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Teaching Effectiveness Function: A Model Developed from Historical Reports Supplemented with Subjective Vocational Teacher Perceptions

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Abstract: A Teaching Effectiveness Function was adapted from theory supporting Multiattribute Utility Technology (MAUT). The model was used to aggregate 19 published attributes into teaching effectiveness utility scores. Each attribute was entered into the related mathematical model in combination with a weighting Coefficient derived from a group of stakeholders. These stakeholders, new teachers at the secondary and postsecondary levels, reflected a business and industry point of

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view about teaching effectiveness. The theoretical intent was to develop from the literature an easily understood mathematical model for indexing teaching effectiveness. The empirical intent was to verify the method by establishing a range of scores representative of effective teaching with 90% confidence, using the same hard data collected from the stakeholder group. Distribution properties for indexing applications of the model (based on effectiveness weights defined from the stakeholder group) to teacher effectiveness problems are presented.

"Recent years have witnessed greatly increased appreciation of the centrality of good teaching to the effectiveness of schooling and the role of research on teaching in developing a knowledge base to inform the teaching profession" (Porter & Brophy, 1988, p.74). In the 60's and 70's, policymakers concerned about equity and improvement in the educational arena did not foresee a great need for research on teaching or for improving the quality of the teaching profession. Several researchers (e.g., Coleman, et al., 1966; Jencks, et al., 1972) were interpreted as downgrading the influence of both schools and teachers on student achievement. However, since the 70's the increasing resurgence of research on teaching has gained continuing emphasis. According to Porter and Brophy, the dramatic increase in research interest has focused on

> sophisticated methods of interviewing and observing teachers, development of rich descriptions of classroom processes, and frequently, information about linkages between classroom process and student outcomes. Much of it was predicated on a deceptively simple thesis: Effective school learning requires good teaching, and good

> teaching requires professionals who exercise judgments in constructing the education of their students (p.74).

Clearly, development of a general mathematical model for indexing teaching effectiveness has importance for assessment and evaluation in all educational areas, and especially in areas of significance to vocational education teachers at secondary and postsecondary levels.

Relevant Background Literature

In the late 70's, teachers either were considered to be the weak links in the process of education or were perceived to be technicians waiting to be programmed. In a report released in 1986, however, reform leaders in education concluded that well-educated teachers were needed to assume greater responsibilities and new positions to create a successful profession for the future (Carnegie Forum on Education and the Economy, 1986).

Subsequent to the Carnegie report, various views of teaching effectiveness have been studied. In the opinion of Doyle (1985), coherent sets of teaching strategies were needed instead of isolated teaching skills. Brophy and Good (1986) reported research showing that students receiving active instruction under supervision from their teachers typically achieved more than those spending most of their time independently working on curriculum materials. Other researchers (e.g., Clark & Peterson, 1986) reported active instruction to be a result of knowing how to plan, think, and make decisions professionally.

Some researchers have reported that teachers are especially effective when they assist students with understanding what should be learned and why it could be useful to them. These teachers provided objectives for lessons, motivated students with explanations, and monitored student task orientation to ensure that they understood the rationale for their

assignments (Anderson, Anderson, & Prawat, 1985; Anderson & Prawat, 1983; Duffy et al., 1986).

Assuring that students understand why they should learn certain content also has been reported to be an important factor in helping students to share responsibility for their own learning. Instructional procedures can help students learn the skills necessary to work independently. On the other hand, insufficient structuring has been found to lead to confusion (Navarro, Berkey, & Minnick, 1986). According to Duffy et al. (1986) and Palincsar and Brown (1984), students can achieve if teachers explicitly provide appropriate "modeling and instructing . . . information processing, . . . comprehension monitoring and correction, problem-solving, and other metacognitive strategies for purposeful learning" (cited in Porter& Brophy, 1988, p. 78).

Anderson and Smith (1987) asserted that important goals of reform in teacher education should be to infuse not only relevant content, but also, by making structural changes, to ensure that thorough subject matter knowledge of the content becomes a prominent characteristic of prospective teachers, Two content areas cited as highly important concerned pedagogy and student development. Also, instructional methods should be developed which integrate knowledge with application-oriented techniques.

