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Educational Effectiveness Function: An Algorithmic Methodology

Uniting Instruments, Stakeholders, and Weighings

Into Numerical Effectiveness Indices

Mary Edith Powell¹

James Noel Wilmoth

Abstract: This study is based on effectiveness data collected from beginning or new vocational education teachers. The report illustrates **multiattribute** utility technology applied to 31 indicator items first reported in a publication of the Association for Supervision and Curriculum Development. Nineteen of the 31 items were aggregated into a teaching effectiveness component and 12 into a component for school effectiveness. The teaching and school effectiveness components then were aggregated into 5 educational effectiveness functions based on as many different weighings (0, 10, 0.25, 0.50, 0.75, and 0.90) of the teaching effectiveness component. Properties of the resulting distributions were presented. Finally, a more general model of educational effectiveness based on **multiattribute** utility technology was explored.

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Past efforts at defining effectiveness in education tended to be restricted to rather narrow procedural definitions. The educational literature is void of systematic, rigorous, reproducible processes for a general solution to the problem. Rather, as reported by **Teddle**, Kirby, and **Stringfield** (1989), the literature has focused on the separately treated, twin dimensions of teaching- and school-effectiveness.

For establishing relative efficacies of the indicator attributes in any **useful** process and for aggregating attributes into effectiveness indices, the methodology in this report is based on assumptions that:

1. Single indicators of effectiveness are linearly related to each other within their dimensions. such as within either their teaching effectiveness or the school effectiveness dimensions. A central problem is determining the relative weights to be applied to the indicator values within each dimension in the aggregation process, for example, to the teaching effectiveness and school effectiveness dimensions described by Walters & Wilmoth (1992, 1993).

2. Different dimensions are linearly related. A **generalization** of the previous solution is needed. The problem becomes one of how to assign weights to dimensions (as indicators of effectiveness) during aggregation to super- or macro-dimensions.

3. Different evaluators could operate from different models of effectiveness. As the researcher moves from one to another of the various publics or clientele groups interested in educational effectiveness, single and aggregated effectiveness attributes may be differently defined.

4. Both subjective expert opinion and objective measurements should be capable of consideration. The methodology should provide for aggregating both subjective and objective measures into effectiveness indices. This requires a sensitivity to rankings or ratings. Classification data should be **recodable** to reflect their assumed properties. Interval data ordinarily should not need transformation.

This report should not be considered as either **defining** an effective education or setting standards for existing effectiveness measures. Rather, it focuses more on the methodology for producing educational effectiveness indices or measures given a set of constituting attributes that could and should vary across and within the variety of educational situations of interest.

The methodology does not depend on a large number of schools, teachers, or students for its implementation: thus, for these and other reasons, it is not difficult to implement. In fact, the methodology may be implemented with no student data at all; however, prudence suggests that at some point, student data should be considered. What is required, **though, is** that effectiveness characteristics for consideration be known by the primary stakeholders who may represent one or more groups, possibly including student groups. At the implementation phase one needs expert judgments concerning how the included attribute data for each set of effectiveness characteristics (that is, for each effectiveness index) should be weighted in aggregating into its effectiveness measures.

Relevant Background Literature

“For a number of years, researchers have examined the extent to which teachers, administrators, and other staff have been successful in their efforts to foster important

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educational outcomes in the children who attend their schools” (Mandeville & Anderson, 1987, p. 203). In the effectiveness terminology of this report, the term educational effectiveness is defined in the sense used by Duke (1983) to suggest a union of leadership functions and instructional effectiveness. The Duke model includes an effective administrator providing coordination, trouble shooting, staff development, instructional support, resource acquisition and allocation, and quality control. These functions, if provided, result in capable instructors, time for direct instruction, orderly environments, adequate resources, high expectations, and monitored programs culminating in effective instruction. However, the challenge of improving educational effectiveness in the United States is complex, as addressed in the report presented to Congress in 1989 entitled “The Education Deficit. ” As reported there, “No nation can long remain competitive in the world economy without an adequately educated and trained work force” (Matz. p. 7). A method for empirically measuring educational effectiveness as provided in this report should encompass a means for evaluating relative efficacies of a variety of educational programs.

