

COST - UTILITY STUDIES: A MEANS TOWARD PUBLIC ACCOUNTABILITY FOR EDUCATIONAL EXPENDITURES

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SUMMARY

Cost-utility analysis can be defined as the process by which costs and certain benefits associated with program outputs are related and studied by the decision-maker in the determination of priorities and the allocation of resources. Most of the educational cost-utility work in the past has been concentrated upon the costs of education. The main problem area, however, is the obtaining of adequate, quantifiable data on facets of education *other* than costs.

In view of increasing student enrollments, increasing demands by employers for their occupational skills, and the necessity of allocating scarce educational resources, several important questions can be raised.

1. Do the existing vocational-technical education programs provide positive cost-utility relations?
2. Can a cost-effectiveness analysis be used to develop optimum utilization models in terms of human resources (staff) and facilities?
3. Can a cost-utility analysis be an effective technique for educational planners at local school system level to develop a Planning, Programming, Budget System?

If educational resources were unlimited, the necessity for careful evaluation and planning of programs in order to assure optimal allocation of resources would be non-existent. However, educational resources are scarce and require a high degree of accurate cost and utility estimation as decisions regarding the expenditure of these scarce resources are made.

This study used data from a representative vocational-technical education program (electronics technology) collected at a vocational-technical education center located in a large Urban Florida county. There are four main phases developed by this cost-utility study.

The first phase identified direct and indirect costs related to the electronics technology program. Algorithms were developed for the retrieval and assignments of program costs from actual expenditure records.

The second phase established criteria for determining marginal program utility in terms of marginal income increases for individual graduates of the program and marginal tax increases received by society as a result of the income gain of program graduates.

The third phase related the public and private costs to their respective utility values in terms of marginal monetary return on investment.

Finally, a cost-utility planning model was developed for use as a conceptual model for implementing a Planning, Programming, Budgeting System. The cost-utility model is presented as being essential to the concept of PPBS—that of designing programs in terms of optimizing human and monetary resources to achieve short and long-range objectives.

Part One

*Cost-Utility Theory: Cost-Benefits, Cost-Effectiveness
and All That*

Richard H. P. Kraft

Cost-benefit analysis is the process by which costs and certain benefits associated with program outputs are related and studied by the decision-maker in the determination of priorities and the allocation of resources. Data are collected for this analysis in many ways, two of these being the traditional cost-analysis procedures and the use of modern quantitative analysis techniques.

The process of cost-benefit can and should be approached from two directions, the long view and the wide view. The long view is concerned with longitudinal studies that will assist in preparing for possible future conditions and needs. The wide view is horizontal in nature and attempts to pinpoint side-effects, spillover, and any other non-direct influences and/or developments that may be derived from the system under analysis.

The complementary nature of the benefits derived from fulfilling of various educational goals make them conceptually more difficult to measure than is measurement of costs. Also, benefits spill over to third parties, often in an immeasurable form, making allocation of costs a difficult task indeed. Education has both investment (in human capital) and consumption aspects that must be dealt with. It is difficult to separate these two aspects for precise measurements and quantification.

Certain indices of benefit, measured in terms of economic efficiency goals, seem to be the educational benefits that are easiest to isolate. Indices developed for socialization goal measurement are less easily dealt with, although to some extent, one can measure and quantify such social indices as voting behavior, crime rate change, and general knowledge of current events.

One of the major problems is obtaining good cost data. Empirical data indicate variations because of size of school population, hours of instruction, quality of equipment and materials. These factors must be more controlled if valid cost-benefit information is to be derived.

Most of the educational cost-benefit work in the past has been concentrated upon the area of costs. The main problem area, however, is the obtaining of adequate, quantifiable data on facets of education *other* than costs. It is relatively easy to obtain the input costs to education, the tax share, the bonds sold, and contributions from the public and industry. Also, there is little difficulty in determining the short and long term financial returns as a result of certain amounts and types of education. The difficult measure is with personal and social outcomes.

