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The relationship of selected district, staff and community characteristics to efficiency among Iowa public elementary schools

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by

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CHAPTER I. INTRODUCTION

The Setting

Dr. Wallace Ogg, an extension economist at Iowa State University, prefaced a recent publication concerning Iowa schools with the following comment, "Public schools--their finance, educational programs, policies, etc.,...probably command the greatest attention of any institution in which the public is involved" (33, p. 1).

In Iowa, average per pupil costs increased from $389 in 1961-1962 to $718 in 1968-1969 (33, p. 6). Thus, in a seven year span, per pupil costs increased more than 80 percent. Generally, school budgets were approved with little public comment during that period. Employment was high, wages were increasing to keep abreast of advancing living costs, and property taxes, while increasing steadily, were not oppressive. Toward the latter years of that period, however, it began to appear as though the combined demands of municipal, county and other local governmental spending, added to the requirements for schools, were too large to be adequately financed by the property tax.

The public began to question the need for new expenditures by schools, and a favorite topic of earlier years was revived--efficiency. It followed that the test of whether a school was utilizing its financial resources "efficiently" was to compare its per pupil costs with those costs in other districts.

There is a major weakness inherent in a per pupil cost basis for the comparison of school systems' efficiency. Per pupil costs are completely made up of "inputs" and do not reflect the product, or "output", of a system.

The Problem

The survey reported herein was concerned with efficiency. It was proposed that a measure of efficiency be compared with staff, system and community characteristics in an effort to discover whether there were characteristics which might be utilized, alone or in combination, to predict the efficiency with which schools use financial resources to produce pupil cognitive learning growth. It was decided that financial resources used would be only those expended for instruction, as recorded in line items 20000 through 20999 of Iowa school budgets, (i.e., teacher salaries, supplies, textbooks, and other instructional materials). Pupil cognitive growth was defined as the average annual gain in achievement from year to year achieved by each student grade level as measured by the Iowa Tests of Basic Skills (30).

The criterion measure of "efficiency" then, was defined an instructional dollars expended per unit of cognitive learning growth produced over time. The time period 1967-68 through

1969-70 was selected for study rather than later years for two very important reasons. The first of these reasons was the fact that these school years were the last of the era of almost total local financial control of school districts in Iowa. After this time, school district budgets were first "frozen" and then limited by arbitrary per pupil spending limits established by legislative fiat. The other reason for this span of years was availability of data.

Two aspects of this survey differ somewhat from recent studies employing similar input-output analyses. The first is that the criterion measure of efficiency incorporates an important element of the output of schools--pupil achievement growth. The second is the attempt to employ a longitudinal approach as opposed to the more common "point in time", or cross-sectional approach.

The nature of the data and the manner in which it was assembled suggested that the problem could probably be understood best by breaking it down into several component parts for analysis. The problem, stated in question form, follows:

1. Are there statistically significant differences among Iowa schools in terms of efficiency, as defined by this investigation?

2. Is it possible, using selected characteristics of Iowa school systems, to construct a model which would predict whether a school system is likely to be efficient as defined in this survey?
3. Using three categories of enrollment size, are there differences which suggest certain characteristics are more predictive in one size level school than at other size levels?
4. Holding the characteristics of fathers' occupational and educational level and income levels constant, what contribution is made by other community, staff, and system characteristics to system efficiency as defined by this study?

The foregoing analyses were suggested by other studies of a similar nature completed since 1967 in Iowa. Two of these, by Cohn (13) and Starler (44) were done at Iowa State University by doctoral candidates in economics. Three others, by Skaggs (42), Chambers (11), and Rajpal (36) were completed by doctoral candidates in education at The University of Iowa.

Except for the Skaggs study, which incorporated Iowa Tests of Basic Skills (ITBS) data, the others were done using achievement data for secondary students as measured by the Iowa Tests of Educational Development (ITED). Each of the studies used a kind of input-output analysis employing the multiple regression technique as the basic statistical method. None of those above used financial data over time, but rather concentrated on analyzing what was apparently statistically significant at some point in time. It is also important to note that the basic criterion in each of the above included only achievement expressed as gain or level without tying it directly to expenditures.

