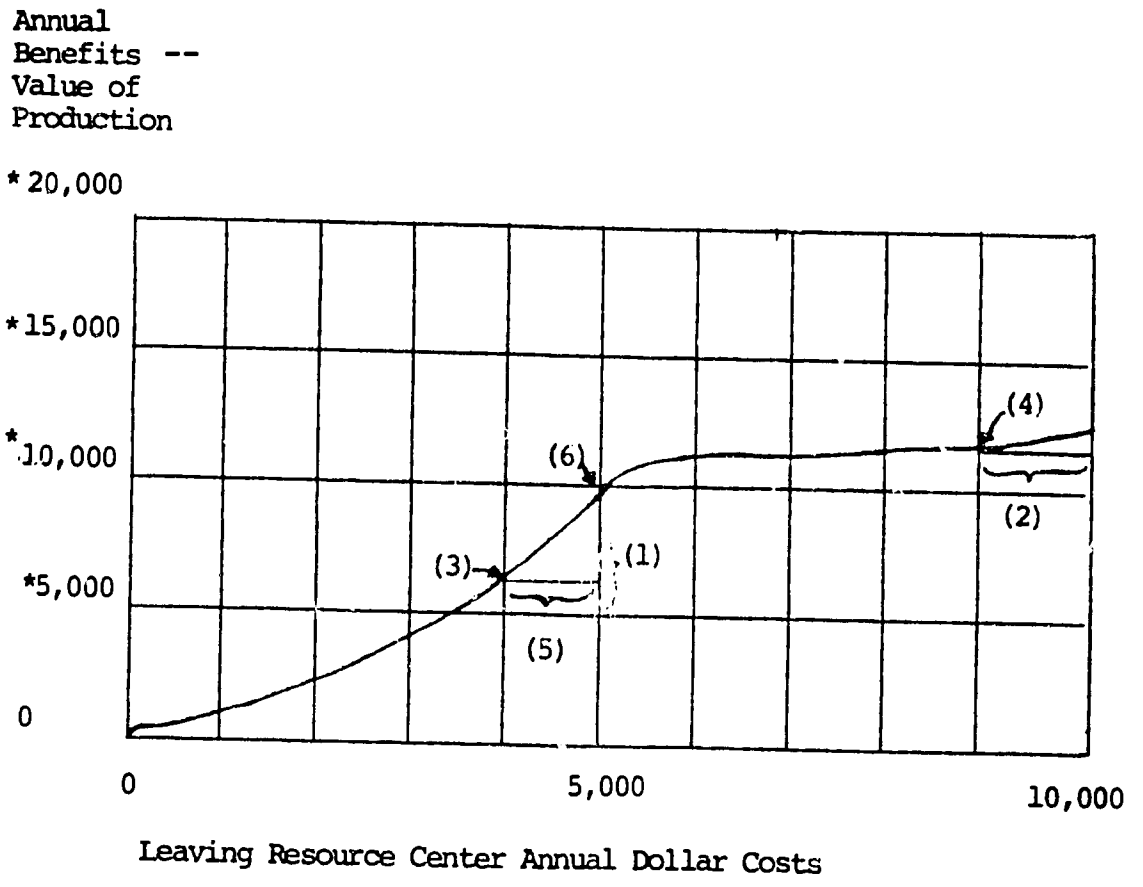

Figure 5

Data for Exercise 6a

* Pesos

IV. ECONOMIC ANALYSIS OF LEARNING RESOURCE CENTERS

A. SELECTING AN APPROPRIATE APPROACH

Picking the right tool is a good way to start off.

(Illustration: Someone picking a tool)

Learning Resource Center plans are analyzed economically by four common tools. Let's repeat them.

1. Benefit/Cost Comparison
2. Cost-Effectiveness Estimate
3. Cost-Efficiency Calculation
4. Cost-Utility Computation

Each has its special use. Briefly, the differences among them are as follows. These methods are studied in greater depth in Section B, below, and applied to sample economic analyses of Learning Resource Centers there.

1. Benefit/Cost Comparison.* This economic analysis technique requires that both the benefits and the costs be measured and expressed directly in monetary terms (that is, in dollars and cents). The costs and benefits are compared directly to each other by calculating either their ratio or their difference.

Example: A shoe repair man figures he could learn to make shoes in the learning resource center of the community at a cost to him of only **200 and 40 hours of free time. He would have to borrow half the money, but judging by the demand he has observed for new shoes and the difficulty of obtaining them at a reasonable price outside the community, he believes he can increase his annual income five fold, from **2,000 to **10,000 if all goes well. The risks are small and he decides to go ahead, having sensed a very favorable ratio of financial benefit to financial cost. His B/C analysis is also reinforced on the "psychic" side, as he would enjoy a lot more prestige as a manufacturer (albeit small) than as a repair man.

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* From here on in this module, the term "benefit" is used in its narrow (monetary) sense in the examples and exercises. This is because "psychic" benefits, although important, are difficult to measure quantitatively. See, however, "cost-utility" analysis, below, where non-quantitative factors are included.

** Pesos

2. Cost-Effectiveness Estimation. This approach needs the numerical specification of one final product or output goal. The goal need not be expressed directly in monetary terms, but it must be equally achieved by all the alternative projects under consideration. In cost-effectiveness studies, the analyst searches for the most desirable (usually defined at the least costly) path to the specified output goal.

Example: A villager is looking for the least expensive way to learn to grow an additional ton of corn in a season. He thereby is making a cost-effectiveness analysis.

Another example: A seamstress of the community wants to learn how to make her own dress patterns. She could move to the city for a period of time and enroll in the city's vocational school Home Economics program, at a total cost to her of 1,500, or she could attend an LRC in her own village in her off hours and learn the same skills at a total cost to her of 200. The less expensive path to the same skill (the LRC) would be the more cost-effective route to her goal.

3. Calculation of Cost-Efficiency. Efficiency is defined in general as useful output divided by input, or "what you get" divided by "what you pay." When the input is cost, the output divided by the cost becomes "cost-efficiency." The lower the cost for a given output, the greater is the cost-efficiency. Or, the bigger the useful output for a given cost, the larger is the cost-efficiency.

Outputs of different LRC projects in cost-efficiency studies are not necessary the same. This is the main difference between cost-efficiency and cost-effectiveness studies. In cost-efficiency calculations, there is not one final product or level of output for all projects being considered, as there must be in cost-effectiveness studies. Cost-efficiency studies can compare different projects with different output benefits and different cost inputs. They can be ranked in order of cost-efficiency.

Example: A member of the community is looking for the way to buy the most cooking oil per dollar, regardless of the quantity that the oil must be purchased in, as long as the total purchase is within an allowable

total cost. She may find herself buying a liter, a gallon or a barrel of oil, depending on the amount that various suppliers provide, but any of these containers is all right with her as long as she gets the most oil for the money. She is thereby seeking the greatest cost-efficiency in her purchase.

Contrast this situation with another person's searching for the lowest price for exactly one, and no more or less, liter of oil. This would be the cost-effectiveness approach to the purchase. Learning Resource Center users are "buying" skills and knowledge, so these examples are relevant. LRC sponsors are also buying something-community modernization.

4. Computation of Cost-Utility. This final technique needs the expression of subjective "value judgements" in the form of relative weighting factors that state the relative "value" or importance of different output results of an LRC project. It permits decision making among projects in which important subjective criteria are present as well as purely quantitative ones. As in 2 and 3 immediately above the benefits need not be measured in dollars and cents and, as in 1 and 3, the output need not be the same for the projects being compared. The crucial difference between cost-utility

analysis and the other three techniques is that someone or group's value judgements are included in the measure of "what you get." The output is not coldly objective.

Example: A rural community is in transition between transportation and farming using horses on the one hand, and automobiles and tractors on the other.

A learning resource center has been proposed that could introudce 4000 man-hours of training in automobile mechanics and the use of road building equipment for $2,000, or 2 man-hours of training per dollar spent.

An alternate farm animal equipment learning resource center proposal would provide for 6400 man-hours of training in foundry, forge and woodworking for building and maintaining horse drawn vehicles and farm implements. The cost would be $800,yielding 8 man-hours of training per dollar or four times the objective output per dollar of the motor-vehicle oriented LRC plan.

The deciding group consensus, however, is that the car training is twice as "valuable" (hour for hour) as the animal-oriented LRC training these days.

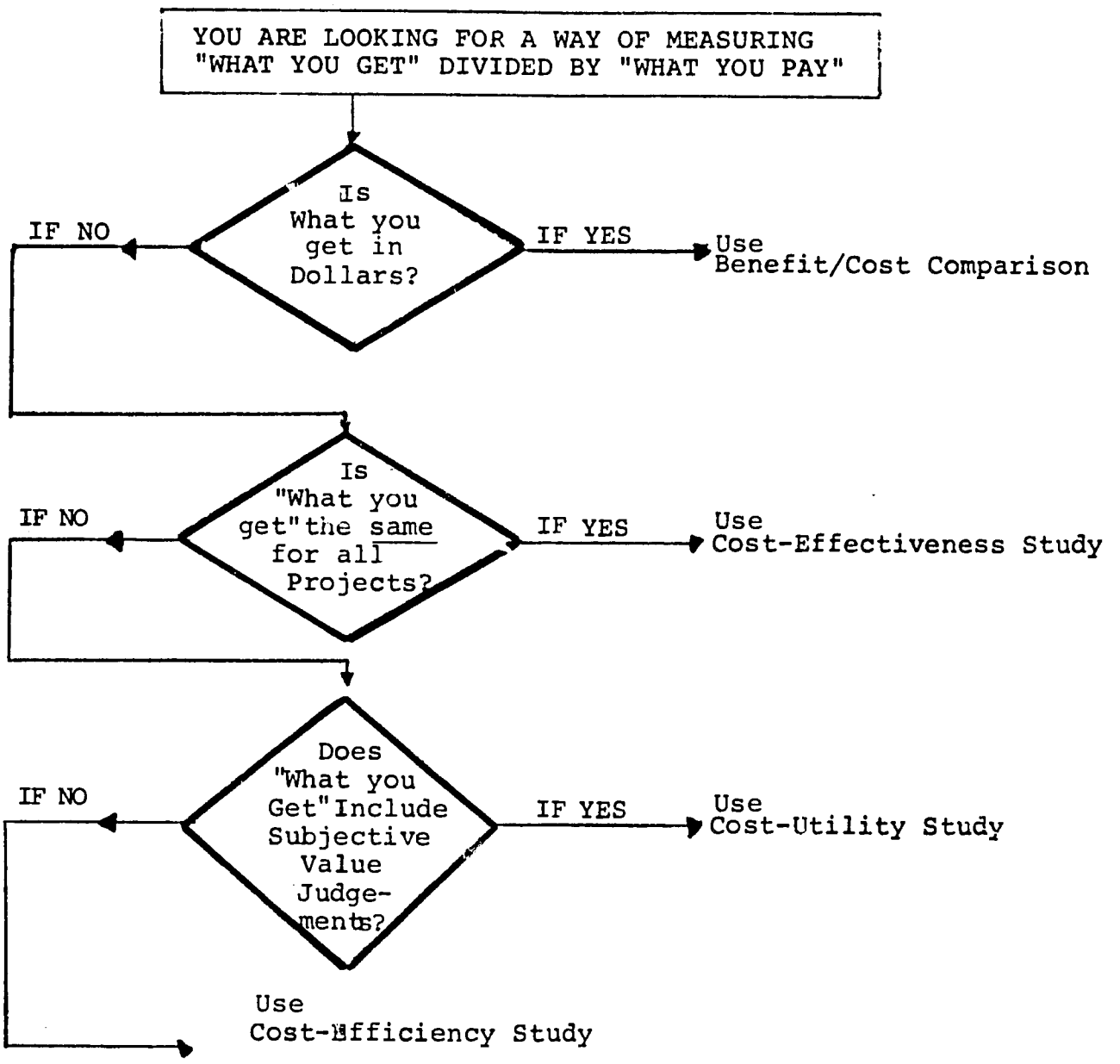
Even with the relative weight included, however, the animal oriented training still has twice the weighted cost-utility as the motor vehicle oriented plan, and the community therefore decides to opt for the traditional animal oriented shop training for the time being.