Walters & Wilmoth (1992, 1993) described in detail, the mathematical modeling of teacher and school contributions to educational effectiveness. The report on the Teaching Effectiveness Function (Walters & Wilmoth, 1992) aggregated indicators from 19 assumed indicators and the report on the School Effectiveness Function (Walters & Wilmoth, 1993) aggregated indicators from 12 assumed components. It is clear, however, that any promising mathematical model of general educational effectiveness should be capable of synthesizing a plethora of indices from these teaching- and school-effectiveness functions, and from other components.

Multiattribute Utility Technology (MAUT), as described by Edwards and Newman (1982). provided foundational guidance for the earlier reported Teaching Effectiveness Function (TEF) and School Effectiveness Function (SEF). Moreover, MAUT potential is sufficient for compositing a variety of specific theoretical levels of effectiveness into more general expressions, Furthermore, the MAUT methodology is intuitively appealing in that it, among other characteristics, (a) is capable of including subjective data on educational effectiveness, (b) may involve a number of publics interested in educational effectiveness, (c) is computable with readily available hand-held calculators with a memory, and (d) is intuitively appealing to educators in being similar to techniques now in place for evaluating student educational achievement. MAUT methodology was applied under the foregoing reasoning to development of this report for an Educational Effectiveness Function (EEF).

Need for Study

Professional and lay views of educational effectiveness encompass increasingly larger and more complicated concerns at all levels of education, **More** and more **laypersons** hold perceptions that stimulate strong opinions rarely complimentary of the state of educational effectiveness nationally, regionally, statewide, or locally. According to Howe (1991), “America 2000. . . purports to leave significant decisions about education to individual schools, but it enlists the full influence of the U.S. Presidency in a major program for educational change, a program with potential impact on every aspect of schooling” (p. 192). In spite of these views from significant publics and clientele, the **call** for funding increases never seems to abate. Often these **calls** promote the claim that with additional resources will come additional effectiveness. Even though America 2000 reportedly honors local control,

expects local initiatives and recognizes the localities and state as senior partners, “it recognizes that real education reform happens community by community and school by school” (America 2000, 1991, p. 11). In addition, the recommendations have inserted pressures for educational effectiveness into a variety of functional domains: school curricula, assessment, teaching practices, and school organization and management (Howe, 1991).

Another characteristic of the present *milieux* is the absence of valid, reliable algorithms for measuring educational effectiveness. Especially absent are objective, mathematically oriented algorithms capable of synthesizing the various component attributes of educational effectiveness into a composite educational effectiveness index, rating, score, or value. Such an algorithm should be capable of synthesizing and building educational effectiveness values from its various components including, in addition to teacher and school components, other dimensional components involving extra institutional social, cultural, political, economic, psychologic, and/or student attributes.

Business and industry personnel seeking teacher certification

Over the past several years, national attention has focused on the **need** for cooperative job training systems among business, industry and vocational education with a long-range commitment to prepare a competent and trained **workforce**, thus ensuring a strong national economy (Cantor, 1990). However, in recent decades, the most severe critics of educational efforts have had strong ties to business and industry. Thus, a sample whose members were new to the education field was chosen from those groups as **stakeholders** from whom weighings for two of the educational effectiveness dimensional functions were computed. Details of their involvement have been formally reported in two documents referenced earlier

as the Teaching Effectiveness Function (Walters & Wilmoth, 1992) and the School Effectiveness Function (Walters & Wilmoth, 1993).

