An Economic Model of Teaching Effectiveness

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The literature on the determinants of good teaching performance has been largely devoted to empirical measurement. A complete review of the publications in this area would require at least an entire issue the size of this journal. Yet, it is virtually impossible to discover attempts to derive hypotheses about the determinants of good teaching from explicit models of behavior. This has led researchers into the trap of exploring only the empirical determinants of good teaching performance. Typically, the results of student evaluations are correlated with affective personality traits of the teachers, with peer evaluations of psychological compositions, or even with the results of various psychological tests. Examples are the works of Robert Isaacson et al., Frank Costin et al., and Wilbert McKeachie et al. In most of these studies, no substantive conclusions are reached regarding the determinants of effective teaching. In the few studies which do contain significant findings, the independent variable in question is difficult to explain as a direct determinant of teaching effectiveness. For example, Isaacson et al. find that virtually the only statistically significant determinant of effective teaching is the personality characteristic which they label "culture." This may imply that simply wearing a tweed jacket and taking up pipesmoking is sufficient to improve teaching.[1]

This paper takes a somewhat different approach to the analysis of teaching. Assume that the individual in question wishes to maximize teaching effectiveness. Clearly, there are constraints on this maximization process. One must necessarily be the time budget constraint. A second constraint, however, adds a good deal of interest to the model. This constraint is best described as the bundle of characteristics available to the individual. These characteristics could be termed the components of the individual's personality. Such attributes include physical appearance, psychological makeup, speaking ability, and a myriad of other variables. Thus, this model bears a resemblance to the standard economic models of monopolistic competition (see A. Michael Spence).

Before proceeding to a formal statement of the problem, a philosophical issue must be addressed. What is meant by "teaching effectiveness"? Generally, this is interpreted as maximizing student evaluations of teachers. However, this is clearly not always equivalent to maximizing student learning. Unfortunately, the latter variable is difficult (but *not* impossible) to measure. (Pre- and post-testing with standardized tests is becoming increasingly accepted, for example). The meaning of teaching effectiveness in this paper must, unfortunately, remain ambiguous. Some teachers (concerned, perhaps, with obtaining tenure) will interpret good teaching as obtaining good evaluations, the criterion by which they are judged. Others may take a more eclectic viewpoint. Since the problem below is an individual maximization problem, the precise definition of effective teaching may simply vary from individual to individual (see W. R. Allen).

Formally, this problem is exactly analogous to one first addressed by Kelvin Lancaster. He assumes that the consumer attempts to maximize satisfaction through purchase of bundles of attributes. Each commodity is possessed of certain of these characteristics. By consuming various combinations of these commodities, the consumer is

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[1]In a previously unreported experiment in the department of economics, California State University-Bakersfield, faculty members were required to wear coats and ties in classes. It was subsequently observed that teaching evaluations improved. Unfortunately, no detailed statistical results of this experiment are available for analysis.

able effectively to consume the particular combination of attributes desired.

Technically, the overall problem for the individual is to maximize his utility function. Maximization of teaching effectiveness is a subsidiary problem. The utility function depends on a variety of factors, such as research, administrative and committee work (negative utility), good teaching, consulting, and leisure. The model presented below is a labor supply model analogous to both of the above threads in the literature. For the individual, the simplied problem can be stated as

$$(1) \qquad Max\ U=U(E, y_1,\ldots, y_m),$$

subject to

(a) $T(E, y_1,\ldots, y_m)=\bar{T}$;

(b) $E=E(x_1,\ldots, x_n)$;

(c) $x_i\leqslant\bar{x}_i,\ i=1,\ldots, n.$

where

$U\equiv$the individual's utility function;
$E\equiv E(x_1, x_2,\ldots, x_n)$ is the individual's teaching effectiveness function;
$x_i\equiv$the amount of characteristic i chosen by the individual to contribute to teaching effectiveness;
$\bar{x}_i\equiv$the maximum amount of characteristic i available to the individual;
$y_1\equiv$research activity;
$y_2\equiv$administrative activity;
$y_3\equiv$consulting activity;
$y_4\equiv$leisure activity;
$T(E, y_1,\ldots, y_m)\equiv$the time functions;
$\bar{T}\equiv$maximum time available to the individual.