The table and flow chart below summarize the main distinguishing characteristics of the four economic analysis tools. Then, Exercise 7 starts you off with some practice in choosing among them for a particular community learning resource center.

SUMMARY OF ECONOMIC ANAYLYSIS METHODS FOR COMMUNITY EDUCATION PROJECTS

METHOD OF ANALYSIS	REQUIRED INFORMATION TO BE ABLE TO MAKE THIS KIND OF ANALYSIS	OBTAINABLE PRODUCT FROM THE ANALYSIS
Benefit/cost Comparison	Benefits as well as costs must be known in dollars.	The costs substracted from the benefits=the "net benefit." The benefits divided by the costs= the "benefit-to-cost ratio." Decision rule: If B exceeds C, "go." If C exceeds B, "no go." Yields priority rank ordering among the alternative projects, according to the net benefit or B-to-C ratio.
Cost-Effective-ness Analysis	Needs one specific, unambiguous and quantitative goal for all the alternative projects under consideration. The goal need not be measurable in dollars. The costs must be known in dollars	The most desirable project is usually defined as the least costly one to achieve the said goal, and can be recommended.
Cost-Efficiency Analysis	Each alternative project must have a quantitative output measure (not necessarily the same level for all projects nor measured in dollars). Costs must be known in dollars.	The output, "what you get," divided by the input, "what you pay" is defined as the cost-efficiency. It is found for each project, and they can be ranked in order of their cost-efficiency.
Cost-Utility Analysis	Each project must have a quantitative output measure as in cost-efficiency study. But in addition, some person or group must assign relative value judgement "weights" to the various outputs. Outputs need not be the same nor monetary, but the costs must be known in dollars.	The value-weighted output measure ("what you get") divided by the cost is the cost-utility. Projects can be ranked in order of cost-utility and the priority order recommended to decision makers.

DECISION TREE FOR SELECTING
APPROPRIATE ECONOMIC ANALYSIS TECHNIQUE



Now apply this tool selector in Exercises 7 through 11.

Figure 5a

CHOOSING THE APPROPRIATE ECONOMIC ANALYSIS TOOL

EXERCISE 7

Select the appropriate economic analysis instrument for studying each of the following proposed learning resource center (LRC) projects. You will be asked to choose from among benefit/cost, cost-effectiveness, cost-efficiency or cost-utility analysis, according to the above review of their differences and the information available for each case. You are not asked here to make an economic analysis yet; just to select an approach, for the time being. All numbers used in the examples are hypothetical and for illustrative purposes only.

Project 1. A community is considering creating a learning resource center (LRC), emphasizing improved agricultural skills. During its life, this LRC project is expected to have a total cost of *200,000. During the same period of time, it is expected that the increased profits, due to greater agricultural production as a result of the increased knowledge and skills instilled in the LRC users, would be *500,000.

Community decision makers wish to know whether or not to go ahead with the LRC project ("go" or "no go"). Choose the correct economic analysis tool among these four and explain the reason for your choice.

1. Benefit/Cost Comparison
2. Cost-Effectiveness Estimate
3. Cost-Efficiency Calculation
4. Cost-Utility Computation

* Pesos

CHOOSING A TOOL

EXERCISE 8

Project 2. It is proposed that an LRC provide a total of 700,000 man-hours of literacy teaching during a six year period, to begin in one year. There are three available alternative literacy delivery methods, all of which are expected to produce equal learning results (that can be quantitatively measured with achievement tests).

Plan A. Conventional personal one-to-one tutoring instruction, using a minimum of written or electronic materials. Total cost: *9,000,000.

Plan B. Utilization of electronic media, with the instructional materials and programs, such as taped lessons, to be produced locally in the LRC. Total estimated cost: 7,000,000.

Plan C. Also uses electronic teaching materials, but produced in and broadcast from a central source located in the national capital city. Total estimated cost: *12,000,000.

The community wants to know which of the three literacy delivery plans to adopt. Choose the appropriate economic analysis technique and explain the reason for your choise.

1. Benefit/Cost Comparison
2. Cost-Effectiveness Estimate
3. Cost-Efficiency Calculation
4. Cost-Utility Computation

* Pesos

CHOOSING A TOOL

EXERCISE 9

Project 3. A community has to make a decision to train health personnel using a learning resource center. These are the three delivery possibilities under consideration:

Plan A. Emphasizes the training of medical aides for disease prevention and betterment of health and hygienic conditions. The plan would have a total cost of *500,000 per year. It would avoid the loss of 50,000 man-hours of work attributable to illness per year.

Plan B. This plan emphasizes the training of personnel qualified to treat specific illnesses. The anticipated cost per year is *1,100,000 per year, with a savings of 200,000 man-hours of work per year that would be otherwise lost due to illness.

Plan C. Would emphazise both the training of medical aides for prevention of disease and of qualified personnel for treating and curing disease. The annual cost of this combined plan would be *800,000. The combined elimination of work time lost due to illness is estimated at 190,000 man-hours annually.

Choose the correct economic analytical tool for LRC decision making, and explain why you made that choice.

1. Benefit/Cost Comparison
2. Cost-Effectiveness Estimate
3. Cost-Efficiency Calculation.
4. Cost-Utility Computation

* pesos

CHOOSING A TOOL

EXERCISE 10

Project 4. The community wants to decide on the type of program they should empasize in an LRC they are thinking of constructing. Two important different alternatives exist.

Plan A: Emphasizes an increased agricultural productivity program, but only for those presently farming. Although this program would have limited participation, the community would observe tangible and immediate results. The total cost would be $40,000 over a 5 year period. The total learning to be provided by the learning resource center (LRC) would be measured as 2,500 participant-hours of training.

Plan B: Emphasizes a literacy program for all members of the community who wish to participate. This program has the advantage of almost universal participation, but the results are not immediately tangible. The total cost is $100,000 for five years. The total learning (participation) to be provided by the LRC under this plan would be 10,000 participant-hours in the same five year period.

The community wishes to decide which of these two options it prefers. --farming or literacy training. Choose the correct economic analytical tool and explain the reason for your choice.

1. Beneft/Cost Comparison
2. Cost-Effectiveness Estimate
3. Cost-Efficiency Calculation
4. Cost-Utility Computation.

CHOOSE A TOOL

EXERCISE 11

Project 5: Let's say you want to make a recommendation to decision makers about the most appropriate LRC educational delivery alternative, using appropriate instruments of economic analysis.

The community is presently considering the creation of and LRC that does not make use of mobile learning units. But there also exists the possibility of incorporating mobile units in the LRC, to offer the same learning resource services. Use data appropriate to your own situation and specify the assumptions in your analysis.

In this exercise you are just supposed to select the appropriate economic analysis technique of the four, not to make the economic analysis (that comes later).

a) What data do you need to know to use the economic analysis technique you would like to use?

Cost LRC Mobile units
Coverage
Value of skills learned (↑ productivity)

b) Putting it the other way, assume that you have certain data. Depending on the data you assume you have, which of the four economic analysis techniques can you use? Use reverse side of page if necessary.

B. EXAMPLES OF ECONOMIC ANALYSIS OF LEARNING RESOURCE CENTERS.

Let's do some specific economic analyses of LRC's. The main distinguishing characteristics of the four common economic decision making techniques are reviewed now in more detail than above, and we turn to numerical examples and exercises.

1. BENEFIT/COST COMPARISONS, As mentioned earlier, both the benefits of a project as well as its costs must be measured, known and expressed directly in dollars and cents (in "monetary terms").

Costs: These include the annual "operating" costs and the annual share of "capital" costs. Operating costs include personnel salaries and purchased items that are expected to be used up in less than a year. Capital expenditures are for items that last more than a year, like buildings and typewriters.

Each of these two main cost categories a "variable cost" component (the cost is dependent on the scale of the operation) and a "fixed" cost component. For example, a learning resource center with a movie projector and only a few reels of film would have a relatively large fixed

cost component and a small variable cost. If the LRC, on the other hand, had the same projector (the same fixed cost) but thousands of reels of film, the variable part of the cost would be much larger. The variable cost depends on the number of reels purchased.

All cost categories can be broken down further into "direct" and "indirect" cost categories. Indirect costs are those in which money does not acutally change hands, but nevertheless represent an economic sacrifice.

An example of an indirect cost in education is "opportunity cost," which is the financial opportunity that is sacrificed by the learner in order to be able to undertake the actual learning activity. A well recognized opportunity cost of education is "foregone income." This is the income that would have been earned but was instead sacrificed in order to be able to undertake the learning activity.

We'll keep these cost categories in mind as we go through several LRC economic analysis examples.

Benefits: Monetary benefits are usually more difficult to evaluate than monetary cost. Benefits in benefit/cost comparison studies have to be actual dollars earned by the

project, e.g., if the LRC sells products directly or if the LRC users boost their subsequent incomes because of their attendance at an LRC. The benefits in a benefit/cost comparison could also be dollars saved because of the project, as in do-it-yourself community projects made possible by the LRC, such as a marketing cooperative that would have otherwise required paying people from outside the community to provide the same service that is provided free by the members.