Methodology

The necessary first step was limiting the problem to fit within a scope that was manageable, would illustrate the mathematics, yet would be broad enough for **applicational** validity. Here, limitation involved decisions at two levels: (a) a decision of what dimensional components constitute educational effectiveness, then, within each dimensional component, and (b) further decisions of what the observable indicators should be. Fundamental to the latter would be the capacity of each indicator to yield to the mathematical operations symbolized in the Educational Effectiveness Function (EEF), collapsing all the indicator data into a single measure. A following section explores in some detail the issues of dimensional components and indicators as both serve to define educational effectiveness.

A subsequent step involved selection of a function capable of fitting all dimensions to their respective indicators in a mathematically sound manner. The function should be theoretically consistent with sound evaluation theory in its capacity for unifying each dimension to its indicators in the form of ratings, rankings, or numbers assigned in a manner consistent with sound measurement theory. The function also needed to be appropriate for linking dimensions composed of indicators into larger aggregates; that is, into conceptually more abstract dimensions whose indicators were themselves dimensions computed from more specific indicators. Considerations and issues in this step beyond those of measurement and evaluation are associated with multiattribute evaluation (Edwards & Newman, 1982) and include the need for common scaling for all indicators.

Operational Definition for Educational Effectiveness

Speaking without qualification about education references an exceedingly complex phenomenon. Effectiveness is a simpler concept in that it has a limited number of interpretations with quantitative meanings, especially when **qualified** with a **modifying** term, such as in “educational effectiveness.” For **illustration** of related methodology, educational effectiveness was considered (for purposes of the current report) to consist of two dimensions: (a) teaching effectiveness, and (b) school effectiveness. Both dimensions have status in the literature. In one view, the teaching effectiveness dimension was considered to be composed of 19 indicators (Walters & Wilmoth, 1992) and the school effectiveness dimension of 12 (Walters & Wilmoth, 1993).

Subjects

The 98 subjects were former business and industry personnel who were either new or prospective vocational education teachers at secondary or **postsecondary** levels. In addition, they were enrolled in vocational teacher certification courses in **preparation** for programs in either secondary or postsecondary industrial education, or in **postsecondary** health occupations. The subjects had been either recently employed or were preparing to teach in their respective fields. Seventy were male, 25 were female. Seventy -two were currently teaching, and 26 were planning to teach. Those having teaching experience at the secondary level averaged 0.526 years, those at the postsecondary level, 0.534 years. (Six participants had experience at both levels.)

Their educational backgrounds varied: Twenty **had completed** high school, 16 had completed one-year technical programs, 19 had associate degrees, **26 had four-year college**

degrees, and 4 had masters degrees. Nine had completed only the specified courses required for obtaining non-pro sessional type of teacher certification. Four had completed other types of educational training. Twenty-six respondents had children in elementary school; 10, in middle or junior high school; 17, in high school; and 12 had children enrolled at the college level,

Instrumentation

A 38-item instrument, consisting of three parts, was designed by the researchers for developing the weighting coefficients for the Teaching Effectiveness Function and the School Effectiveness Function. Since educational effectiveness was defined for this report as consisting of the twin dimensions of teaching effectiveness and school effectiveness, indices from their respective functions were aggregated according to MAUT techniques into composite scores defined as the Educational Effectiveness Function (EEF).

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), and educational level. No illustrative figure for the demographic variables is reported here due to the self-evident nature of the individual items.

The 19 items following the demographics were statements identifying characteristics of teaching effectiveness. The final 12 items were statements related to school effectiveness. These teaching and school effectiveness items originally 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

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others” (AS CD, 1981, p. 19). The ASCD statements on the instrument, therefore, were
assumed to have validity for this report and two previous reports (Walters & Wilmoth, 1992,
1993).

As noted in Figure 1 under the headings m1, m2, m19 for teaching, and in Figure
2, m1, m2, ..., m 12 for school, respondents were requested to rate, for both teaching and
school dimensions of effectiveness, their perceptions of the levels of importance for each
item on a five-point scale ranging between 5 = very **high** importance, and 1 =not important.
As presented. the ratings applied in general to effective teachers and schools. Their
reliability y coefficient (standardized alpha), determined from the stakeholder
raw (or untransformed) data, was 0.72 for the teaching effectiveness and 0.74 for the school
effectiveness items.