Related studies in health care using medical technology and/or nursing students have identified certain instructional techniques associated with both effective and ineffective teaching. Turgeon (1987), for example, found that organization and relevance of content and instructor confidence were highly important. On the other hand, Theis (1988) revealed some unethical teaching behaviors described by nursing students as violations of major principles:

respect for persons, justice, and beneficence. The largest number of unethical teaching behaviors could be subsumed under the rubric of principles of respect for students.

Need for Study

Pressure to evaluate teaching effectiveness seems to increase continuously. An already intense level of pressure recently was augmented by pressures produced by national trends beginning with reports published by the National Commission on Excellence in Education (1983), the National Coalition of Advocates of Students (1985), and by former U.S. Secretary of Education, William J. Bennett (1986). Additional pressures have been generated by congressional mandates, state and local efforts to attain educational excellence, and parents who are increasingly called upon to make choices between public and private schools for their school-age children.

Educational administrators need options for evaluating, monitoring, and communicating the different levels of teaching effectiveness manifested by teachers under their responsibility (Hanny, 1987). Supported only by a history of subjective practice in making judgments about teaching, administrators could be well served with a Teaching Effectiveness Function (TEF) based on theoretical principles or research findings weighted with derivations from a system of ratings such as those developed from the vocational educators whose data support this report. Similar TEFs could be developed for use in any discipline or at any instructional level. These might be useful to those interested in educational auditing (either external or internal). Auditing with a TEF, in combination with other data, could be helpful in deciding between several applicant for open positions, in

comparing the merits of tsvo or more programs, or in policy analyses, including policies affecting the creation of new programs and the elimination of existing ones.

Conventional public wisdom maintains that major problems in economic development and in general preparation for the American work force are associated with teaching effectiveness, with business and industry being the most vocal. Their influence on vocational education policy is strong because vocational education seeks personnel from business and industry to enter its teaching ranks. Thus, it seemed appropriate to use a group of business and industry professionals who were new to teaching to provide data from which weighings of their perhaps unencumbered views of the various dimensional attributes of high quality teaching effectiveness could be computed. However, any stakeholder group's interest to vocational educators could have been selected (analytic procedures are independent of stakeholder characteristics).

Purpose

The theoretical intent supporting this study was the development (from the literature) of a general mathematical method for indexing teaching effectiveness. The empirical intent was to test the method with hard data from the stakeholder group. Three restraints delimited this study: (a) an arbitrary constraint to employ an easily understood methodology as similar as possible to methodologies already in use in education, (b) a necessary constraint to use a methodology suitable for hand-held calculator applications, and (c) a constraint to define the lower limit or minimum boundary condition separating mediocre teaching from effective teaching.

Theoretical Principles

Standards for teaching effectiveness may vary from one discipline to another. Within any general model for assessing teaching effectiveness it would seem appropriate to apply effectiveness standards addressed to, and developed from, the interests and practices of the specific constituencies the general model was intended to serve. In this case, standards of effectiveness should be derived from, and be appropriate for, teachers in vocational education programs at secondary and postsecondary levels.

Any instrument for defining corresponding teaching effectiveness should be capable of weighted aggregation of separate evaluations or observations (one evaluation of each attribute) for each teacher. Each evaluation should assess effectiveness corresponding to its respective attribute and each weighting should reflect the relative importance of the corresponding evaluation to the aggregated teaching effectiveness score. The process should be similar to the commonly used process of summative grading as practiced by teachers in assessing student achievement over extended time periods. In summative grading, each summative grading function aggregates a series of differentially weighted tests or other measures of performance into a single score to which a grade is assigned. For example, a teacher in summative grading arbitrarily may weight homework as 10%, quizzes as 30%, major tests as 40%, and the final examination as 20% of the final grade.

TEFs, however, should be subjected to deliberate rather than arbitrary development to avoid, as much as possible, a single stakeholder' s/evaluator's subjective judgment in establishing the differential weighting coefficients for the various dimensions.