The advantage of doing a benefit/cost comparison over the other three forms of economic analysis of LRC's is that since the costs and benefits are both measured in the same (dollar) units of measurement, those costs and benefits can be directly compared with each other. This is done, as was mentioned, either in the form of their arithmetic difference ("net benefit") or their quotient (the B/C ratio). This arithmetic is portrayed in Illustrative Example 1.

ILLUSTRATIVE EXAMPLE 1

HOW TO COMPARE THE BENEFITS OF AN LRC PROJECT WITH ITS COSTS

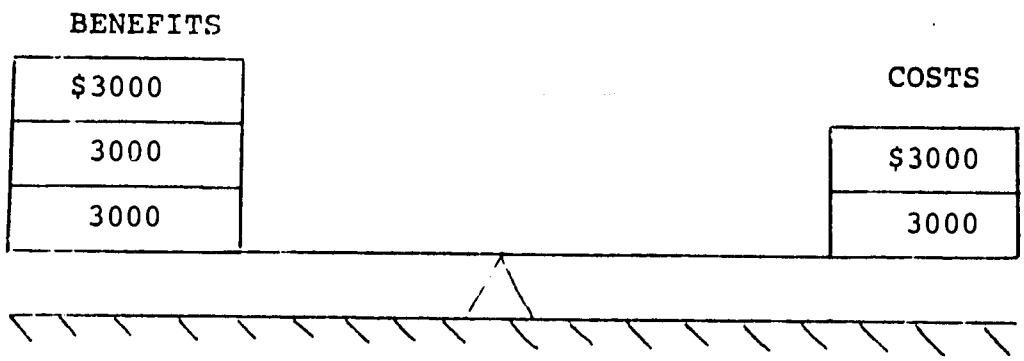


Figure 6

Benefits Vs. Costs

Two Types of B/C comparisons are:

Division: B ÷ C, the "B/C RATIO"; $\frac{\$9000}{\$6000} = 1.5$, o.k., "go"

Difference: B - C, the "NET BENEFIT:" $9000 - $6000

NET BENEFIT= $3000 o.k., "go"

Illustrative Example 2: A community is considering the creation of a learning resource center (LRC), emphasizing improved agricultural skills. During its life, this LRC project is expected to have a total cost of $200,000. During the same period of time, it is expected that the increased profits earned, due to the greater agricultural production created as a result of the increased knowledge and skills instilled in the LRC users, would be $500,000. (The data are hypothetical, for illustrative purposes).

Community decision makers wish to know whether or not to go ahead with the proposed LRC project (a "go" or "no go" decision). In Exercise 7, you have already chosen the correct economic analystical tool among the four for this problem, which is a benefit/cost comparison, and explained the reason for that choice. Now let's numerically calculate the benefits divided by the cost.

This is $\frac{\$500,000}{\$200,000}$ or 2.5, a favorable B/C ratio. Therefore "GO" would be the economic analysis implication to decision makers. The project should be carried out.

Illustrative Example 3: B/C Comparison of Two Projects.

Benefits and cost may be compared between two projects, to see which one is better economically. This is portrayed in Figure 7.

Project I (The better choice)

(GO) $\frac{\$\ 40,000}{\$\ 10,000} = 4$ to $1 = \frac{B}{C}$

Project II (The worse one of the two)

(NO GO)

$\frac{B}{C} = \frac{\$20,000}{\$30,000} = .67$

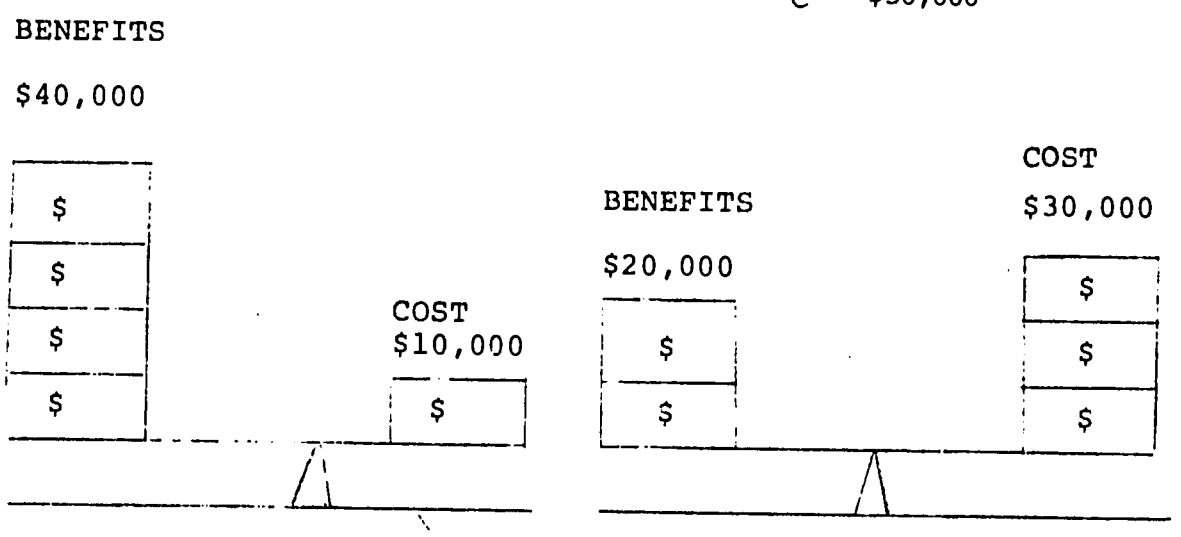


Figure 7

B/C Comparison in Two Projects

COMPARING MORE THAN TWO PROJECTS

With benefit/cost comparison, two competing projects can both be compared to the present LRC system. This leads to a priority rank order of desirability among the three LRC projects -- the old one and two possible new ones.

Sometimes (usually) you are constrained by your cost ceilings. Let's say you're working within $60,000.

Supposed the annual costs and benefits can be estimated monetarily, as shown in the existing learning resource center on the extreme left side of Figure 8 and the two proposed new LRC's (Project III and Project IV), in the center and right side of the figure.

Illustrative Example 4. Improving an LRC

Our community's present learning resource center is economically unattractive ($20,000 benefit vs $30,000 cost--Fig.8a) and has to be justified to funding sources by being very desirable socially. What if the community could replace or expand it so that a new LRC system would be equally socially desirable but would also be more "profitable" from the purely economic point of view?

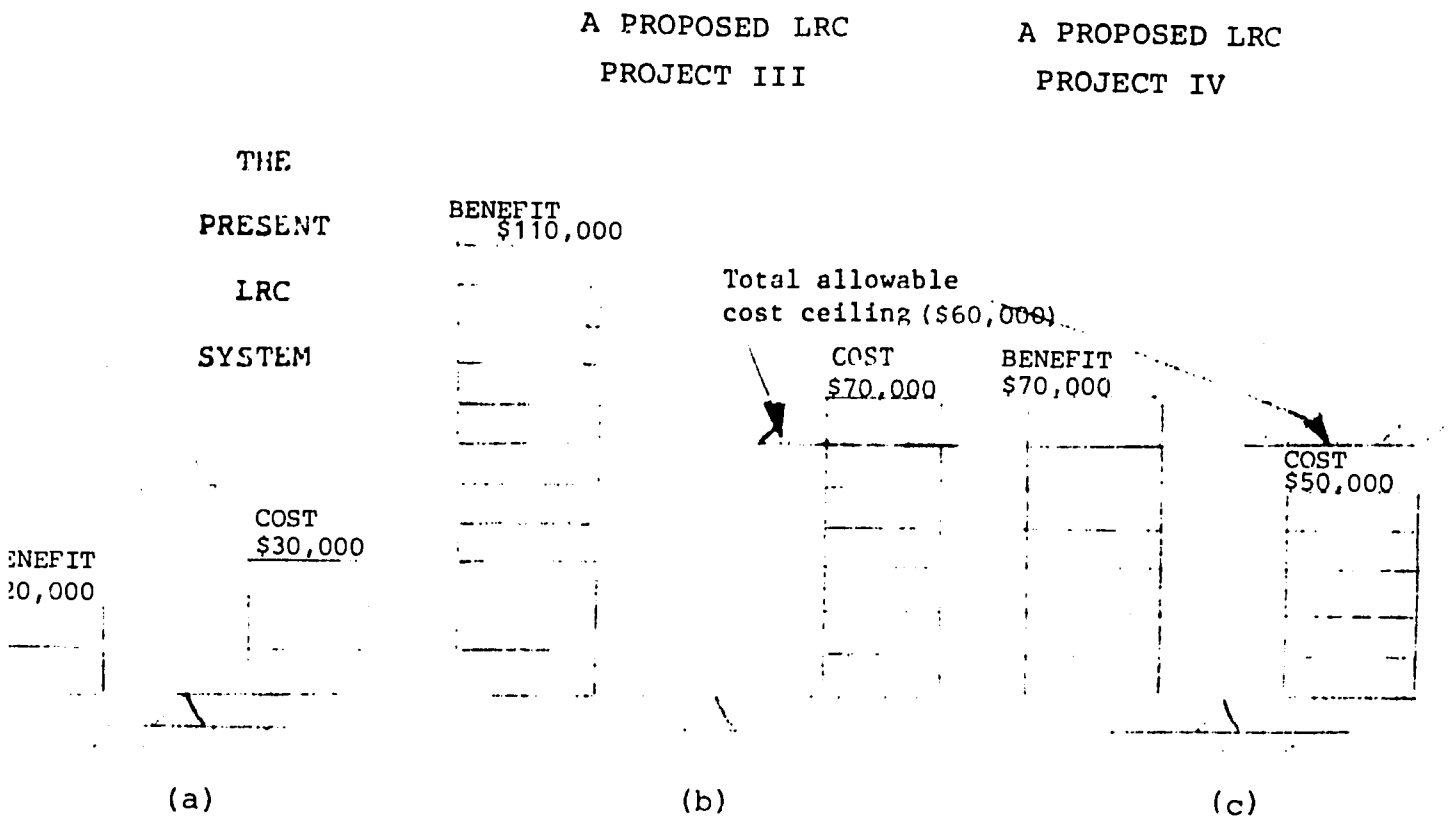


Figure 8

Picture an LRC budget analyst standing at a meeting of the town's learning resource center planning committee showing the members bar charts like figure 8 on a flip chart. (Illustration of a meeting here).