To solve problem (1), the usual Lagrangean method will be employed (see Michael Intriligator):

$$(2) \qquad \Lambda=U(E, y_1,\ldots, y_m)+\lambda(\bar{T}-T)+\sum_{i=1}^{n} W_i(x_i-\bar{x}_i+s_i)$$

where the s_i are the n slack variables. The utility function is conveniently rewritten in reduced form as $U=U(x_1,\ldots, x_n, y_1,\ldots, y_m)$. Thus, the Kuhn-Tucker conditions are

$$(3a) \quad \partial U/\partial x_i-\lambda(\partial T/\partial x_i)+W_i\leqslant 0; \qquad i=1,\ldots, n.$$

$$(3b) \quad \left[\partial U/\partial x_i-\lambda(\partial T/\partial x_i)+W_i\right]x_i^*=0; \qquad i=1,\ldots, n.$$

$$(3c) \quad \partial U/\partial y_j-\lambda(\partial T/\partial y_j)=0; \qquad j=1,\ldots, m.$$

$$(3d) \quad \lambda\geqslant 0$$

$$(3e) \quad W_i\geqslant 0; \qquad i=1,\ldots, n.$$

$$(3f) \quad W_i[x_i^*-\bar{x}_i+s_i]=0.$$

$$(3g) \quad T=\bar{T}.$$

$$(3h) \quad x_i^*\geqslant 0.$$

$$(3i) \quad x_i^*-\bar{x}_i+s_i\leqslant 0.$$

There is an apparent technical difficulty with this approach. If the characteristic in question contributes positively at all levels of effective teaching, then the solution to one part of the above problem is clearly for the individual to set $x_i=\bar{x}_i$ for all characteristics which he possesses. This problem does not exist in model (1) for two reasons. First, for a particular individual, certain characteristics may contribute positively to effective teaching only up to a certain level. Beyond that level, these characteristics may detract from teaching. For example, a sense of humor is often cited as a "good" characteristic. However, a teacher with an extremely well-developed sense of humor would not find teaching effectiveness enhanced by spending the entire class time telling jokes. (It must be noted, however, that jokes are unlikely to do any harm).

The second answer to this question is a bit less obvious. Certain characteristics may exhibit negative complementarity. That is, they may simply not "fit" well together. For example, an instructor who wears a tweed jacket and smokes a pipe will probably not find that telling obscene jokes in class enhances

his teaching. It may be important to present a consistent image. Therefore, it may be unwise for the individual to use each characteristic to the fullest extent available.

Finally, it should be noted that the problem as presented is extremely difficult to solve, even if the E and U functions are known. The only simple analytic solutions which exist will be for the (unrealistic) case in which E is a linear function of the x_i and U is linear. (See George Dantzig.)

The first-order conditions (3) imply one usual and one unusual result. As is well known, equation (3c) implies that the individual will equate the ratio of marginal utility to marginal time requirements across all "major" activities. For example:

$$(4) \quad \partial U/\partial y_i/\partial T/\partial y_i = \partial U/\partial y_k/\partial T/\partial y_k.$$

However, for teaching effectiveness, the model implies

$$(5) \qquad \frac{\partial U/\partial y_i}{\partial T/\partial y_i} = \frac{\partial U/\partial x_i + w_i}{\partial T/\partial x_i}.$$

This implies that the marginal utility from using characteristic i must be corrected for the "cost" of that characteristic in terms of using all of it (w_i) or, alternatively, the cost of using any more of it (if $s_i > 0$).

Another way of viewing this is to consider an individual utilizing all of characteristic g and less than the total available of characteristic h. For characteristic g, $W_g > 0$ and $S_g = 0$. Therefore, the marginal utility from using one more unit of that characteristic will be lower than would be the case if the constraint were not present. For characteristic h, $W_h = 0$, $S_h > 0$, and the individual is using less of the characteristic, than is available. In this case, he is at a maximum with respect to the particular characteristic.

Different individuals will probably adopt differing teaching styles. This will occur for five reasons. First, differing individuals have different endowments of qualities ($\bar{x}_i$'s). In other words, what works for one teacher will not be feasible for another, since they have different personality characteristics. An informal, discussion-type classroom style will simply not work for an individual who is not comfortable in that sort of situation. Such an individual will probably adopt a more structured approach to lectures.

The second reason for the difference in teaching skills will be the nature of the teaching effectiveness function. Different individuals will have different perceptions of what constitutes good teaching. This implies that they will place different values on personality characteristics, and will therefore consciously adopt different styles.

The third reason, of course, is that utility functions will differ from individual to individual. If one individual places a good deal of emphasis on effective teaching and another individual emphasizes research, they will probably adopt (markedly) different teaching styles.