Economic criteria to be used by the educational decision-maker in any cost-utility analysis would be: income, earning differentials and cost differentials, payback periods, cost-benefit ratios, expected capital values, and expected internal rate of return. The ultimate criterion that the educational administrator could desire would maximize the difference between the present value of benefits and the present value of costs.

Estimating and projecting the capital and operational costs of future educational programs is not so easy, however. This problem is due, mainly, to the financial accounting and budgeting system.

In view of increasing student enrollments, increasing demands by employers for occupational skills, and the problem of allocating scarce educational resources, several important questions can be raised.

1. Do the existing education programs provide positive cost-benefit relationships?
2. Can cost-benefit techniques be used to develop optimum utilization models in terms of human resources (staff) and facilities?
3. Can cost-utility analysis be an effective technique for educational planners at local school system level to develop a planning, programming, budgeting system?

A Short Literature Review

A review of the development of cost-utility analysis approaches to program planning and evaluation reveals that relatively few attempts to apply concepts of cost-utility analysis to educational programs have been primarily concerned with evaluating outputs in relation to input and processing costs in order to obtain a criterion for the decision to continue, expand, or discard the program under study.

The term *systems analysis* will be used here as a broad term defining any orderly analytic study designed to help a decision maker identify a preferred course of action from among possible alternatives. As commonly used, the phrase *systems analysis* refers to a formal study intended to advise a decision maker on the policy choices involved in matters such as planning program objectives.

A somewhat narrower definition is usually assigned to a cost-utility analysis. For example, each cost-utility analysis will involve, as one phase, a comparison of alternative courses of action in terms of their costs and utility aspects related to specific objective outputs. Usually the study consists of an attempt to minimize dollar cost subject to utility requirements or to maximize some measurable output subject to a budget constraint.

Other related terms—*cost-benefit analysis* and *cost-effectiveness analysis*, depending on the context and user—imply some subtle distinction from a cost-utility analysis. Some writers, for example, suggest that cost-benefit and cost-effectiveness studies are distinguished by their output measure. They define *benefits* as being measurable in monetary or market value which accrues at the margin of outputs, and *effectiveness* as an output which cannot be evaluated in monetary or market value units, as seems to be true of many of the objectives in the humanities and social sciences educational programs.

The basic characteristics these analytic approaches seem to have in common include an effort to make comparisons systematically in quantitative terms, using a logical sequence of steps. To qualify as a complete analysis, Quade (1965) suggests that a study must look at the entire problem in its proper context. Characteristically, such an analysis will involve a systematic investigation of the decision maker's objectives and of the relative criteria—costs, effectiveness, risks, and timing—associated with alternative strategies of achieving each objective.

Recent studies of the goals and objectives of education have been primarily concerned with verifying the appropriateness of existing objectives. The most widely used procedures in these types of studies essentially utilize value judgments for rating the objectives in terms of their appropriateness to contemporary needs. These objectives usually are not stated in behavioral terms and, thus, are not subject to quantitative evaluation.

Empirical studies conducted on the economic impact of education in recent years have been concerned primarily with the determination of the effects of educational investments on growth of the economy and the rates of return, both private and social, attributable to alternative levels of schooling.

Carrol and Ihnen (1967) in a comparative study of 45 high school graduates and an equal number of ability-matched post-high school technical education graduates, found that "social and private rates of return on investment in technical education were estimated at 16.5, and 22 percent, respectively." They concluded that while returns on individual technical education graduates were highly variable, 95 percent received positive investment return.

In a cost-benefit study among four types of vocational-technical education programs, Corazzini (1967) found that annual salaries of graduates of vocational high schools were \$82 to \$560 higher than the salaries of regular high school graduates. He argued, however, that the salary differences observed would decrease to zero in five to 10 years, an argument based upon the assumption that vocational-technical training is primarily a substitute for on-the-job training.

Anderson (1967) studied direct costs in eight junior colleges and found substantial cost differences among curricula. His findings indicated that a majority of the vocational-technical curricula offered in comprehensive junior colleges included in this study cost more per student than liberal art and transfer curricula in the same institutions. Unit costs for curricula classified as industrial-technical were found to be 1.52 times as costly than unit costs for liberal arts and transfer programs.