Furthermore, the aggregation function should have other properties: (a) it should be capable of including evaluations based on subjective judgments in numerical form; (b) the coefficients should be representative of the values held by the teachers the TEF is intended to evaluate; (c) the attributes included in the function should be comprehensive of the dimensions the constituents attribute to teaching effectiveness, yet should not contain duplicated or highly overlapping dimensions; and (d) the attributes should represent dimensions on which the teachers to be evaluated are expected to vary. Irrelevant attributes should not be elements of the function.

The findings presented here include subjective judgments of teachers (stakeholders) representative of those who were evaluated by the Teaching Effectiveness Function. Multiattribute Utility Technology (MAUI') described by Edwards and Newman (1982) provides a suitable evaluation model for this situation. However, not all provisions of the MAUT were applied in this current analysis. For example, in this case, the scale of each attribute monotonically increased across ranges of 1 through 5, with larger values indicating greater effectiveness than smaller values. Thus, not all of the Edwards and Newman considerations for "location measures" were of concern here and only those which satisfied their primary condition were used: "It is necessary for all location measures to be on a common scale, in order for the assessment of weights to make any sense" (Edwards and Newman, 1982, p. 24).

Instrumentation

A 26 item instrument consisting of two parts was designed by the researchers for developing the weighting coefficients of the Teaching Effectiveness Function. The

instrument contained demographic and teaching effectiveness items designed to elicit data associated with the purposes of the study. The first seven items produced demographic characteristics for the stakeholders: age, gender, years teaching at secondary level, years teaching at postsecondary level, teaching status (teaching or not teaching at present time), educational level, and children enrolled in educational programs at various levels. The last 19 items were statements identifying characteristics (attributes) of teaching effectiveness. These attributes were published by the Association for Supervision and Curriculum Development (ASCD) in 1981. They were "based upon interpretations of research by Ronald Edmonds, Peter Mortimore, Barak Rosenshine, and others" (ASCD, 1981, p. 19). Therefore, the validity of the attributes was assumed. The reliability coefficient (standardized alpha) for the list of attributes, determined from the stakeholder data, was 0.72. As noted in Figure 1, respondents were requested to rate their perceptions of the levels of importance for each attribute on a five-point scale ranging between 5 (very high importance) and 1 (not important).

As noted in Figure 1, an arbitrary decision was made in developing the scale for recording each attribute judgment. The primary criterion was to develop a scale independent of time-intensive algorithms. Clearly, a way of establishing relative attribute importance to teaching effectiveness was essential. Also essential was the necessity (under previous constraints and assumptions) of developing an importance scale to reflect ordinal judgments.

Subjects

The 98 subjects (former business and industry personnel) were enrolled in courses in preparation for teacher certification as vocational education teachers in either secondary or postsecondary industrial education, or in postsecondary health occupations programs. The

Figure 1. The effective teacher

Instructions: Rate the following items according to level of importance for teaching effectiveness. Write the appropriate number in the blank to the left of each item using the following levels of importance:

5 = Very High, 4 = High, 3 = Average, 2 = Low, 1 = Not Important

An effective teacher:

__ 1. is well organized and thus prevents problems from occurring.
__ 2. gives students more time on academic tasks because classroom routines do not require as much time.
__ 3. tends to teach the class as a whole or in large groups, giving less independent seat work.
__ 4. emphasizes academic achievement and ***expects that all*** students will achieve.
__ 5. selects and directs classroom activities.
__ 6. makes sure that students master one unit before moving on to the next.
__ 7. involves students in learning activities whenever possible.
__ 8. assigns tasks for which students have a high likelihood of succeeding.
__ 9. has a good grasp of the subject matter.
__ 10. has excellent presentation skills (can explain well, demonstrate, and lead a good discussion).
__ 11. monitors student progress by asking questions and circulating around the room.
__ 12. gives adequate feedback so students know what they have learned and what still needs to be learned.
__ 13. finds ways to get students to cooperate with one another and take responsibility for their work.
__ 14. directs questions to specific students rather than to those who volunteer.
__ 15. uses guides and probing questions when students don't know answers.
__ 16. encourages positive behavior and controls negative behavior.
__ 17. does not grade papers during the class period.
__ 18. does not socialize or allow students to socialize in class.
__ 19. does not permit interruptions of class activities or negative behavior.