The proposed new Project III looks better at first to the group than its competitor, Project IV, on a purely B/C ratio basis. But unfortunatly, Project III would exceed the $60,000 absolute budget constraint.

After some discussion, a consensus would emerge. The priority order among the three projects would be --

<u>Top Priority Project</u>: Project IV. It is not the most efficient, but it is at least affordable. Therefore, IV has the highest priority, since it is more attractive than the present learning resource system. Its B/C ratio is $70,000/$50,000 =1.40, a respectable "profitability" index.

<u>Second Priority:</u> The present system. It has a poor benefit-to-cost ratio, $20,000/ $30,000 or 0.67 but is affordable.

<u>Third Priority</u>: Project III. It is too expensive, even though it would have the best benefit-to-cost ratio ($110,000/ $70,000 or 1.57).

BENEFIT/COST ANALYSIS IN THE BIG PICTURE.

This kind of benefit/cost comparison can be made from the point of view of the total public education system.

For example, one educational scheme under consideration might be to reduce the budget of the formal education system, and increase that of the non-formal education system, including community based learning resource centers. Figure 9 represents the relevant data in bar chart form. This example assumes that the benefits can be and are known in dollars.

EXAMPLE OF COMBINED EDUCATION SYSTEM VIEWPOINT

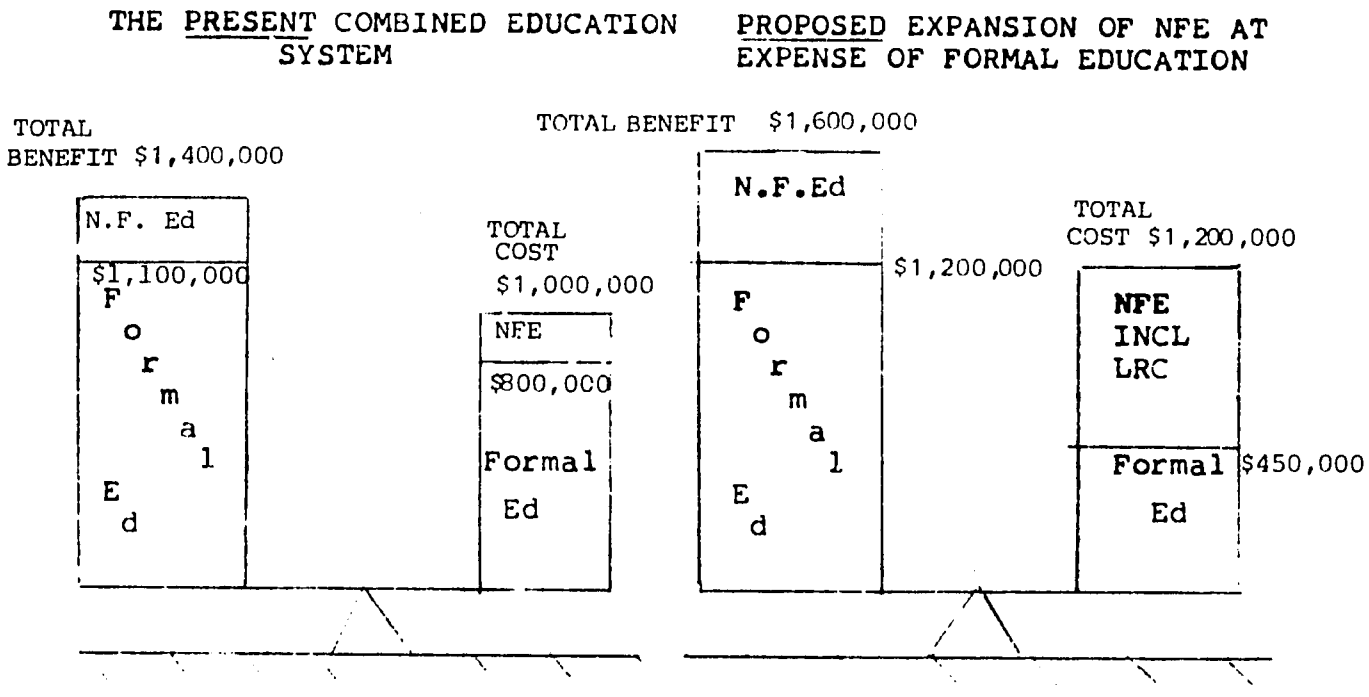


Figure 9
Proposed Change of Formal-Non-Formal Education "Mix"

Now let's use these data in a typical analysis that a Ministry of Education economist might do.

B/C ANALYSIS IN THE BIG EDUCATION PICTURE

EXERCISE 12

Suppose that a country is considering a plan to change the "mix" between its efforts directed toward the formal and non-formal education systems, and the monetary benefits can be estimated, according to data in Figure 9.

a) Is the change attractive from the point of view of education in general? What tool can we use to get a handle on it: Benefit/cost comparison, cost-effectiveness, cost-efficiency or cost-utility? This exercise is your first economic analysis as such. Why did you chose the tool you did?

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b) Is the proposed change attractive from only the formal education systems point of view? Note that the change would expect the formal education system to produce more beneficial output with a greatly diminished formal education budget. Analyze this and discuss. That is, how do the benefits compare with the costs?

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c) Now, is the proposed change economically attractive from the non-formal education point of view? Discuss how the benefits from this sector compare with the costs.

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Now that you have done your first economic analysis of learning resource centers, it is well to know that benefit and cost implications are quite different on a total or an incremental benefit/cost basis.

Example 5: Incremental vs. Total B/C Analysis

The financial situation described by figure 10a is good economically on the incremental benefit and cost basis Δ B/ΔC= \$2,000,000/\$1,000,000 = 2.0 but poor on the total basis, where total B/C = \$4,000,000/\$5,000,000 = 0.80 .

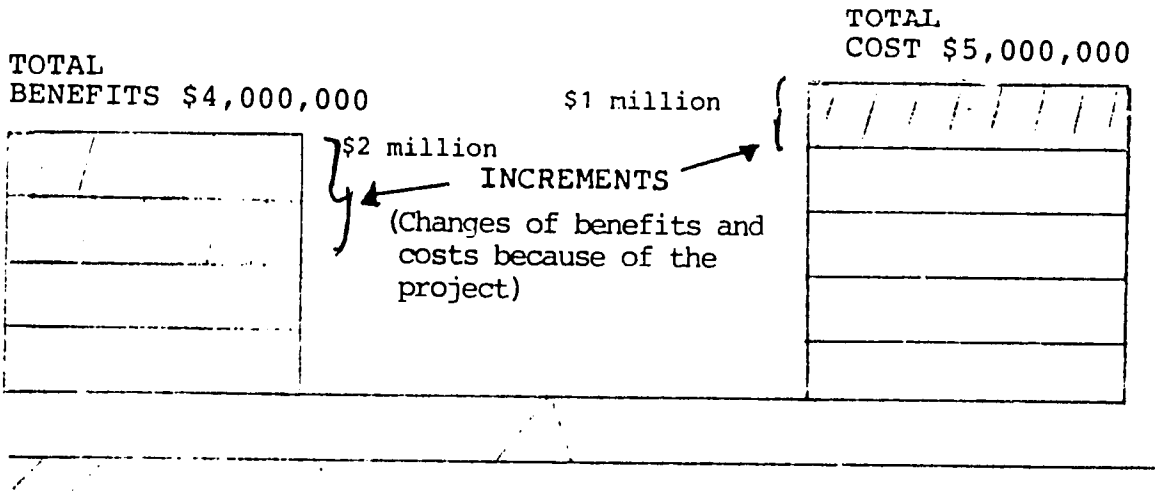
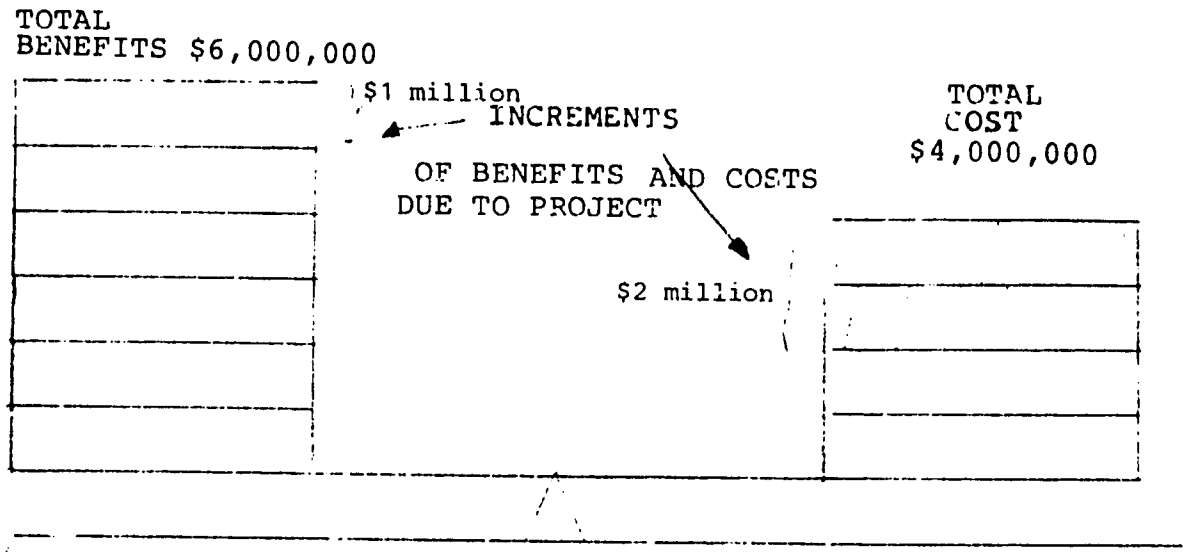


Figure 10 a
Good Incremental Economics
in LRC Project

The LRC financial situation in Figure 10b, on the other hand, is poor on the incremental B/C basis (Δ B/Δ C = \$1,000,000/\$2,000,000) but good on the total basis of B/C comparison, where the benefit to-cost ratio is 6,000,000/ \$4,000,000 or 1.5.



Poor Incremental Economics
in LRC Project
Figure 10b

Since hardly any educational project begins entirely from "scratch", but builds on the base of a project already in operation, you will probably find that the incremental cost and benefit method is the more useful of the two types of LRC economic analyses. Exercise 13 illustrates the choice.

To illustrate the importance of building on existing educational delivery infrastructure, consider the hypothetical TV cost information given in Table 1.