A number of valid precautions for those who base educational policy decisions on cost-utility analyses are offered by Williams (1965). Included among these are:

1. Although costs of educating one student one year can be described in general terms by use of averages, one could not adequately understand the activities of an institution by the use of such average costs alone.
2. There are so many variations in the factors affecting costs that comparisons of average costs, with implied meanings for efficiency of operation without consideration of quality, become of highly questionable value.

3. Statements of average costs of instruction are simple numerical descriptions of an operation. They may stimulate study of an instructional process but they should not control the process.
4. High costs in a given instructional area are not sufficient cause alone to abandon the educational program. Any curriculum with a small enrollment will have high unit costs . . . These facts do not alter the necessity for training people in urgently needed specialities.

A Cost-Value Model

Before carrying out a cost-benefit study, it is necessary to define the means and criteria whereby the analysis will be made and conclusions drawn. First, all terms must be defined. Although "cost-effectiveness," "cost-benefit," and "cost-utility" are often used interchangeably, there seem to be three distinct levels for which the analysis is to be made.

We will define *effectiveness* as relating to fulfillment of short-range objectives and criteria which usually will be of a directly quantifiable nature (e.g., test scores, number of graduates, initial employment, drop-outs, etc.). This is the area which is of greatest interest to the educational administrator.

Benefits can be defined as a fulfillment of intermediate-range goals, where many of the data are still quantifiable, but qualitative data are also needed. These include as examples, earnings-five-years-after-graduation and job stability. Internal benefits which are stressed here are of greatest interest to the educational planner and the economist.

Long-range objectives are fulfilled by *utility* criteria, which involve, primarily, external benefits, or returns to society. This area would include not only such quantitative factors as lifetime earnings and returns to society in the form of taxes, but also such qualitative factors as fulfillment of social demands, leisure activities, etc. through education. This is the realm in which formal education is, at best, indirectly involved and in which further study is required to quantify (if possible) the extent of its influence. This is the realm of greatest concern to the economist and social planner.

In the development of educational strategies, it is important, first, to set the time period for planning. Three levels of objectives are set for the outputs of the educational system. These

are determined by the needs of the greater societal system of which the school is a part.

The process of identifying and selecting objectives is next. Objectives are determined at three levels: long-range, intermediate-range, and short-range. Criteria must be set, for achievement of objectives as measured by utility criteria, intermediate-range by benefit criteria, and short-range by effectiveness criteria. Criteria may be defined as standards on which a judgment or decision may be based. These would, ideally, measure utility, benefits, and effectiveness quantitatively, but may also be proximate. Criteria are formulated to determine successful achievement of the goals. They may be measured directly (through physical properties), indirectly (by sampling), and by survey (attitudes).

Next, limits are set on cost and utility (composite of utility, benefit, and effectiveness measures) factors. That is, maximum available cost and minimum acceptable utility are defined for any program which will be implemented. A mathematical formulation of cost-utility, cost-benefit, and cost-effectiveness functions is then made by incorporating the criteria generated by the three levels of objectives.

Following this, a feasible set of alternatives is generated, with corresponding costs. Each program is broken down into activities, their elements, and corresponding costs. Alternative programs can be broken down in terms of learning and support activities, with personnel, materials, and other resources as the cost-elements.

Next, it is necessary to project into the future. Cost is first to be projected, utilizing a dynamic approach, and taking an appropriate discount rate into account. The cost of each alternative must be checked against the maximum allowable cost, eliminating those which exceed this limit.

The outputs of each program must be estimated—from research and/or known trends. Due to the uncertainty associated with time, however, various techniques can be applied to project these outputs. These include statistical techniques such as Monte Carlo, as well as sensitivity analysis, contingency analysis, and fortiori analysis. From these results, through the application of the mathematical functions, estimates of utility, benefits, and effectiveness of each alternative can be made. If the composite of utility, benefit, and effectiveness of any alternative is less than the minimum acceptable level, that alternative is rejected.