The Effective Teacher

Instructions: Rate the following items according to level of importance for teaching
effectiveness. Use the following scale to guide your response.

Levels of Importance
5 = Verv **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.

(figure continued)

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- ___ 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.

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

"Based upon interpretations of research by Ronald Edmonds, Peter Mortimore, Barak Rosenshine, and others" (ASCD, 1981, p. 19)

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.

In applying the same items to measure effectiveness of a particular teacher or school, the response instructions and, perhaps, the anchored values for levels of **practice** should be altered. Possible alterations might take the forms shown in Figures 3 and 4.

The Common Scale. Obviously, with **different** numbers (19 and 12) of attributes characterizing teaching and school effectiveness as components of educational effectiveness, one needs to consider transformations to a common scale such that compositing mathematically would be meaningful. Theoretical considerations for developing scales in the field of education lie in the subdiscipline of educational measurement. As noted in Figure 1, a considered, although arbitrary decision was taken in developing the scale for recording each attribute judgment. The primary operational criterion was developing a scale independent of time-intensive algorithms. Clearly, a way of establishing relative attribute importance was essential. Also clear was the necessity (under previous constraints and assumptions) of considering any scale of importance to reflect judgments that were ordinal, at best.

If the attributes were tied to a similar scale, e.g., a scale of 1 to 5, 1 to 50, or 1 to 100, scaling artifacts would be minimized. The question became one of which arbitrary scale to use. Having decided on 5 anchor points, the scaling decision was driven by debating the capacity of stakeholders for discriminating between freer and freer scaling options. On the other hand, it would be intuitive] y appealing to have a scale on which ratings of 0 and 100

The Effective School

Instructions: Rate the following items according to level of importance for school effectiveness. Use the following scale to guide your response.

Levels of Importance

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

An effective school:

- 1. has strong leadership, especially in reading and math instruction.
- 2. provides a pleasant and orderly atmosphere; the classroom climate is business-like with teacher-directed student activities.
- 3. expects all students to learn.
- 4. makes learning the chief priority: all staff members understand this emphasis.
- 5. monitors student progress carefully, reports test results, and uses them to improve teaching and learning.
- 6. gives students adequate time on task and opportunity to learn expected content.
- 7. stresses rewards rather than punishment.
- 8. is committed to mastery of subject matter; insists that each student succeed before moving on to the next unit.
- 9. has high expectations for teachers as well as for students.
- 10. encourages and facilitates visits of teachers to other teachers' classrooms to observe techniques and amount of time on task.
- 11. maintains consistency among teachers in treatment of students.
- 12. gives adequate feedback so students know what they have learned and what still needs to be learned.

(figure continued)

Figure 2. ASCD items on "The Effective School" presented as Items 27 through 38 of the opinionnaire for computing SEF weighings.

"Based upon interpretations of research by Ronald Edmonds, Peter Mortimore, Barak Rosenshine, and others" (ASCD, 1981, p. 19)

Note. Items are from Teacher and School Effectiveness: Teacher's Guide (p. 19) by Dorothy Mulligan, 1981, Alexandria, VA: Association for Supervision and Curriculum Development. Adapted by permission.

could serve as anchors for "absence" and "perfection." Our arbitrary decision was to develop weighings from the stakeholders using a scale of 1 to 5 with coarseness to match their probable subjective inability to discriminate finer possibilities. (Implicit in a 5 point scale is the expectation that the stakeholders may have capacity to discriminate with at best 20% accuracy.)

Teaching Practices

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

<p><u>Levels of Practice</u></p> <p>5= Exceptional, 4= Above Avg, 3= Average, 2 = Below Avg, 1 = Unsatisfactory</p>

The teacher being assessed:

Figure 3. Substitute title and instructions for instrument to evaluate teaching effectiveness.