INCREMENTAL Vs. TOTAL COSTS IN LRC PLANNING

EXERCISE 13

INSTRUCTIONAL TV WITH AND WITHOUT EXISTING INFRASTRUCTURE

If a community is considering using instructional TV (or radio) as an LRC educational delivery system, the appropriate computation of relevant costs to the community would be its additional cost if there already is a national or regional TV system in existence. In Colombia, for example, an extensive radio network is in existence and in El Salvador an educational TV network has been installed.

When such a TV production and distribution infrastructure does not exist, however, the community would have to consider all the costs to be incurred in constructing the necessary TV infrastructure. This might make it unattractive to the community.

TABLE 1

ANNUAL TV COSTS
(ILLUSTRATIVE)

				Plan (A) With TV Infra-structure	Plan (B) Without TV Infra-structure
Annual Cost, Millions of Dollars	Investment (Capital Costs)	On National Level	Before the New Project (1)	100	0
			After the New Project (2)	101	0
			Difference (3)	1	0
		On Community Level	Before the New Project (4)	30	0
			After the New Project (5)	31	10
			Difference (6)	1	10
	Operating Costs	On National Level	Before the New Project (7)	100	0
			After the New Project (8)	101	0
			Difference (9)	1	0
		On Community Level	Before the New Project (10)	0	0
			After the New Project (11)	1	10
			Difference (12)	1	10
	Total Costs	On National Level	Before the New Project (1)+(7)= (13)	200	0
			After the New Project (2)+(8) = (14)	202	0
			Difference (14)-(13)=(15)	2	0

Millions of Dollars	Total Costs	On Community Level	Before the New Project (4)+(10) = (16)	30	0
			After the New Project (5)+(11)= (17)	32	20
			Difference (18)=(17)-(16)	2	20

Indicate which are costs that the community and the national government should consider in their respective planning.

In both plans A and B, what are the grand total costs of the project, and what implications do they have for top-level decision making about the proposed project?

Note to Instructor: The numerical data on lines (13) through (18) of Table 1 can be "blanked out" when assigning the problem as an exercise, as well as possibly lines (3), (6), (9), (12) if maximum active student response is desired. Alternatively, as an illustrative example, all data could be left in the table, as given.

The Time Value of Money: The value of money depends on time; it has a "time sense." People buy a car "on time" because it is easier than gathering the cash all at once. People are willing to pay more for a larger than a smaller fruit tree of the same type because the larger one has already more years of growth "in" it. Because it began earlier, it is worth more today.

The next exercise is the first in a series using the time value of money in economic analysis. It's important.

THE TIME VALUE OF MONEY

EXERCISE 14

Would you rather receive $1030 one year from now or $1,000 right now? Why or why not?

If not, would you be willing to accept $1,500 one year from now instead of $1,000 now? Wny or Why not?

This was a brief warm up leading into Exercises 15 through 18 which simulate important issues in the economic analysis of learning resource centers.

Let's review the compound interest idea first.

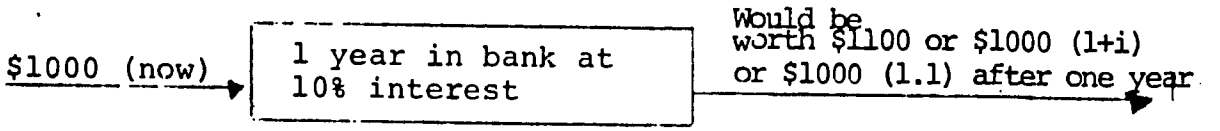
Cost and benefits of a learning resource center project are usually spread out over a period of time. An annual time series projected into the future is called a "stream." We speak of a future "cost stream" and a future "benefit stream."

Cost and benefit streams may be recorded either in bar graphs as in Figure 11 in the next exercise or in equivalent table form as in columns (2) and (4) in Table 2 of Exercise 16.

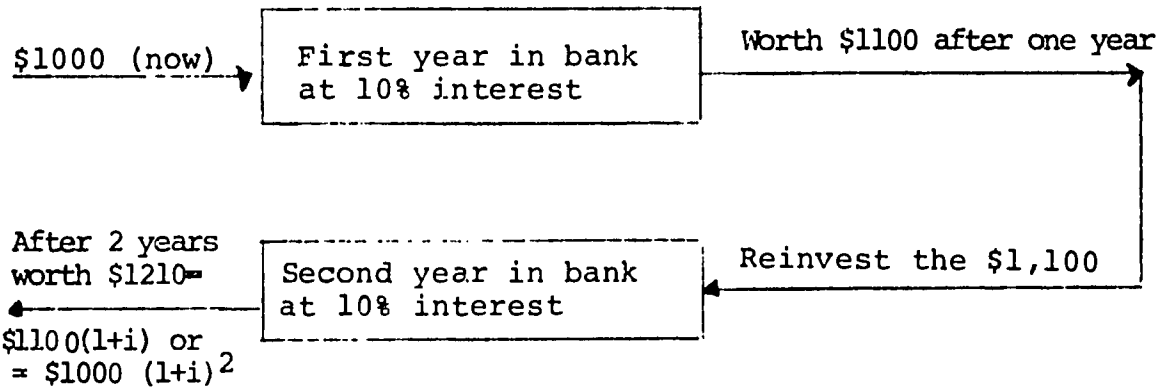
Medium and long range projects (generally of more than five years duration) should be analyzed by computed "present values" of the cost and benefit streams. This is to adequately account for the "time value of money" in figuring and comparing costs and benefits.

Present values of future amounts of money are found using the idea of compound interest, which we review briefly here before proceeding with examples of economic analysis of learning resource centers.

Let's start with the pleasing prospect of having some cash to be able to place in the bank. The "present value" is a lump sum of money today. If we put, let's say, $1,000 (the "present value") into the bank "now" and let it stay there for one year at 10 per cent annual compund interest rate, that is, at an interest rate expressed as a decimal of $i = .10$, your $1,000 would grow to $1,100 by the end of the first year:



Now if that $1,100 were then placed into a <u>second</u> (or kept in the same) bank for a <u>second</u> year, your money would come out having increased by an <u>additional</u> 10 per cent of $1,100, or by $110 during the second year. The money at the end of the second year would be worth $1,100 x (1+i), or $1,100 x 1.1, or $1210, or $1,000 x (1+i) x (1+i), or $1,000 x $(1+i)^2$, which is the "future value" of the original $1,000 after having stayed for two years in the bank. Let's diagram it :



After a third year in a bank at the same 10 per cent compound interest rate, the original $1,000 would then have grown to a future value of $1,000 x (1+i) (1+i)(1+i), or $1,000 x $(1+i)^3$ or $1,000 x (1.1) x (1.1) x (1.1) or $1,000 x $(1.1)^3$ or $1,000 x 1.32, all of which equal $1,320.

The master pattern is: Future value = present value x $(1+i)^n$ where "n" is the number of annual interest periods that have passed since the initial "now" point in time and "i" is the annual compound interest rate expressed as a decimal.

Since we now know that FV = PV x $(1+i)^n$

we can rearrange this statment of equivalence to read:

PV = FV/ $(1=i)^n$

This is the important working formula for finding present values and is used in Table 2 of Exercise 16.

Let's turn to Exercise 15 which looks at LRC plans that rely on an initial purchase of fairly expensive equipment.

We will see how the concepts of cost streams and benefit streams apply to the LRC Project.

B/C ANALYSIS WITH HIGH INITIAL COST

EXERCISE 15

HIGH COST EQUIPMENT LRC PROJECT

Consider a typical "high cost equipment" LRC project as in the streams of Figure 11. One hundred thousand dollars a year are first spent for three years for purchasing LRC equipment. Assume three years will pass before benefits begin to show up in the form of $100,000 per year of increased learner earnings. Annual operating costs are $25,000 per year after three years. Annual costs and benefits are in dollars in the figure, but could be any currency.

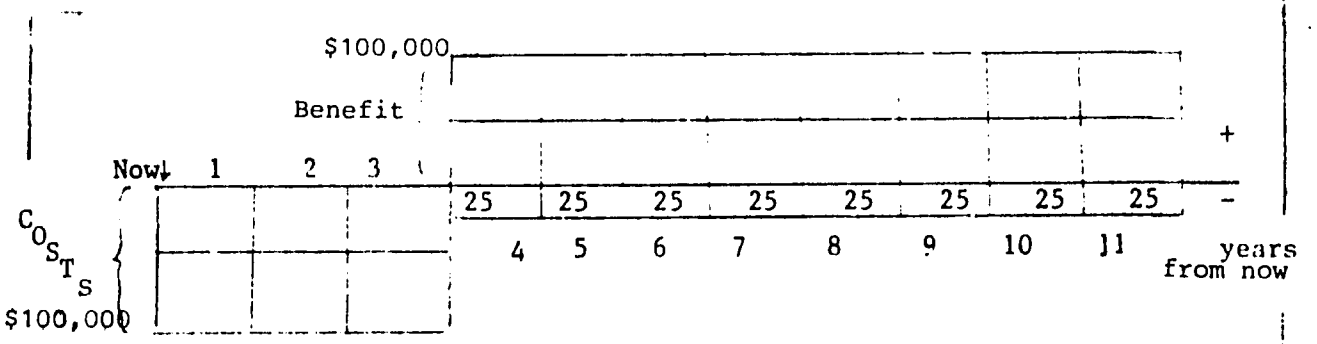


Figure 11
"High Cost Equipment" Project
Benefit and Cost Streams

Consider a total of 11 years into the future begining "now."

Total Benefit = 800 money units (thousand of dollars)
Total Cost = 300 capital + 200 operating expenses
or Total Cost = 500 money units (thousands of dollars)

So the benefits exceed the cost, and the project appears economically desirable. Let's get going on the construction!

Do you agree with this analysis?

But wait a minute....

In an initial B/C comparison, this proposed educational LRC project looks attractive, but note that the major costs are in the near present and the benefits are in the farther future, so the real B/C ratio is not so sure when the time value of money is considered. Remember money has a time value.

We need to look at and compare the "present values" of the cost and benefit streams. The effective benefit/cost ratio for decision making might be unfavorable, as suggested in Figure 12.

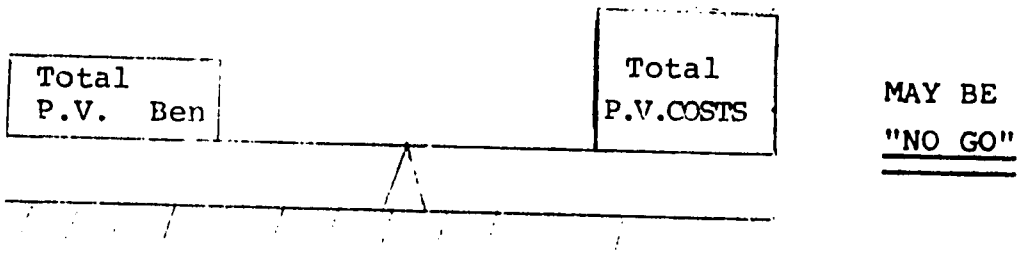


Figure 12

Present Value of Costs May Outweigh Present Value of Benefits

In Exercise 16, we apply the compound interest idea to convert the annual actual cost and benefit streams to their "present value," so that we can better decide the economic "profitability" of the project and then recommend a decision to the community.

