# ECONOMIC EFFICIENCY AND THE DISTRIBUTION OF BENEFITS FROM COLLEGE INSTRUCTION*

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Economic efficiency implies an equating, at the margin, of benefits and costs. In this paper we explore a concept of "efficiency" which is broader than the usual framework and which applies to commodities and services produced and distributed largely outside the private, profit maximizing sector. An assessment of the economic efficiency of producing such a commodity requires the determination of its outputs and the valuation or weighting of these outputs.[1] Our principal point is that these weights, in turn, depend on who receives the outputs; thus, distributional issues are at the heart of economic efficiency studies involving a wide range of activities undertaken in the governmental and private, nonprofit sectors.[2] One of these activities—the production and distribution of college instruction in economics—illustrates well the significance of this particular approach to the analysis of economic efficiency.

We argue that in analyzing the economic efficiency of instruction, distributional issues—that is, who receives the benefits—should be considered explicitly; if not, they will necessarily be considered implicitly. The pervasive failure to include distributional issues in efficiency studies suggests an excessively narrow concept of efficiency. This is particularly inappropriate in evaluating instruction, since in education, as in most services, decisions regarding what to teach and how to teach have a strong influence on who receives the benefits.[3]

## I

Total benefits from instruction are a function of the amounts gained by each student and of the values of each amount; these values vary among different students or types of students. Therefore, aggregate benefits are a function of how the outputs are distributed among students. Symbolically, the marginal benefits, $B_k$, from resources employed in an instructional approach (technique and/or course content) $k$ is:

$$B_k = \sum_{j=1}^{n} \frac{\partial q_j}{\partial dk} \frac{\partial b_j}{\partial q_j}, \tag{1}$$

where

$q_j$ = the quantity of output produced by the input mix $k$ and received by student $j$[4]; and
$b_j$ = the value of benefits (output) accruing to student $j$.

Of the two partial derivatives the first is the marginal physical product of input (or input mix) $k$ for student $j$, and the second indicates the valuation of the marginal product.

As expression (1) reveals, the importance (both in quantity and in value) of any particular form of output may vary with the type of student recipient. For a student planning graduate work certain course outputs may have great value, whereas these same outputs may be of slight value to the student who plans to continue no further in the field. Similarly, instruction about behavior of the stock market may contribute greatly to the knowledge of persons from disadvantaged backgrounds while adding little to the knowledge of other students.

Most studies of instructional efficiency or studies which appraise the merits of particular teaching techniques have not estimated—nor have they even considered—the impact of alternative teaching approaches (input mixes) on the distribution of outputs among students. Neither have they examined the possibility that the value of outputs varies according to the distribution of the output. In terms of the model, the subscript $j$ has been entirely disregarded. The assumption implicit in such a simplification is either that students are a homogeneous group—each student receives the same amounts of outputs from a given course and the outputs have the same value

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[1] We assume throughout that output is measured in incremental, units-added terms.

[2] This general point has been developed in detail by B. A. Weisbrod [17]. In his study the concept of efficiency which encompasses the traditional view of efficiency as well as the distribution of output is termed "grand efficiency."

[3] This is true of most services because of the requirement that the consumer be present at the time and place of production (consumption) of the service.

[4] In practice, the summation will be over groups of students who possess roughly similar and "relevant" attributes. Parenthetically, it might be noted that if $j = 1$, expression (1) represents the value of an input used to produce a private good.

for each student—or that students should be treated as if they were a homogeneous group. Neither assumption seems reasonable, for rather obvious reasons.

This discussion has assumed implicitly that it is students' valuations that should count. There are many who feel, however, that valuations should be made by other groups, such as the faculty, the college administration, the taxpayers, or particular groups of students. Our general point—that the magnitude and distribution of benefits depends on the values assigned—is general and is invariant to whose values are applied.

In the following pages we discuss how instructional techniques and approaches influence the distribution of total output and the value of that output and how the distribution of output relates to a broad concept of economic efficiency.[5]

## II

Consensus on course content or instructional technique has not been reached in economics or in general. The literature abounds with arguments for or against the "citizenship" focus [4] [5] [16] or the preparation of potential graduate students [13]. At another level we find some economists calling for a heavy mathematical orientation [2] (though whether as a "means" or as an "end" is not always clear); others advocate a decision-making framework [3]; and still others argue the merits of shifting emphasis from macro- to micro-economics [15]. And recently there has been much discussion of the impact of new instructional techniques, among them programmed instruction [1] [8], television [9] [12], and TIPS (Teaching Information Processing System) [6].