In addition, any new alternatives which may have been formulated while studying these results must be analyzed. The process just described is used in analyzing these alternatives also.

At this point the validity of the model must be tested. The following questions should be answered to determine the validity of the model:

- A. Can the model describe known facts and situations reasonably well?
- B. When the principal parameters involved are varied, do the results remain consistent and plausible?
- C. Can it handle special cases where we already have some indication as to what the outcome should be?
- D. Can it assign causes to known effects?

The cost-effectiveness, cost-benefit, and cost-utility ratios can then be formed for each alternative. These results should be supplemented by a qualitative analysis of the situation. Qualitative considerations, according to Fisher, can take the following forms:

- A. Qualitative analysis per se, as an integral part of the total analytical effort.
- B. Interpretation of the quantitative work.
- C. Discussion of relevant non-quantitative considerations that could not be taken into account in the "formal" analysis.*

The final choice of program or optimal mix of programs can then be determined. Implementation of the program is the next phase. Then, actual outputs of the system are fed back to the model and used to update it as necessary to insure optimal functioning.

*Fisher, G. H. *The World of Program Budgeting*. Paper presented at University of California, Los Angeles, June 2, 1966 (Santa Monica, California: The Rand Corporation), p. 19.

*Part Two**Public and Private Cost-Utility Aspects of a Selected Vocational-Technical Education Program: A Case Study***Henry F. Raichle**

Public investment in vocational-technical education in Florida has increased substantially during recent years, particularly since the Vocational Education Act of 1963. The combination of increasing demands by employers for a higher proportion of semi-skilled and skilled workers and rapidly increasing enrollments in post-secondary vocational-technical education centers in Florida indicate the need for continuous evaluation of existing programs and careful planning to meet short and long-term needs of students and society. Inherent in the educational evaluation and planning process is a system of analyzing costs and utility value of a given program with respect to stated behavioral objectives of the program.

If educational resources were unlimited, the necessity for careful evaluation and planning of programs in order to assure optimal allocation of resources would not exist. However, educational resources are scarce and require a high degree of accurate cost and utility estimation as decisions regarding the expenditure of these scarce resources are made.

This study used data from a representative vocational-technical education program (electronics technology) collected at a vocational-technical education center located in a large urban Florida county. There were four main phases developed by this cost-utility study.

The first phase identified direct and indirect costs related to the electronics technology program. Algorithms were developed for the retrieval and assignment of program costs from actual expenditure records. Program costs were then assigned to the private sector or individual students and the public sector or society.

The second phase established criteria for determining marginal program utility in terms of marginal income increases for individual graduates of the program and increase in marginal tax yields received by society as a result of the income gain of program graduates. These marginal salary gains were computed from empirical graduate follow-up income data taken from records of the sample vocational-technical education center.

The third phase related the public and private costs to their respective utility values in terms of marginal monetary return on investment. These values were expressed as cost-utility ratios and yielded estimated times-to-replace dollars spent by both individual students and the public. The reciprocal of the cost-utility ratio yielded the monetary return on investment.

Finally, a cost-utility planning model was developed for use as a conceptual model for implementing a *Planning, Programming, Budgeting System*. The cost-utility model was presented as being essential to the concept of PPBS—that of designing programs in terms of optimizing human and monetary resources to achieve short and long-range objectives.

The authors have reached a number of conclusions based upon the evidence assembled in this study. As no single study is expected to be definitive, a number of further analyses using different samples and different assumptions within the same basic economic framework need to be made. In view of the size of the sample, it should be emphasized that a larger and more representative sample is required before any generalizations can be made about the magnitude of the private and public returns on investment in vocational-technical education. The conclusions, which are significant in themselves, also suggest further directions of study.