CALCULATING PRESENT VALUES OF COSTS AND BENEFITS

EXERCISE 16

CONVERSION TO PRESENT VALUES

Convert the streams of costs and of cost and benefits given in Figure 11 into their "present values" each year (in columns 3 and 5) and the net present value of benefits (present value of benefits minus present value of costs) each year. Do it by filling the rest of the spaces in Table 2 and assuming, as shown, that annual compound interest rates are 10 and 15 percent, to see the difference interest makes.

To calculate numbers in columns (3),(5),(6) and (7) of Table 2, use the formulas at the top of those columns.

TABLE 2

COST AND BENEFITS CONVERTED TO PRESENT VALUES
(THOUSANDS OF DOLLARS)

Refer to Figure 11

(1) Annual Period n	(2) Annual Benefit Thousands of $	(3) Present Value of Annual Ben (2)/(1+i)^n		(4) Annual Cost Thous. of $	(5) Present Value of Annual Cost (4)/1+i)^n Thousands of $		Present Value of Net Benefit; Thousands of $ Annual (3)-(5) = (6)		Cumulative (7)	
		i=.10	i=.15		i=.10	i=.15	i=.10	i=.15	i=.10	i=.15
1	0	0	0	100	91	87	-91	-87	-91	-87
2	0	0	0	100	83*	76	-83	-76	-174	-163
3	0	0	0	100	75	66	-75	-66	-249	-229
4	100	68	57	25	17	14	51	43	-198	-186
5	100	62	50	25	16	12	46	38	-152	-148
6	100	56	43	25	14	11	42	32	-110	-116
7	100	51	38	25	13	9	38	29	fill	in
8	100	fill in rest		25	fill in rest					
9	100			25						
10	100			25						
11	100			25						

* Sample: PV =FV/$(1+i)^n$ = 100/$(1+.10)^2$ = 100/$(1.1)^2$ = 83. Note n=2 on the second line.

i = Annual compound interest rate expressed as a decimal.
n = number of annual periods from the start of the series.
Source : Figure 11 data.

What is the benefit/ cost present value ratio in the "high cost equipment" project for each of the two assumed compound interest rates? Use the cumulative present values of the costs and benefits over the entire 11 year period from the totals of columns (3) and (5).

for i = 1.10; $\frac{\text{Cumulative Present Value of Benefits}}{\text{Cumulative Present Value of Costs}}$ = _____ =

for i = .15; $\frac{\text{Cumulative Present Value of Benefits}}{\text{Cumulative Present Value of Costs}}$ = _____ =

What are the decision implications ("GO" or "NO GO") at each interest rate? Is the high equipment project worth initiating?

BENEFIT/COST ANALYSIS IN PROJECTS WITHOUT HIGH INITIAL EXPENSES

EXERCISE 17

PERSONNEL EMPHASIS LRC PROJECT

Now let's compare the benefit/cost results obtained in Exercise 16, above, which was for an expensive equipment project, with the following assumed cost and benefit streams of an LRC project that uses only a small amount of expensive equipment, but has a relatively high continuing operating cost component ($45,000 a year) for personnel training (Figure 13)

Use the same assumed annual compound interest rates as in Exercise 16 (10 percent and 15 percent). The annual benefit and cost values given in Figure 13 are in dollars. Benefits are $80,000 per year. Use a calculation table similar to Table 2. The purpose of this exercise is to emphasize the importance of including the time value of money in your benefit/cost analyses. It affects the recommendations you would make for longer term projects.

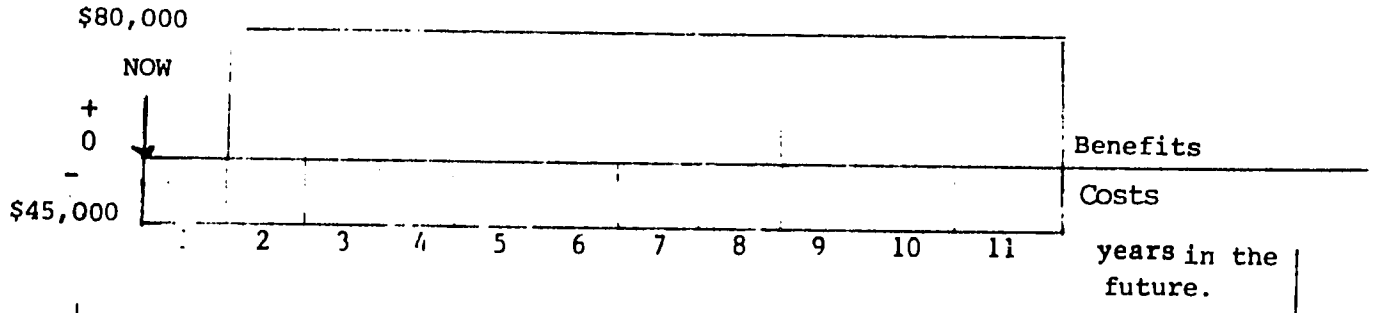


Figure 13
Personnel Emphasis LRC Project, Cost and Benefit Streams

DO IT YOURSELF B/C ANALYSIS

EXERCISE 18

Make up and solve an appropriate exercise using a benefit/cost comparison in the analysis of a proposed learning resource center for community based education in Latin America. State your assumptions in your solution. Take the time value of money into consideration if it is a medium or long range project, i.e., of more then five years duration.

- First make a sketch of the time histories of your expected future cost and benefits streams, as in Figures 11 or 13.

- Convert these assumed annual costs and benefit streams into annual "present values," as by the method shown in Table 2. Use another sheet of paper and construct your own table.

- Calculate the ratio of the cumulative present value of the benefits to the cumulative present value of the costs, as was done in Exercise 16.

$$\frac{\text{Cumulative Present Value Benefits}}{\text{Cumulative Present Value of Costs}} = \underline{\qquad\qquad} =$$

- Use this PVB/PVC ratio to decide if the project is economically attractive. Is PVB/PVC bigger than or smaller than 1?

- Did you use an incremental or a total cost and benefit basis? Why?

- What do you recommend ("go" or "no go")? Should the community initiate the LRC?

Note: Another form of comparing monetary costs and benefits when the time value of money is important is the "internal rate of return" on an investment. The internal rate of return is computed and expressed as an annual percentage yield rate -- the compound interest rate that would be "earned" by investment in the LRC being analyzed.

For example, if the "rate of return on an LRC were 35 percent per year, it would be a good investment, compared to say, 6 percent per year earned in a bank. On the other hand, if the rate of return were only two or three percent, or negative, then the LRC project would not be economically "profitable," and would probably be dropped or have to be justified by other than purely economic considerations. The advantage of knowing rate of return to an educational project is that with it, investment in human capital can be compared directly to investment in physical capital, to find the best payoff. We don't calculate rates of return here, but you can learn about it if you want to, elsewhere. See the economics of education literature.

2. COST-EFFECTIVENESS ESTIMATION. Now suppose we can't put the benefits of a proposed LRC in dollar and cents terms but nevertheless think a project is important. Then we turn to cost-effectiveness. This method of economic analysis needs the specification of one measurable output goal (not necessarily a monetary goal, as above). An example would be to provide 100,000 man-hours of LRC usage per year for a period of five years, to begin three years from now.

As mentioned, cost-effectiveness analysis compares the costs of all the alternative projects that would reach the same goal, and it seeks the most desirable (usually the least costly) of the alternate routes under consideration.

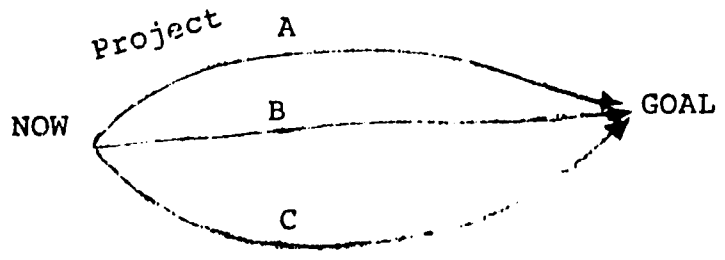


Figure 1 4
Multiple Paths to the Same Goal

For example, if Project A would cost one million dollars, Project B two million dollars and Project C three million dollars, and would all achieve the same objective, then a cost-effectiveness analysis would lead to the selection of Project A as the most cost-effective (desirable) of the three competitors. It's basically the cheapest way to buy something.

Exercise 19 will give you a chance to apply the cost-effectiveness technique. But first, let's look at an LRC illustrative example:

Illustrative Example 5 : Cost-Effectiveness Study

It is proposed that an LRC provide a total of 700,000 man-hours of literacy training during a six year period, to begin in one year. There are three alternative literacy delivery methods available, all of which are expected to produce equal and comparable literacy learning results that can be quantitatively measured with achievement tests.

Plan A: Conventional personal one-to-one tutoring instruction, using a minimum of written or electronic materials. Total cost $9,000,000.

Plan B. Utilization of electronic media, with instructional materials and programs, such as taped lessons, to be produced locally in the LRC. Total estimated cost: $7,000,000.

Plan C: Also uses electronic teaching materials, but produced in and broadcast from a central source located in the national capital city. Total estimated cost: $12,000,000.

The community wants to know which of these three proposed literacy delivery plans to adopt. In Exercise 8

you probably chose cost-effectiveness as the appropriate economic analysis methodology for this choice, and explained the reason for your choice (equal outcomes, different costs).

Now, let's calculate the cost-effectiveness of the three projects. Since the output (a definite amount of literacy gain) would be the same for all three projects, we just look for the least costly alternative among the projects. In this case, Plan B is the least expensive, and therefore, it is the most cost-effective of the three. Other things being equal, then, Plan B would be recommended to LRC decision makers.

Since everybody knows that $7,000,000 is less than $12,000,000 and even less than $9,000,000, the essense of cost-effectiveness is being able to make sure that the same achievement would be provided by all competing alternatives.