In all of these illustrations, either course content or instructional technique is being considered explicitly. But the distribution of benefits among types of student clientele is also very much at stake, and differences in judgments as to whom it is most "important" to teach may be at the root of much of the controversy. The issue of importance or values is reflected in the right-hand derivative ($\partial b_j/\partial q_j$) in expression (1), above.

Even if the importance of benefiting all types of students is equal or is assigned to be equal, the actual benefits (the left-hand derivative, ($\partial q_j/\partial k_i$ in expression (1)) are not likely to be equal. It seems intuitively clear that different types of students—as defined by previous academic performance, desire for theoretical rigor, degree of social concern, family background, and the like—will benefit differentially, depending upon course content and instructional technique. A highly theoretical and mathematical formulation in the basic economics course may provide the largest benefits for students already thinking seriously about graduate work in economics, whereas a course focusing on a less formal treatment of contemporary economic problems (and employing a similar instructional technique)[6] may benefit most those students seeking a "general" education. Still another choice of course content is likely to be most beneficial to pre-law students. Given the heterogeneity of the enrolled students and the difficulty of offering simultaneously a variety of course contents, some students are certain to receive larger outputs[7] than will others. Yet little or no evidence exists on the strength of the linkage between the distribution of outputs and the choice of course content.[8]

What has just been said about course content also applies to instructional technique. The traditional theory of production assumes that the

[5] Although much of college instruction is outside the public sector, our framework is relevant to the theory of the public sector which permits analytically separable allocation and distribution branches. If the allocation branch decisions affect the distribution of welfare, then it is not possible to determine what and how much of some commodity to produce unless costless lump-sum redistributions are possible, or unless the welfare function—involving the value-weights referred to in expression (1)—is known [10] [17]. The formulation in expression (1) permits the quantity of output to vary among consumers. This is by contrast with some of the literature on the pure theory of public goods, in which it is assumed that all consumers benefit equally in the sense of receiving equal quantities of output of the public good [14]. It is clear, of course, that even if all did receive equal quantities of output, the individual's valuations could differ greatly. Instruction does have a considerable public-good element; thus we might well have couched our argument simply in terms of differences in consumers' (students') valuations rather than in terms of differences both in their valuations and in the quantities of outputs. The difference in approach, however, is not substantive. Decisions will depend on the products of quantities and values—as expression (1) indicates—and our point is that these products are likely to vary significantly with the choice of course approach.

[6] This qualification is intended to hold instructional technique constant in the present discussion so as to concentrate attention on course content.

[7] Important problems exist with respect to the definition and measurement of "outputs"—they may well be multidimensional—but these are outside the scope of this paper.

[8] In practice it may be difficult to separate the quantity of output from its value, and, indeed, the two may be interrelated. For example, if the consumer places a high value on increments of a particular type of course content, then his attitude toward learning may be "better," with the result that he will receive a larger quantity of output. This would make expression (1) more complex, for $q_j/k=f(b_j/q_j)$. An exploration of this complexity is beyond the scope of our present efforts.

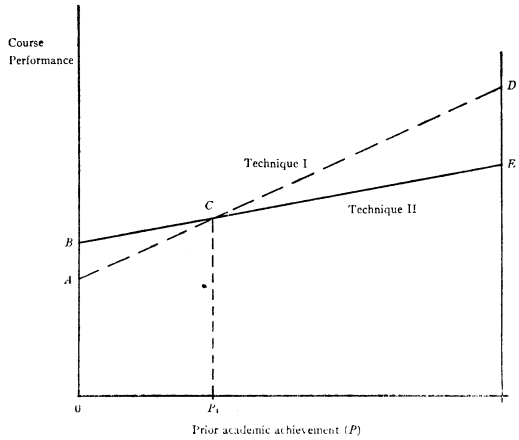


FIGURE 1

choice of production technique is a decision separable from the decision regarding the distribution of output. This assumption seems to dominate much of the evaluative research in economics education, for little effort has been devoted to finding out which kinds of students benefit by how much from the use of different instructional techniques; e.g., television and programmed instruction.[9] The available evidence often shows whether the new technique is an improvement in the sense that students attain higher average scores than they do in courses using conventional methods. But the degree to which the new technique alters the distribution of performance is a subject scarcely ever raised.

The differential effectiveness of a given instructional technique for different groups of students and the differential value of a unit of "effectiveness" for different groups of students are illustrated in Figure 1. In this example, students are arrayed according to prior academic achievement, as measured on the $X$ axis by a test given prior to beginning a particular course of study. The $Y$ axis measures performance on an appropriate test of accomplishment following completion of the particular course. The curves labeled I and II show course performance—using alternative instructional techniques on two comparable groups of students—as a function of the type of student within each group. "Course performance" reflects use of a particular test instrument for measuring "outputs" of the course.