Note. Items are from Teacher and School Effectiveness: Teacher's Guide (p. 18) by Dorothy Mulligan, 1981, Alexandria, VA: Association for Supervision and Curriculum Development. Adapted by ***permission.***

Figure 1. ASCD items on "The Effective Teacher" presented as items 8 through 26 of the opinionnaire for computing TEF weighings.

subjects either had been recently employed to teach or were preparing to teach in their respective fields. Seventy were male, 28 were female. Seventy-two were currently teaching and 26 were planning to teach. Those having teaching experience at the secondary level averaged 0.53 years, those at the postsecondary level, 0.53 years. (Six participants had experience at both levels.)

The subjects' educational backgrounds varied: 20 had completed high school, 16 had completed a one-year technical program, 19 had an associate degree, 26 had a baccalaureate degree, and 4 had a masters degree. Nine had completed the specified courses required for obtaining a non-professional type of teacher certification. Four had completed other types of educational mining. Twenty-six respondents had children in elementary school; 10 children were in middle or junior high school, 17 in high school, and 12 were enrolled in college.

Data Collection

Data were collected from the 98 subjects. They were either a new or prospective teacher in vocational education at the secondary or postsecondary level. All 98 were enrolled in one of the education courses required for teacher certification. A part of each course focused on characteristics of an effective teacher. The courses included lectures, and a film which was reported to be' an "effective means for helping students acquire knowledge" (ASCD, 1981, p.5) about teaching efficacy. The instruction also included activities in group discussion and problem solving. This latter component was intended to facilitate comprehension and application of effectiveness related content. Each class was conducted under a plan containing a standard set of procedures to insure similar treatment. After the sessions, each participant completed the instrument.

Statistical Methodology

A statistical methodology supportive of MAUT evaluation was developed. The spirit of analytic considerations of Edwards and, Newman (1982) was followed as closely as possible. Having gathered response data from the 98 subjects, the researchers then determined the relative weights to be assigned each attribute dimension based on the items assessed for effective teaching. These weights became coefficients in the Teaching Effectiveness Function (TEF), producing an aggregate score or index value in each application of the model.

The rank sum weight option of Edwards and Newman (1982) derived weights for the attributes from the rank orderings of the attribute responses by all subjects. Average ratings for each attribute were used to establish its relative contribution to teaching effectiveness" in context of the remaining items. Precedents for the related mathematical operations on ordinal data are well-established in the literature of non-parametric statistics (e.g. Siegel 1956).

The 98 ordinal responses were totaled for each of the separate attributes, then an average rating was computed for the relative contribution (weight) of the attribute to the TEF. The average ratings for each of the 19 attributes were added and an attribute proportion (weight for each attribute) was computed. Each attribute proportion derived in this manner served as the relative weight for the respective attribute. That is, each attribute proportion became a weight coefficient for that attribute in the teaching effectiveness function.

The Teaching Effectiveness Function is the sum (TEF linear aggregate) of the attribute values derived by respectively weighting the values for all attributes. The aggregates produced serve as indices of relative teaching effectiveness, with larger indices associated with greater effectiveness and smaller indices associated with lesser effectiveness. The teaching effectiveness of a teacher could be indexed, in practice, by first assigning a value between 1 and 5 to each of the 19 attributes," matching each attribute with its weighting coefficient, then aggregating the products of those assigned pairs of values to produce a teaching effectiveness value on the same scale of 1 to 5. Multiplying the teaching effectiveness value by 20 rescales the value to a scale of 20 to 100. An alternative method would be to first multiply each of the 19 attribute responses by 20, then compute a TEF value on a scale of 20 to 100 using the attribute weights. Most inexpensive, hand-held calculators with a memory are capable of these mathematical operations.