MAKE YOUR OWN COST-EFFECTIVENESS LRC ANALYSIS

EXERCISE 19

Make up and solve a realistic problem illustrating a cost-effectiveness economic analysis of learning resource centers for community based education. Use data that seem to be reasonable in the context you are considering. State your assumptions. Cost streams should be converted into "present values" if the costs are disbursed over a period of five years or longer.

What is the common objective or output goal of all the LRC projects under consideration, quantitatively stated?

How much would each of the alternative projects cost? Use present values of the cost streams if the costs are to be disbursed over a period of five years or more. (use extra paper)

Which of the alternative LRC projects that lead to the same goal is the least costly, and therefore the most cost-effective?

Did you use an incremental or total cost basis? Why? (Use the other side of the paper if necessary.)

What is your recommendation? Which alternative LRC do you recommend to the town council?

You have just done an LRC economic analysis.

Well done.

3. COST - EFFICIENCY APPROACH This method compares inputs and outputs of different LRC projects when:

- The benefits are not necessarily monetary, (so benefit/cost technique is not applicable).
- The benefits are not necessarily the same goal, so cost-effectiveness approach is not applicable
- Output divided by input is defined as efficiency. When the input is cost, output divided by cost is cost-efficiency.

Consider two incremental projects, Project V, on Fig. 15, where the increment is from 1, the old operating point, to 2, and Project VI, where the increment is from 3 to 4. We can find their separate incremental cost-efficiencies (Table 3).

TABLE 3

INCREMENTAL COST-EFFICIENCY OF TWO LRC'S

USING FIGURE 15 DATA

	Computed Incremental Cost-Efficiency = Δ OUTPUT/ Δ INPUT	Is Resource Cost Limit Exceeded? (We hope not)	Is Required Minimum Output Exceeded? (We hope so)
LRC Project V	A/B (Better--more--than C/D)	Not by V (that's good)	Yes (V is acceptable)
LRC Project VI	C/D (Worse --lower--than A/B)	Yes by VI (must reject Project VI)	Yes (VI is also acceptable on this basis)

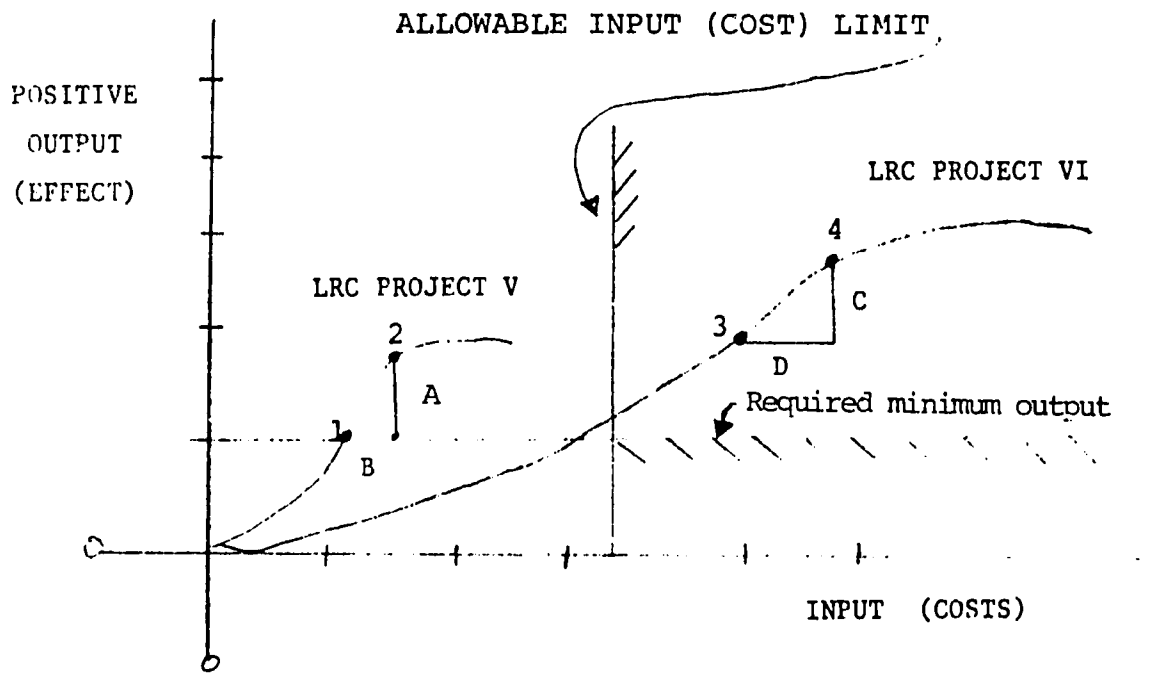


Figure 15
Input-Output Curves for two LRC Projects

Now let's look at two examples and then do an exercise in cost-efficiency applicable to learning resource centers.

Illustrative Example 6: Cost-Efficiency in Health Care

A community wants to make a decision to train health personnel using an LRC. There are the three viable training delivery possibilities under consideration.

Plan A: Emphasizes the training of medical aides for disease prevention and betterment of health and hygienic conditions. The plan would have a total cost of $500,000 per year. It would avoid the loss of 50,000 man-hours of work attributable to illness per year.

Plan B: This plan emphasizes the training of personnel qualified to treat specific illnesses. The anticipated cost is $1,000,000 per year, with a savings of 200,000 man-hours of work per year that would otherwise be lost due to illness.

Plan C: Would emphasize both the training of medical aides for prevention of disease and of qualified personnel for treating and curing disease. The annual cost of this combined plan would be $800,000. The total elimination of work time lost due to illness is estimated to be 190,000 man-hours annually in Plan C.

In exercise 9 you probably chose cost-efficiency as the correct economic analytical tool for this LRC decision choice, and explained why you selected that tool (different intputs, different outputs).

Now let's numerically calculate the cost-efficiencies of the three health plans in the table.

Health Plan	Annual Man-hours saved due to Plan	Annual Cost $	Cost-Efficiency = Man-hours saved per dollar
(1)	(2)	(3)	(2)/(3)
Plan A	50,000	500,000	.10
Plan B	200,000	1,000,000	.18
Plan C	190,000	800,000	.24 (the most cost - efficient)

LRC Plan C gets the nod. and is recommended to the community.

Illustrative Example 7: Cost-Efficiency of Self-Paced Learning.

Self-paced learning methods may be appropriate in community learning resource centers. One study experimented with self-paced learning (PSI)* as an alternative to the traditional group lecture approach in technical education. The self-paced approach was 39 percent more cost-efficient than the lecture approach (See table on following page).

* PSI=Personalized System of Instruction

Do you confirm the conclusions in the cost-efficiency calculation table shown below for that experiment?

Cost-efficiency

In the following table, the data on cost comparison between the PSI and control groups were calculated. 1/

	Group		% Difference
	PSI (Exper.)	(Control) Lecture	PSI Relative to Control Group
1) Nominal cost per 25-student section of 3 credit semester course	$5875	$5475	+7.3%
2) Class GPA achieved on 4 point max. scale	3.1	2.1	+48%
3) Nominal "Unit Cost" $/Class GPA (1)/(2)	$1895	$2607	-27%
4) Cost-Efficiency Index (Class GPA x $1000/Cost) $\frac{1000 \times (2)}{(1)}$	.53	.38	+39%

1 Philip Blair, "The Cost and Efficiency of Self-Paced Education," Education Research and Methods, American Society for Engineering Education, Vol. 10, No.1, Fall 1977, p. 11 .

This estimate of costs and results for a PSI method as an alternative to the lecture method yielded a 48% higher average class GPA. (3.1 instead of 2.1) The result of this apparent 39% increase in cost-efficiency of PSI over the control group was a concomitant 27% reduction in unit cost.

DO IT YOURSELF COST-EFFICIENCY ANALYSIS

EXERCISE 20

Make up and solve a problem suitable for demonstrating the use of the cost-efficiency method of economic analysis applied to the study of learning resource centers for community based education in Latin America. State the assumptions in your solution. Follow the steps of Example 6.

- Estimate the output of the learning resource center project under consideration. The output must be stated quantitatively, but not necessarily in dollars.

- Estimate the cost of the LRC project. Use a present value of cost computation if the costs are to be spent over a period of five years or more.

- Divide the output measure by the cost of the project, i.e., find the cost-efficiency of that project.

- Find the output of a second LRC project.

- Find the cost of that second project.

- Find the ratio of its output to its cost, i.e, the cost-efficiency for the second project.

- Repeat the cycle for any other LRC projects being considered.

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- Rank the projects in order of cost efficiency. What conclusions can be drawn concerning the relative economic attractiveness of the alternative learning resouce center projects you considered?

- Did you use an incremental or a total cost and output basis? Why?

- What is your recommendation? What Should LRC deciders do?

You are well on your way to becoming an LRC cost analyst.

4. METHOD OF COST-UTILITY. This final technique of the four includes a multiplicative weighting of the output by a numerical factor expressing the relative subjective value, to estimate the "effective" output. Cost-utility helps in choosing between LRC alternatives when a clear decision is difficult to make among LRC projects on purely quantitative grounds. The benefits need not be monetary or equal, so the benefit/cost or the cost-effectiveness approaches cannot be used. Subjective values of the outcomes are important, so cost-efficiency is not applicable, either. That leaves cost-utility as the tool.

Illustrative Example 8: LRC Projects with Different Weighted Outputs at Same Total Cost.

Suppose two alternative learning resource center projects, A and B in Table 4, each have farming and literacy training components, but in different proportions. Project A is heavier on the literacy and lighter on the farming. Suppose, also, that Projects A and B both have the same estimated total cost (not shown). Here the emphasis is on the outputs and how to weight them.

a) Which project, A or B, has the greater combined output measure on an unweighted basis?

b) Now, which project has the greater combined output measure on a weighted basis, using the subjective weighting factors given in Table 4, Columns b and e. These numerical values are illustrative, in this example. Note that one of the subjective value judgements (for farming) has been assigned the value of 1; this makes the multiplication calculation easier.

TABLE 4

CALCULATING OUTPUTS IN

COST-UTILITY CALCULATION

	FARMING TRAINING COMPONENT			LITERACY TRAINING COMPONENT			COMBINED OUTPUT, FARMING AND LITERACY TRAINING	
	Actual Output Measure*	Relative Weight Factor of Value	Wtd. Output Measure	Actual Output Measure*	Relative Weight Factor of Value	Wtd. Output Measure	Un Weighted Basis	Weighted Basis
	a	b	c=ab	d	e	f=de	a+d	c+f
PROJECT A	12	1	12	20	.5	10	32 (Higher than B)	22 (Less than B)
PROJECT B	18	1	18	12	.5	6	30 (Less than A)	24 Higher than A)

* Thousands of man-hours of training

Project B is seen to produce more "utility" (24 units of weighted output) than does project A (22 units), when subjective weighting preference factors of output are included. Note how including the subjective weighting factors reversed the priority order between LRC projects A and B in this illustrative example, demonstrating the importance of <u>including</u> the subjective weighting factors of the outputs.