Data Collection

In the required certification courses, the subjects focused on characteristics of an effective teacher. In addition to lecture, a film was employed which was reported to be an "effective means for helping students acquire knowledge" (ASCD, 1981, p. 5) about teaching

Practices in School

Instructions: Rate the following items according to level of practice for the school being assessed. Write the appropriate response in the blank to the left of each item.

<p><u>Levels of Practice</u></p> <p>5= Exceptional, 4= Above Avg., 3= Average, 2= Below Avg. 1 = Unsatisfactory</p>

The school being assessed:

Figure 4. Substitute title and instructions for instrument to evaluate school effectiveness.

and school effectiveness. Activities in group discussion and problem solving were incorporated into the instruction. The latter were intended to facilitate comprehension and application of effectiveness related content. Each class was conducted under a plan containing the same procedures to insure similar treatment. After the sessions, each participant completed the instrument.

Statistical Methodology

Figure 5 is a schematic presenting the layout of the raw indicator data illustrating a point of view translatable into computerized analysis. From reference to Figure 5 some of the following ideas may be clarified,

Figure 5 provides two perspectives on the data as required by MAUT analysis of a function composed of two components. As presented, entries on the lies represent subjects in the sample. The data were **analyzed** in two stages, the first stage viewing the subjects as stakeholders, the second stage as respondents from whom a distribution of values characterizing effective education may be derived.

T E A C H E R	F U N C T I O N																	
	Teaching Effectiveness							School Effectiveness							EFF AGG			
	A1	A2	...	A19	TEF		A1	A2	...	A12	SEF							
	w1	m1	w2	m2	...	19	19	W1	V1	w1	m1	w2	m2	...	12	12	W2	V2
1						m	SUMS								m	SUMS		SUMS
2	w					e	W		w						e	W		
.	e					a	E	of	e						a	E	of	of
.	i					s	I		i						s	I		
.	g					u	G	P	g						u	G	P	<u>P</u>
.	h					r	H	D	h						r	H	D	<u>D</u>
.	t					e	T	T	t						e	T	T	<u>T</u>
98	s					s	S	S	s						s	S	S	<u>S</u>

Figure 5. MAUT layout of Educational Effectiveness Function having 2 components: teaching effectiveness and school effectiveness.

As stakeholders, the subjects supplied data for deriving indicator item weights. As stakeholder ratings, the raw data subsequently were mathematically transformed according to well-specified procedures. The mathematical transformation was applied independently to the two situations presented on the instrument: teaching effectiveness and school effectiveness. The process in each case has been fully reported by Walters & Wilmoth (1992, 1993). Upon comparison with those reports, one will note a difference in schematics necessitated by the greater complexity inherent in the current problem of educational effectiveness which is based by definition on a combination of teaching and school effectiveness.

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Rating-means by item were computed and rank ordered within their respective functions, and function specific item weights were computed by methods specified in the earlier reports by Walters & Wilmoth (1992, 1993). The item weights were resealed to produce composite scale values lying theoretically between 20 and 100. The item weights are represented on the schematic in Figure 5 as m_1, m_2, \dots, m_k , where m_k represents the 19th item under teaching effectiveness and the 12th item under school effectiveness.

Item weights producing acceptable scale properties under teaching effectiveness and school effectiveness permitted computation of corresponding component scores for each of the 98 subjects. For each subject, each component score was an aggregation of its weight by rating values. This series of computations produced the V 1 and V 2 values under the TEF and SEF headings of Figure 5.

The Educational Effectiveness Function. Remaining was the need to aggregate the Teaching Effectiveness Function (TEF) and School Effectiveness Function (SEF) values into a more comprehensive value for each subject. The latter value was called the Educational Effectiveness Function (EEF) value.