The crossing of the two curves indicates that Technique I is more successful for the "stronger" students—those with prior academic achievement above $P$—whereas Technique II is more successful for the weaker students. Assuming an equal number of students at each level of prior achievement, $P$, it is clear that the average student gained more from the use of Technique I (that is, area $CDE$ exceeds area $ABC$). Thus, if one and only one of the two techniques is to be used, the preferred approach is certainly number I. Or is it?

True, Technique I gives a larger mean and, hence, aggregate level of course performance. But what of the value of that performance? Despite the apparent superiority of Technique I, it would actually be inferior to II if the function for valuing benefits attached sufficiently greater weight to a unit benefit when realized by students with poorer prior achievement (e.g., the "disadvantaged"?). How to establish the values assigned is not an easy matter. But it is at this stage, involving valuation, that normative judgments are blended with positive findings as to the effectiveness of alternative instructional techniques or course contents.

The efficiency of Techniques I and II depends, ultimately, on costs as well as benefits. The technique producing the largest value of gross benefits (output) is not the most efficient choice if its costs are enough greater so that the value of benefits, net of costs, is smaller than for some other instructional approach. Moreover, it may be the case that none of the alternatives is efficient; that is, perhaps none produces net benefits that are positive.

Two important implications of the framework captured in Figure 1 might be noted at this point. First, the possibility of interesecting lines has profound implications regarding an analysis of the literature on the appraisal of teaching approaches. In general, although many studies in the education and economics literature show no significant impact of an experimental teaching approach, the studies are incomplete. They do not distinguish between the case of zero impact for all students and the case of positive impacts for some students and roughly equal negative impacts for others. Indeed, as McKeachie emphasizes, in his review of the voluminous literature on college teaching: "One reason for the host of experimental comparisons resulting in non-significant differences may be simply that methods optimal for some

[9] This is true for all subject-matter areas, not only economics, and at all levels of education, not merely collegiate. This gap in educational research has been pointed out by others. For example, Robert Locke, an executive of the McGraw-Hill Book Company, has forcefully argued, ". . . the ideal program should not only use the most appropriate media for each task or objective, but it should also offer alternative media to accommodate differences among learners in ability, experience, motivation, style, and rate" [7].

students are detrimental to the achievement of others" [11, p. 1157]. However, neither we nor McKeachie knows which of the two cases above is closer to the truth. The implication is that much of the prior research needs to be reworked.

Second, if there is a distributional impact of the teaching approach (i.e., if the benefit curves of the experimental and control approaches are nonparallel, whether or not they intersect), then empirical tests which omit these distributional effects will produce statistically biased results.

## III

One of us has experimented with a new instructional technique in the principles course in economics at the University of Wisconsin, and some of the preliminary findings are relevant here. The details of this experiment are not important to the present discussion. What is interesting is that this experimental approach, while having a beneficial impact on all students, provided larger quantities of output (in terms of the left-hand derivative in expression (1) above) to some groups of students than to others.

Figure 2 shows that the experimental technique, by comparison with a standard lecture technique (used with an essentially randomized control group of students), produced positive amounts of output for students at every level of prior achievement.[10] But it also shows that the largest outputs went to students with the lowest ACT scores.

The fact that the experimental technique dominates the standard technique may appear to suggest that our findings are uninteresting in the context of concern about economic efficiency. Since the experimental technique involves added cost, however, this is not so. Even with the observed dominance, two issues remain unresolved: (1) Are the benefits disclosed in Figure 2—the area $ABCD$—large enough to warrant the costs? (2) If total cost is a constraint, so that the experimental technique can be provided to some students but not to all of them, to whom should it be provided?

The answer to the first question depends critically on how the outputs (benefits) are valued; i.e., on the welfare function. There is, in general, no unique value for a unit of benefit (a point of added test score), for the value is a function of who the beneficiary is.[11]

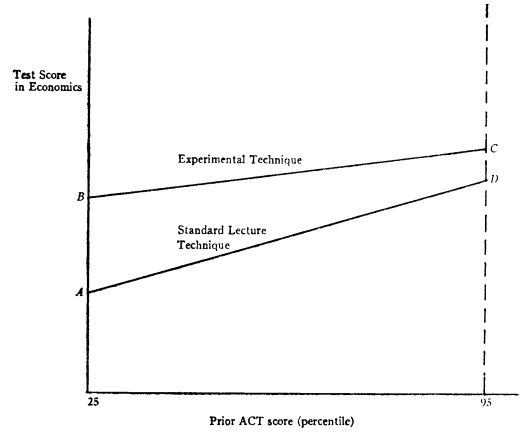


FIGURE 2

With regard to the second question, if the experimental technique is to be provided to, say, one-half of the students, which group should receive it? In other words, if total resources available are fixed, for which students will the value of output be a maximum?