Illustrative Example 9: LRC's with Weighted Outputs and Different Costs.

In this example, a community is considering operating a learning resource center to provide either only agricultural training or only literacy training. The expected costs, outputs (participation) and subjective weighting factors that express someone's judgement of the relative importance (or desirability) of farming and literacy training (Plan C or Plan D) are indicated in Table 5.

In the "source" column are found the formulas used in calculating the results in the last two columns.

TABLE 5

DATA FOR CALCULATING UNIT COST
AND
COST-UTILITY FOR TWO ALTERNATE LRC PLANS;
ALL AGRICULTURE OR ALL LITERACY

No.	Item	Units	Source	Plan C, Agricult. Program	Plan D, Literacy Program
(1)	Total Cost	Dollars	Cost Estimate	$4,000	$10,000
(2)	Total Participation by users	Man-hours provided	Participation Estimate	250	1,000
(3)	Unit Cost on an Unweighted Basis	$ per man-hour	Division = (1)/(2)	16	10 *
(4)	Cost-Utility Index Unweighted	Man-hours per $	Division: (2)/(1) Also=1/(3)	.0667	.10 *
(5)	Subjective Weightint Factor of Relative Importance of Farming and Lit.	Unitless	Individual or Group Judgement	1.0	0.5
(6)	Weighted Participation by users	Man-hours	Multiplication (2)x(5)	250	500
(7)	Weighted Unit Cost	$ per Man-hour	Division (1)/(6)	16 *	20
(8)	Weighted Cost-Utility Index	Man-hours per $	Division (6)/(1) Also 1/(7)	.0667 *	.050

The asterisk indicates the more attractive plan of the two considered, that is, the one having the lower unit cost and higher cost-utility index. It is plan D on the unweighted basis and Plan C on the weighted. Note how the more attractive plan changes when value judgements are included.

Estimate the "unit costs" (cost per unit of output) on an unweighted basis and on a weighted basis, using the relative subjective value judgements given in line (5) of the table. "Unit cost" is the inverse of cost-utility. Unit cost is cost per output, while cost-utility is output per cost. Thus, the lower the unit cost, the better, and the highter the cost-utility,the better.

See, or work out, the calculations in lines (3), (4), (7) and (8).

Note how the relative desirability of Plans C and D reverses in this example, when the subjective weighting factors expressing somebody's judgement of the relative importance of agricultural and literacy training are introduced into the calculation.

Note to Instructor: You may blank out the numerical entries on lines (3), (4) and (8) if you desire, to assign this example as an exercise to be solved by the participant instead of supplying all the data in the table as a solved example.

The previous was an "either-or" problem--either agriculture or literacy training. Now a community wishes to initiate an LRC program that includes both farming and literacy training in some desirable proportion in an LRC.

CALCULATING COST-UTILITY IN LRC's WITH COMBINED ACTIVITIES

EXERCISE 21

EQUAL COSTS AND BEST "MIX" OF COMBINED LRC OUTPUTS

Two projects, E and F, have been proposed. Project E, as observed in Table 6, leans more heavily toward literacy training (20,000 man-hours) than does project F, which offers only 12,000 literacy man-hours). Project F, on the other hand, would provide a greater number of man-hours of agricultural training (18,000) than Project E, which offers only 12,000 man-hours of agriculture training. Suppose Project E and F each cost $100,000. Look at the output sice costs are equal.

How would you help the community select the LRC project it prefers of the two. You should include subjective value judgements for the relative importance of farming training and literacy training.

Evaluate the data given in Table 6 in such a way as to compute both the "unit cost" and the "cost-utility" indexes for each project, including the subjective weighting factors given in lines (3) and (6) of the table, and not including those factors.

Note to Instructor: Different amounts of numerical data can be blanked out from the table, especially lines (8) through (11), to assign student exercises of varying difficulty, according to the learners' needs.

TABLE 6

DATA FOR EXAMPLE OF COST UTILICY ANALYSIS METHOD FOR TWO LRCE PROJECTS, EACH HAVING AGRICULTURAL AND LITERACY COMPONENTS

			Source	Units	Project E	Project F
(1)	Agri. Component	Total Cost of Project	Est.	Thous. of $	100	100
(2)		Agri. participation by users	Est.	man-hours	12,000	18,000
(3)		Relative Subjective Weighting Factor for Agriculture	Judge ment	None	1.0	1.0
(4)		Weighted participation in agriculture component	(2)x(3)	man-hours	12,000	18,000
(5)	Lit. Component	Literacy participation by users	Est.	man-hours	20,000	12,000
(6)		Relative subjective weighting factor for literacy	Judge-ment	None	0.5	0.5
(7)		Weighted participation of literacy component	(5)x(6)	man-hours	10,000	6,000
(8)	Total Program	Total user participation, in both components	(2)+(5)	Thousand man-hours	32	30
(9)		Total Weighted participation, both components	(4)+(7)	Thousand man-hours	22	24
(10)		Weighted combined Unit cost	(1)/(9)	$ / man-hour	4.54	4.18*
(11)		Overall index of Cost-Utility	(9)/(1) =i/(10)	man-hours / $	.22	.24*

* Asterisk indicates the more attractive LRC alternative between Project E and Project F (the project with the lower unit cost and higher cost utility)

DO IT YOURSELF COST-UTILITY ANALYSIS

EXERCISE 22

Make up and solve an exercise demonstrating the use of the cost-utility method of economic analysis in the planning of learning resource centers for community based education in Latin America. Be sure to state your assumptions. It might be based on a comparison of mobile vs. non-mobile LRC units, for example; or anything else of interest to you.

If the cost stream is of five years' or more duration, use the "present values" of costs, from the formula $PV=FV/(1+i)^n$

It is suggested that you follow the calculation format in Table 6. Don't forget to:

- Estimate and tabulate the costs for all of the learning resource center projects being considered. (Use more space on a separate sheet of paper.)

- Estimate and tabulate the quantitative learning outputs of all of these LRC projects. Use other paper.

- Give relative weighting factors for the judged "value" or "importance" of the various LRC outputs, based on political, cultural or other preferences. Let one weighting factor be assigned the value of 1, to make the calculation easier. Enter them in the calculation table, as in table 6.

- Multiply the quantitative outputs of each project by the appropriate subjective weighting factor.

- Divide this resulting weighted output by the cost of each project, to yield a mesure of the "cost-utility" index.

- Calculate the reciprocal of the cost-utility index for each project. This reciprocal is the "unit cost." Find the unit cost for each project.

- Based on your analysis, what is the recommmended priority order among the alternative projects that should be brought to the attention of learning resource center planners responsible for decision making?

Congratulations; you have survived a fairly strong dose of economic analysis of community learning resource centers in a very short time. You should now feel more comfortable with economic analysis of LRC's.

EPILOGUE

THE ECONOMIC ANALYSIS "UNCERTAINTY PRINCIPLE"

You have learned to apply some economic analysis techniques to LRC's. Yet, it is well to keep in mind that in planning learning resource centers, as in other forms of economics of education analysis, only two of the three factors: time, money and accomplishment can be accurately specified in advance of the completion of a project.

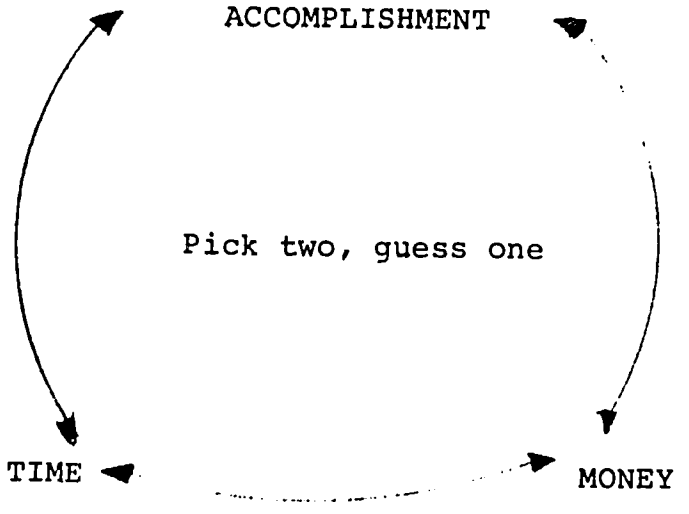

Figure 16
The Economic Analysis Uncertainty Principle

This uncertainty leads to three kinds of estimating:

1. Given a definite period of time in which to complete a project and a specified amount of money available, the actual accomplishment that will be achieved is uncertain in advance, and can only be estimated. This guessing exercise is called "scenario projecting."

2. Given the time available and the required accomplishment, the eventual cost cannot be known exactly in advance, and must be estimated. This guessing is "classical budgeting."

3. Given the amount of money available and the needed accomplishment, the time that will actually be consumed in achieving the specified goal cannot be foretold accurately in advance of the completion of the project. This type of uncertainty leads to the need for guessing, such as by Gantt charts, PERT or other methods.

It has been said that anyone who thinks that time, money and accomplishment can all be specified accurately in advance of the end of a project simply does not understand the situation! Nevertheless, we keep trying. Good luck in your economic analyses.

Glossary of Vocabulary

Cost-Effectiveness Approach: a form of economic analysis seeking the least costly way of achieving some specified goal.

Benefit/Cost Comparison: A form of economic analysis in which benefits are expressed in dollars as well as the costs. Then the costs are either substracted from the benefits to yield the net benefit or the benefit is divided by the cost to yield the benefit-to-cost ratio. Projects can be rendered accordingly.

Cost-Efficiency Approach: A form of economic analysis in which the useful outcome of an activity is divided by its cost. What you get divided by what you pay. Project can be ranked.

Unit Cost: The reciprocal of cost efficiency; the cost of an activity divided by its useful outcome measure. What you pay divided by what you get.

Cost - Utility Approach: A form of economic analysis in which subjective weighting factors are multiplied by the objective measure of output and the product of these divided by the cost to yield the weighted cost-utility. In comparative projects, usually the weighting factor is assigned a value of 1 to one output. Another output which is subjectively judged as being 80 percent as desirable as the first one would be assigned a weighting factor of 0.8. If the second output were considered to be half again as valuable as the first output the second would be assigned the value weight of 1.5. Ranking can be done.

Non-formal education: Defined here as out-of-school education.