EEF values are reported as aggregates (EFF AGG) under their column on the right side of Figure 5. Each value required specification of a "stakeholder" weight reflecting the respective contributions of TEF and SEF values. Because the authors were not stakeholders and the subjects were not surveyed on the matter of educational effectiveness, a series of 5 arbitrary choices were taken as specifications of relative weights for the TEF and SEF component values. TEF values were weighted accordingly as: 0.10, 0.25, 0.50, 0.75, and 0.90. Corresponding SEF values were weighted as: 0.90, 0.75, 0.50, 0.25, and 0.10.

Repeated measures MANOVA techniques were used to test differences in the means for the 5 EEF distributions scaled according to the preceding weights.

Results

Weightings

Stakeholder weightings computed by methods described earlier appear as Tables 1 and 2. The Scaled column partition under Weight functions to scale the products in the linear aggregation model to a maximum theoretical value of 100. Since each subject responded to all items with a minimum value of 1, the minimum theoretical aggregation value is 20 for both the TEF and SEF items.

Weights under the Observed column partition of Tables 1 and 2 are reported to the 7th decimal digit to enable desirable precision under the Scaled partition prior to rounding to the 3rd decimal digit. Distribution values of the TEF and SEF components at selected percentiles are in the lower thirds of Tables 1 and 2.

The empirical distributions represented at the 5 percentile values of Tables 1 and 2 represent distributions for rating effective teaching and schools after the subjects experienced the ASCD treatment program. These data reveal that 80% of the subjects reflected scores for effective teaching to lie on the interval bounded by about 75 and 92, and for effective schools on the interval bounded by about 80 and 99.

Reliabilities of the indicators of teaching and school effectiveness are presented as the bottom entries of Tables 1 and 2. The alphas were about 0.69 for the teaching effectiveness indicators and about 0.74 for the school effectiveness indicators.

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Table 1

Observed and Scaled Weightings for the 19 Teaching Effectiveness Items, and Distribution

Properties for the Teaching Effectiveness Scale

Item No.	Weight		No.	Weight		Item Scaled
	Observed	Scaled		Observed	Scaled	
1	0.0586176	1.172	11	0.0555051	1.110	
2	0.0416288	0.832	12	0.0588769	1.176	
3	0.0336461	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	0.0487615	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				

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

Valid cases	98	Missing cases	0	Std Dev	6.341
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Reliability Coefficients for 12 Items:

ALPHA = .6907	Standardized Item ALPHA = .7286
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Table 2

Observed and Scaled Weightings for the 12 School Effectiveness Items. and Distribution
Properties for the School Effectiveness Scale

Item No.	Weight		Item No.	Weight	
	Observed	Scaled		Observed	scaled
1	0.0850535	1.700	7	0.0837156	1.674
2	0.0848624	1.696	8	0.0800841	1.600
3	0.0863914	1.726	9	0.0867737	1.734
4	0.0879205	1.758	10	0.0716743	1.432
5	0.0852446	1.704	11	0.0808486	1.616
6	0.0844801	1.688	12	0.0829511	1.658

Percentile	Value	Percentile	Value	Percentile	Value
10.00	79.869	50.00	90.101	75.00	95.018
25.00	83.824			90.00	98.558

Valid cases	98	Missing cases	0	Std Dev	7.245
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RELIABILITY COEFFICIENTS 12 ITEMS

ALPHA = .7375 STANDARDIZED ITEM ALPHA = .7462

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Table 3 presents distribution characteristics for the linear aggregates of the 98 **EEF** scores produced from the TEF and SEF components. Column headings under the Teaching Effectiveness spanner indicate the weightings for previously computed values of that component. The school effectiveness component corresponding to the respective teaching effectiveness weights would be the weight complements of the weights used for teaching effectiveness. Table 3 reveals that the 50th percentile values tend to rise with decreases in teaching effectiveness weights (increases in school effectiveness weights). The repeated measures analysis of variance reflected in Table 4 permits inferences on the statistical similarity/difference among the 5 means corresponding to the different weights assigned to teaching effectiveness. The reporting procedure of Table 4 parallels analytic standards presented in Wirier (1971, p. 266),