Results

Table 1 presents two sets of weighings for the 19 attributes in the Teaching Effectiveness Function: a set based on observed (1 through 5) and a set on transformed (20 through 100) observations. The transformed values were derived from the observed by multiplying each of the observed values by 20 as a scaling factor. If one wanted a TEF value on a scale of 1 to 5 one could apply the observed column weights to item scores on their observed 1 to 5 scale. Alternatively, if one wanted a TEF value on a scale of 20 to 100, one could apply the scaled weights to the same item values on their observed 1 through 5 scale.

Table 1

Observed and Scaled Weightings for the 19 Teaching Effectiveness Items

Item No.	Weight Observed	scaled	Item No.	Weight Observed	Soled
1	0.0586176	1.172	11	0.0555051	1.110
2	0.0416288	0.832	12	0.0588769	1.176
3	0.0386461	0.772	13	0.0552458	1.104
4	0.0488912	0.976	14	0.0450006	0.900
5	0.0565426	1.130	15	0.0495396	0.990
6	0.0564129	1.128	16	0.0577098	1.154
7	0.0593957	1.186	17	0.0437615	0.974
8	0.0505771	1.010	18	0.0429257	0.858
9	0.0614706	1.228	19	0.0558942	1.116
10	0.0583582	1.166			

Each weighting represents a proportional contribution of the rated attribute to an aggregate score produced from application of the TEF. As indicated in the foregoing, from purely mathematical considerations one deduces from the observed weighings that the maximum possible aggregated weighting is 5, and for the scaled weighting it is 10Q, given a scaling factor of 20.

After computing weighting coefficients, the instrument may be adapted for indexing teaching effectiveness in vocational education. The evaluator should adjust the instructions from the stakeholder instrument to produce instruments suitable for use in the evaluation process.

Discussion, Implications, and Recommendations

Teaching Effectiveness Instrumentation

Typically, teachers whose effectiveness would be indexed would not be the stakeholders on whose responses the weighting coefficients were determined. That is, the teachers being evaluated would have been measured with an instrument whose items would have been weighted by other (perhaps non-teacher) stakeholders and observed for the evaluation process by an evaluator (perhaps an administrator, a student, or another teacher). Having a computed TEF value for a teacher, the evaluator could make a judgment of effectiveness through consideration of TEF scale properties such as those presented in the remainder of this report.

Should scaled weighting coefficients such as those shown in Table 1 be used to weight the attributes, one would expect the aggregates to produce values no larger than 100. For the present study, the scaled weighings of Table 1 were applied to the stakeholders' ratings to obtain aggregates having the distribution shown in Table 2. Table 2 represents the stakeholders' range of judgment on teaching effectiveness scores descriptive of effective teaching. That is, Table 2 presents a range of scores indexing TEF values for teaching known or assumed to be effective. Scores lower than, say, the tenth percentile value with over 90 percent confidence may be said to represent degrees of teaching ineffectiveness, with lower scores representing lower levels of effectiveness.

Educational Policy

Policy makers, using data similar to those presented in Table 2, may decide to provide assistance to all teachers whose aggregate scores fall below some arbitrary value,

Table 2

Distribution Properties for Aggregate Scores from the Teaching Effectiveness Function

Percentile	Value	Percentile	Value	Percentile	Value
10.00	75.098	50.00	84.923	75.00	87.974
25.00	79.246			90.00	92.066

Note. Valid cases = 98, Missing cases = O, Std Dev = 6.341.

perhaps below the value associated with the 10th percentile. Or, teachers having teaching effectiveness aggregate scores higher than some arbitrary value may be honored, perhaps the value associated with the 90th percentile. In addition, persons whose responsibilities include arranging in-service experiences for teachers could use attribute distributions in arranging workshops or seminars.

Involvement of Other Evaluators

The rating instructions for the evaluation instrument could be modified so that students could respond (Figure 2). In such a case, a teacher could have' a teaching effectiveness aggregate score generated by all, or a sample of, students for whom the teacher is responsible. The student aggregate scores derived from applying the TEF could be averaged to arrive at a mean teaching effectiveness value for the purpose of (a) a tenure

Figure 2. Substitute title and instructions for effectiveness instrument (Figure 1).