The fourth reason is somewhat more technical. However, it is apparent with a little reflection that the E function will probably not have a unique maximum. Even given the constraints, there is no reason to expect that two identical individuals will adopt identical teaching styles. This is strongly related to the one finding which virtually all of the empirical literature supports: teachers can improve their teaching skills if they are given feedback on their strong and weak points. This feedback process will ultimately result in an increase in $\bar{x}_i$ for some of the x_i. Thus, good teaching is a learning process. As such, the above static model abstracts from the dynamic nature of the process of developing effective teaching. One plausible model is that the development of teaching skills is simply a stochastic learning process. That is, the individual begins with some model of what a good teacher does in the classroom (subject to the limitations of available characteristics, of course). He receives some feedback on what has worked and what has not worked. He then reduces or does not use fully some characteristics which have not worked, and develops some other characteristics which may work. As more feedback is received, another correction would be made. Through this trial and error process, the teacher learns how to be a better teacher. Thus, it is apparent that, if the E function has multiple optima, the stochastic nature of the learning process virtually guarantees that different optimums will be achieved by different individuals.

Finally, in order to progress in an academic environment, the faculty member must be aware of the weights placed on typical faculty achievements by evaluation committees. Some universities heavily reward publications, others stress teaching, and still others general university community involvement. Thus two individuals with equal $\bar{x}_i$ may well develop different teaching styles based upon the expected rewards at their respective universities.[2]

This model suggests that there is no reason to expect that different teachers will have the same mode of teaching. This has the (unfortunate) further implication that individuals doing research into the empirical determinants of teaching effectiveness are doomed to be searching through a haystack which simply contains no needle. If, in fact, different styles are effective for different individuals, it would be expected that a cross-sectional correlation analysis would give only insignificant results. In fact, the expected value of the correlation coefficients would be near zero (see Henri Theil). Therefore, under the present model, there is no reason for even continuing the search for "the" determinant of good teaching.

While this conclusion is undoubtedly depressing to academic researchers, it is immensely hopeful for future teachers. The model presented in this paper seems to indicate that most individuals who wish to become effective teachers can do so if they are given regular, constructive feedback and the opportunity to practice different styles. The empirical prediction from this model is that new teachers are likely to show the most dramatic improvements in teaching effectiveness, since they are testing different styles to determine what works for them. However, not much improvement should be shown by teachers who have been active in the profession for some length of time. Thus, for one of the few times in economics, researchers have been looking at cross-sectional data when time-series data would have been more appropriate.

To summarize the conclusions of this paper, a model has been presented which suggests that different equally effective teachers will adopt different teaching styles due to different endowments, differing perceptions of what constitutes good teaching, and different search paths to determine which of the available styles works for them. The model explains the absence of empirical findings on the subject of teacher effectiveness, and suggests that the search for empirical results should be spent on the study of new entrants to the teaching profession who are traced and evaluated for several years, rather than simply looking at panels of teachers at one point in time. Finally, the model suggests that learning is an important component of effective teaching, and that good learners are likely to become good teachers if they set that goal for themselves.

[2] This model ignores another factor which is undoubtedly significant. This can best be characterized as the "audience" factor. For example, effective teaching to a graduate economics class would probably be totally ineffective in an undergraduate rhetoric course. There is room for further research in this area.

REFERENCES

W. R. Allen, "On Lecturing and Teaching," mimeo., Univ. California-Los Angeles.

F. Costin, W. T. Greenough, and R. J. Menges, "Student Ratings of College Teaching: Reliability, Validity, and Usefulness," *Rev. Educational Res.*, Dec. 1971, *41*, 511–33.

George Dantzig, *Linear Programming and Extensions*, Princeton: Princeton University Press, 1963.

Michael Intriligator, *Mathematical Optimization and Economic Theory*, Englewood Cliffs: Prentice-Hall, 1971.

R. L. Isaacson, W. J. McKeachie, and J. E. Milholland, "Correlations of Teacher Personality Variables and Study Ratings," *J. Educational Psych.*, Mar. 1963, *54*, 110–17.

K. Lancaster, "A New Approach to Consumer Theory," *J. Polit. Econ.*, Apr. 1966, *74*, 132–57.

W. J. McKeachie, Y. Lin, and W. Mann, "Student Ratings of Teacher Effectiveness: Validity Studies," *Amer. Educational Res. J.*, May 1971, *8*, 435–46.

A. M. Spence, "Product Selection, Fixed Costs, and Monopolistic Competition," *Rev. Econ. Studies*, June 1976, *43*, 217–35.

Henri Theil, *Principles of Econometrics*, New York: John Wiley & Sons, 1971.