Table 3

Distribution Characteristics for Educational Effectiveness Scores Produced from 5 Arbitrary Weightings for the Teaching Effectiveness Component

Teaching Effectiveness					
Percentile ↓	0.10	0.25	0.50	0.75	0.90
10	80.322	80.028	78.372	77.014	75.876
25	83.531	83.191	82.250	80.731	79.531
50	89.440	88.627	86.425	85.757	85.165
75	94.149	92.848	91.802	90.052	88.843
90	98.071	96.774	94.429	93.150	92.135
Min	67.162	67.493	68.045	68.596	68.927
Max	100.000	100.000	100.000	100.000	100.000
Std Dev	6.989	6.663	6.296	6.184	6.247

Table 4

Reweated Measures Analysis of Variance of Educational Effectiveness Scores

(n=98)

Source	Sum of Squares	df	MS	F	Prob
Between People	19287.	97	198.9	33.2	0.0
Within People	2341.6	392	5.97		
Treatments	1137.8	4	284.4	114.6	0.0001
Residual	1203.8	485	2.482		
Total	21629.				

Note: Means for Treatments after excising between people effects were 2.03, 1.32, -0.053, -1.27, and -2.03 for **EEF's** produced by TEF weights of 0.10, 0.25, 0.50, 0.75, and 0.90 respectively. Post hoc **Scheffe** testing indicated each mean to be significantly different from each of the others. As expected, the lion's share (about 89 %) of the EEF variance accounted for is assigned to Between People. Of the remaining variance (about 2342 units), about 48 % represents differences in the computing algorithms (TEF weights of .10, .25, .50, .75, and .90) that produced the 5 sets of treatment scores.

Discussion, Implications, and Recommendations

An Instrument for Auditing/MonitoringEducational Effectiveness in Vocational Education

The authors do not claim that present data are exhaustive in defining educational effectiveness. Rather, the claim is one pertaining to methodology. Given a set of effectiveness characterizing components with their respective indicators, a given group of stakeholders has provided information permitting weighting for related linear aggregation functions. Were other theoretical approaches applied to the educational effectiveness construct, one would, of necessity, generate different models providing different scores requiring different interpretations.

Powell and Wilmoth: Educational Effectiveness Function

According to Rosenshine (1986), for example, teaching effectiveness should be based on indicators reflecting the variability with which teachers use systematic, functional **step-by-step** instructional processes to teach concepts and skills. The more systematic, the greater the teaching effectiveness expected for the teacher. Rosenshine's suggested process includes the following steps: review, presentation, guided practice, corrections, and feedback.

The effectiveness activity could also be extended to include empirical determination for what constitutes effectiveness. The problem could be approached through research based on teaching contests using experimental teaching units as a means of identifying teaching skills differential] y effective for different grades and subject areas (Rosenshine, 1977). In addition, staff development activities could be planned for defining the instructional model (labeled Direct Instruction) containing the best general principles for forming a basis for teacher training (Rosen shine & Meyers, 1978), and should be used with prospective teachers (Rosenshine, 1987).

The relationship of the physical environment to academic achievement in high school as reported by Burkhalter (1983) suggests an exploratory program involving students in their more educational] y effective communities rather than in traditional school classrooms. However, a later Burkhalter study (1987) involving students participating in the United States Space Camp Program showed that regardless of the learning environment, students with field-independent differentiation were more likely to show cognitive gain while studying scientific matter.

Educational Policy

As indicated by Preston (1989), “most people and organizations reach a point in time when they must assess their current status and then decide whether to perpetuate the status quo or consider a new direction” (p. 48). Moreover, American educators and policy-makers seem increasingly supportive of the concept that education **will** have a tremendous impact on quality of life and will be directly related to the level of U.S. competitiveness in the world economy. Thus, “. . . academic standards in the classrooms of America must be elevated if we are to meet the economic challenges ahead” (Preston, 1989, p.49). The question remains, however, about how the level of educational effectiveness may be known (or certified) to have changed in the absence of corresponding (a) unifying conceptual models that comprehensive] y address the problem, and (b) assessment algorithms for monitoring the change process both formatively and summative] y.