1. The analysis of program costs and marginal utility in terms of monetary returns to an individual and society can be a significant program evaluation in its own right.
 - a. Reporting program costs and returns generated by education (educational capital) to the public can be a meaningful way of providing *feedback* to the public on what they can expect in return for their investment (taxes) in public education. This is especially significant politically when public referendums are held upon providing funds for educational program facilities and operations.
 - b. Since this analysis functioned at the marginal level it has considerable economic merit.

2. The sampled electronics technology education program is an economically worthwhile investment both for individuals and society.
 - a. Statistical mean data indicate that a 1968 ET program graduate, without prior electronic training or experience, invested \$5815 of his own funds. This investment, including foregone earnings, was returned to him within two and one-half years at the rate of 39.8 percent per year.
 - b. A public investment in this same student of \$1597 is returned to society in the form of increased local, state, and federal taxes paid by the graduate in less than three (2.9) years at the rate of 34.3 percent per year.
 - c. The rates of return for graduates with prior electronic training or experience were even higher because they required less time (school terms) to complete the program.
3. The findings of this cost-utility analysis illuminated the importance of the general *public's* investment in education. People other than those directly involved with education (non-parents, retirees, etc.) have a vested interest in the decreased tax burden or increased public services provided for them by the additional taxes paid by persons raising their income levels through post-secondary education.
4. It does not follow that an educational program with a lesser degree of monetary utility than another is less worthwhile and therefore should be assigned a lower resource allocation. Further studies of the more subjective aspects of program utility need also to be considered along with the value judgments of program evaluators and planners. Meaningful measures of these other program aspects need to be further developed.*

*These non-financial aspects would include utility values such as increased intellectual curiosity, creativity, employment satisfaction, social mobility and adaptation, social status, utilization of leisure time, and growth of an informed electorate.

5. The author feels that many program utility aspects will not be refined to the point of being precisely quantified. Therefore, value judgments will continue to remain as a necessary part of the decision-making process. As procedures for evaluating non-monetary benefits of educational programs become more refined, the precision and efficiency for cost-utility analysis undoubtedly will increase.
6. Accurate cost-utility analyses are of significant value and use to the educational planner.
 - a. Wide variations in direct teaching costs per course were caused by variations in: (1) class size; and (2) class load of teacher or teacher utilization. Cost implications can be analyzed of varying differentiated staffing plans by running alternative designs through the simulation model.
 - b. Other direct cost elements such as facility space, equipment, and furniture were also subject to wide variations in cost per course. These variations were caused by differences in the efficiency of space utilization which in turn were caused by an inflexible schedule of courses during a given school week. It is not reasonable to schedule all program courses in blocks of one or two hours daily, five days per week, regardless of the course content. More flexible scheduling of classes should be designed for post-secondary vocational-technical schools. The program cost implications can be analyzed by using the simulation model.
 - c. The educational planner using a cost-simulation model such as the one suggested is enabled to consider the above educational program variations separately and in combination for planning optimal efficiency in each educational program. The planner has data upon which to base cost projections for the continuation, expansion, or other modification of an existing program. All of these planning concepts are directly related to the broader concept of programming, planning, budgeting system.

7. The theory that cost-utility analysis techniques are useful in estimating costs of new programs for future years was further verified and developed. History indicates that educational programs that intuitively appeared attractive sometimes proved to be poor educational investments. Such unfortunate investments may be avoided through application of the suggested analysis.

8. It is essential to define and organize relevant information about educational programs—data concerning students, staff, course schedules, facilities, equipment, and expenditures—in order to perform cost-utility analyses. All records and reporting of these data need to be kept in computer-readable form and incorporated in a computer-based educational information system at a local or regional level. It is *not* economically feasible to manually extract and organize the relevant data necessary to perform a cost-utility analysis. The program-cost algorithm is of such a complex nature, requiring a substantially large number of calculations, that the procedure necessitates the use of an electronic computer. The complexity of calculation arises from three major factors:
 - a. joint costs of programs shared with instructors, rooms, and equipment at one educational center;
 - b. an object-classification-oriented accounting-budgeting system rather than program-oriented system;
 - c. fiscal year accounting-budgeting dates being non-coincidental with school term or school year dates.

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