Teaching Practices

Instructions: Rate the following items according to level of practice for the teacher being assessed. Write the appropriate number in the blank to the left of each item using the following levels of practice:

5 = Exceptional, 4 = Above Avg., 3 = Average, 2 = Below Ave., 1 = Satisfactory

The teacher being assessed:

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consideration, (b) continuation of a teaching contract, (c) a merit raise, (d) a mentoring session, or (e) some other policy response at the administrative level. Nothing in the method precludes other interested evaluators from applying suitably modified instruments to which the same weighings would generate TEF aggregate scores. Figure 3 could guide the data layout and computational procedures. However, different weighings would generate different aggregate scores for the TEF attributes when comparing results if, others, such as principals, vocational directors, deans of instruction, students, or parents were used to establish the weighting coefficients.

General Interoretations

As a general rule, attributes vary in importance, with differences in weights expressing the respective importance of each attribute relative to the others. Magnitudes of weights, however, generally vary over time for the same set of subjects. Magnitudes also may vary from one program to another and from one group of subjects to another. Situational caution should be exercised accordingly.

Figure 3. A schematic showing relationships between raw data, observed and scaled weighting coefficients, and aggregate scores

Stake-holders (i)	Item (j) 1	2	. . .	k	Σa_{ij} (j=1 to k)	$s*\Sigma a_{ij}$ (j=1 to k)
1					RAW AGGREGATED	SCALED AGGREGATED
2						
3						
	a_{ij}					
n						

$$\text{Grand Total} = \sum_{i=1}^{n} \Sigma a_{ij} = \sum_{i=1}^{n} \sum_{j=1}^{k} a_{ij}$$

$$\text{Observed weighting coefficients} = \Sigma a_{ij} \; I \; \sum_{i=1}^{n} \sum_{j=1}^{k} a_{ij}$$

Scaled weighting coefficients = S * (Observed weighting coefficients)
[S is scaling factor]

A TEF should assess decomposition of teaching effectiveness as a set of non-redundant contributing component attributes. Each attribute should possess defensible levels of validity and reliability. When attributes are complementary rather than competitive, it is necessary to weigh them with reduced coefficients for aggregation so that their combination does not inappropriately dominate other competitive attributes in the TEF. In every case, "each stakeholder should judge weights in the level or levels of the tree in which he or she has knowledge, expertise, or interest" (Edwards & Newman, 1982, p. 53). The weights used in this study were derived from separate ratings of each of the 19 teaching effectiveness attributes by each of the 98 stakeholders. In replication, one would expect slightly different results should the 19 attributes be ranked comparatively (rather than rated separately) by each of the 98 stakeholders.

Research on teaching effectiveness should be continued to meet any set of national education goals, such as those established by President Bush and the National Association of Governors in February 1990:

> By the year 2000, American students will leave grades 4, 8, and 12 having demonstrated competency in challenging subject matters, including English, mathematics, science, history, and geography. In addition, every school in America will ensure that all students learn to use their minds, in order to prepare them for responsible citizenship, further learning, and productive employment in a modem economy. . . . [Moreover,] by the year 2000, the high school graduation rate will increase to at least 90 percent. (Teacher, 1990, p. 17)

Clearly, effective instruction is needed to support such lofty political goals. But, to determine whether instruction is ineffective and to remediate ineffective instruction, one needs to perform analyses based on multidimensional weighted attributes such as the ones presented here. Health occupations education teachers will recognize that this approach and methodology are by no means the only ones available for evaluating teaching effectiveness, but they are easily implemented and are not founded on complex conceptualizations that are difficult or impossible to defend. Teaching effectiveness is important to all health occupations education teachers in their individual classrooms, programs, and schools. TEF offers teachers, peers, and students a tool to evaluate their individual teaching.

Follow-up Research

Teaching effectiveness is but one segment of a larger, complex effectiveness mosaic involving institutional, social, cultural, political, economic, psychologic, and student components. From this research, a follow-up study will focus on school effectiveness as one level of the institutional contribution to the mosaic. Another follow-up study will address a more general educational effectiveness assessment methodology that is capable of reducing the complex mosaic into a manageable synthesis of component parts in which teaching effectiveness and school effectiveness are two exemplary research initiatives.

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