The first thing to note is that Figure 2 cannot provide the answer. What it does show is that the program should be provided to the students with the lowest ACT scores if the objective is to maximize the measured quantity of output. But whether such an allocation would maximize the value of output is another issue. It will if the value of a unit increase in economics test score is a constant or decreasing function of prior ACT score, *ceteris paribus*.

If, however, there were a preference for helping "strong" students—a preference that may be reflected in the offering of "honors" courses—then it could be efficient to devote the added resources to students with high ACT scores.[12] All that is formally required to produce this result is that the value of output $CD$ (Figure 2) exceed the value of $AB$, and that there be no sizable interaction effects among students.[13] Since $AB = 5CD$

[10] In this illustration students are classified by prior level of academic achievement; clearly, however, other classifications may be appropriate; e.g., in terms of family background.

[11] It may also be a function of the amount of benefit realized by any given beneficiary; that is, there may be decreasing, or perhaps increasing, marginal value with respect to added units of benefit to a particular student or group of students.

[12] It would be instructive to consider the forms of weighting functions that would justify providing large amounts of resources to particular subsets of students, as is done in honors courses and in special programs for the disadvantaged.

[13] The latter assumption is necessary to insure that the separation of students into two or more homogeneous groups would not alter their respective class performance.

in the figure, an allocation of the experimental technique toward strong students is efficient if the value of additional economics output (as defined by the test used) be at least five times as great for a student at the 95th ACT percentile as it is for a student at the 25th percentile.[14]

## IV

The arguments in this paper have a number of research implications. Granted that an efficient allocation of instructional resources requires comparisons of benefits with costs of alternative programs, more information is needed as to the magnitudes of the benefits. These, in turn, depend on the distribution of benefits, since the value of a given absolute increment in output of instruction (i.e., achievement) is specific to the recipient. Therefore, it is clear that we need to learn more about who benefits; that is, what types of students benefit and how much each benefits when various combinations of course content and instructional technique are used. With this information in hand, normative judgments can then be applied—as expression (1) above indicates—in order to estimate the value of benefits from any particular course content or instructional technique.

The following are some specific research suggestions:

1. Batteries of pre- and post-course evaluations should be developed which reflect well-articulated output goals. While this paper has not concentrated on a precise specification of outputs, the importance of such a specification is clear. The distribution of benefits (outputs) cannot be ascertained without a prior decision—either explicit or implicit—as to the definition of output. More tests measuring different types of outputs are needed.[15]

2. When regression techniques or other statistical procedures are used in evaluating teaching alternatives, interaction effects should be included so as to permit estimation of relationships between the instructional approach and a variety of student attributes (e.g., class, major, mathematics knowledge, family background). Parameters of the interaction effects—such terms as the application of television or programmed learning to students with and without calculus—will provide information about the distributional impact of the teaching approach that is being studied.[16] If students benefit differentially from alternative teaching approaches, then failure to account for interaction effects between the teaching approach and student attributes will result in a mis-specified statistical model, biased parameter estimates, and often uninterpretable results.

3. Finally, it is important to face up to the issue of delineating explicitly our normative criteria on what "should" be the distribution of outputs. We must place "values" on the outputs. Until these value weights are made explicit—and the task is not simple—they will continue to be implicit and, hence, not open to critical examination.

## V. *Summary*

The central thesis of this paper is that production decisions in education on what and how to teach have distributional effects; as a result, distributional considerations should enter directly when making teaching decisions and evaluating these decisions.

The importance of this proposition and thus the validity of the inferences derived from it involve both factual and normative matters. If alternative teaching techniques do have differential impacts by type of student (the factual issue) and/or if social objectives dictate that it is more important to benefit some types of students than others (the normative issue), then the distributional consequences of selecting a teaching technique or course approach should receive explicit attention in benefit-cost analyses of production choices.

[14] For this problem—with the cost level constant—only an index of relative values is needed, not absolute monetary values.

[15] TUCE (Test of Understanding in College Economics) and TEU (Tests of Economic Understanding) represent an excellent beginning on this long-term project [5] [18].

[16] With respect to the pathbreaking research of Attiyeh, Bach, and Lumsden on the impact of programmed instruction in economics [1] [8] we are encouraged to learn that analysis is currently under way to investigate some of these types of interactions, and thus the distributional effects of programmed learning.

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