Research Opportunities

Figure 6 provides a layout perspective for new data on educational effectiveness were MAUT to be used as the primary assessment and analytic algorithm. A logical first step would be specification of the stakeholders who would utilize the effectiveness outcomes. Would the stakeholders be a group of students, teachers, administrators, parents, legislators, a combination of the foregoing, or some other arbitrarily **specified** group? Having **specified** a stakeholder group, two additional decisions would be required as suggested in the additional steps described below.

E N T I T Y	F U N C T I O N														E F F E C T I V E N E S S		
	Teaching Effectiveness						SUCCESSIVE Components				School Effectiveness					S E F A G E	
	Att 1	Att 2	...	Att t	T E P W	T E P V	Att 1	EFS(i)		Att 1	Att 2	...	Att s	S E P W			S E P V
	w1	m1	w2	m2	...	wt	mt	w1	m1	w1	m1	w2	m2	...			ws
Ent 1						r	SUMS								m	SUMS	SUMS
Ent 2	w					e	W								e	W	
.						a	E of								a	E of	of
.						s	I								s	I	
.						u	G P								u	G P	P
						h	r H D								h	r H D	D
						t	e T T								t	e T T	T
Ent E	s					s	S S S								s	S S S	S

sum
Mean
Std Dev

Figure 6. Schematic for GENERALIZED layout of MAUT data for Educational Effectiveness Function having 2 or more components including SEF and TEF.

The second step relates to how the researcher, with stakeholder input, will isolate the effectiveness components and their indicators for the conceptual model of effectiveness. The third step relates to how the researcher will secure data from the stakeholders for assigning the weights to be applied in the MAUT algorithm. Figure 6 may enlighten the decision process.

Figure 6 shows that one operating assumption characterizing new educational effectiveness research is its having teaching effectiveness (on the left) and school effectiveness components (on the right) as well as an arbitrary number of other components at the same level (in the middle). One also observes that each component may consist of an arbitrary number of attributes; however, the researcher must control the assignment of weights within components such that the sum of the weights for any component is exactly 1. With the weights, the researcher would also control the limits on the scaled values for each component for instance, to lie between 0 and 100, with the added requirement that the component scales have essential] y similar or comparable ranges, Application of creative scaling factors to the weights assigned the indicator attributes accomplishes these goals mathematically.

Another important weighting consideration requires the researcher to determine carefully from the stakeholders, or from some equivalent source, the relative weights to be assigned to each component in the process of aggregating the educational effectiveness values in the most general function. Again, these weights must add to 1 for the process to be sensible.

The stakeholders do not need to be the same persons as the entities along the rows of Figure 6. Usually stakeholders and entities are different. It was acceptable for them to be the same in the current study primarily because all consequent educational effectiveness scores were interpreted only in a context defining empirical educational effectiveness outcomes. Outside this empirical range on the low end would lie outcomes that would be regarded as descriptive of ineffective education. Researchers may wish to focus on

properties of a more general range of effectiveness outcomes which, unlike the present study, should extend downward to values close to 20.

Figure 6 also suggests added statistical computations on the data including production of salient distribution data for each set of measures with headings in the figure. Three such statistics are listed: the sum of the column values, their respective means, and standard deviations. These can be applied to traditional (usual) interpretational algorithms.

Education reform is a critical issue on the agendas at both state and federal levels. Equally as critical is the issue of health care reform which **will** require a paradigm shift affecting all preparatory curricula including the Health Occupations Education Curriculum. Global competition requires an adequately educated and trained **workforce**; yet our present educational system is heavily criticized for failing to accomplish this goal. The foregoing methodology is presented for measuring generalized educational **effectiveness** as a means for improving policy decisions in a variety of settings for a variety of purposes.

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