No attempt has been made in the investigation reported herein to "control for" or to treat in some special way the differences among schools as to the so-called "ability" of pupils. I.Q. measures are found to be highly related both to achievement and to socio-economic status. Each of these receives attention in this study. Another reason for this decision was that results of analyses of pupil achievement by those directing the Iowa Testing Program show schools in the size range represented in this study to be quite similar in achievement per se. (For a more detailed discussion of this question, the reader is directed to Chapter II, page 23).

This survey was both an extension and a variation of the work of earlier researchers in the field of input-output analyses comparing Iowa school systems.

The Purposes

The purposes of this study were:

1. To demonstrate the possibility of analyzing differences among schools on the basis of expenditures per unit of output rather than on the basis of expenditures per pupil.
2. To develop a model which would help to predict whether a district might be efficient, as defined in this study.
3. To help determine the effect of school size on the model used by dividing the 375 schools into three groups and analyzing the effect of independent variables on efficiency and achievement growth.
4. To aid further in the analyses of school systems by discovering whether, by removing the effects of fathers' occupational and educational levels (which seem so significantly related to achievement levels), there might be other characteristics of a system that could explain further system differences. This part of the study was directly related to the work done by Skaggs (42) and was included in this survey at the suggestion of Dr. A. N. Heironymus, who directed Skaggs' work at the University of Iowa.

Hypotheses

Basic hypotheses were suggested by the purposes of this survey. In null form, they may be stated as follows:

Ho_1: There are no statistically significant differences among Iowa school systems in efficiency, as defined by this survey.

Ho_2: There are no statistically significant relationships between efficiency, as defined in this survey, and selected characteristics of Iowa school systems.

Ho_3: There are no statistically significant relationships between efficiency, as defined in this study, and selected characteristics of Iowa school systems among schools of less than 500 in elementary enrollment.

Ho_4: There are no statistically significant relationships between efficiency, as defined in this study, and selected characteristics of Iowa school systems among schools of between 500 and 750 in elementary enrollment.

Ho_5: There are no statistically significant relationships between efficiency, as defined in this study, and selected characteristics of Iowa school systems among schools of over 750 in elementary enrollment.

Ho_6: There are no statistically significant relationships between efficiency, as defined in this study, and selected characteristics of Iowa school systems among districts where fathers' occupational levels average less than 4.6.

Ho_7: There are no statistically significant relationships between efficiency as defined in this study and selected characteristics of Iowa school systems among districts where fathers' occupational levels average more than 4.5.

Ho_8: There are no statistically significant relationships between efficiency as defined in this study and selected characteristics of Iowa school systems among districts where fathers' educational levels average less than 3.6.

Ho_9: There are no statistically significant relationships between efficiency and selected characteristics of Iowa school systems where fathers' eudcational levels average more than 3.5.

Assumptions

Naturally, the study of basically human systems is fraught with problems of mathematical neatness. It must be assumed that school systems in Iowa represent a fairly homogeneous population. Other assumptions made for purposes of this survey include:

1. Schools in Iowa offer basically the same instructional programs to pupils in grades three through eight, concentrating on the goals of skills development.
2. Schools did not "teach to the test".
3. The Iowa Tests of Basic Skills were an acceptable measure of learner cognitive growth among Iowa schools.
4. The financial reports of Iowa school systems were uniformly consistent with the format suggested by the Uniform Financial Accounting for Iowa Schools manual published by the Iowa Department of Public Instruction.
5. Those school systems of similar size not selected for study were not significantly different from those selected.
6. Changes in class membership over the time span selected for this study did not significantly affect the growth in cognitive learning as measured by the Iowa Tests of Basic Skills.

Definition of Terms

Terms used in this survey which required definition were:

1. Efficiency: A relationship of financial input to learner cognitive growth output represented as instructional dollars expended per growth unit produced over time.
2. Pupil cognitive growth: The difference in average class achievement levels from year to year as measured by the Iowa Tests of Basic Skills.
3. Instructional expenditures: Those expenditures for instructional purposes (i.e., teachers salaries, supplies, textbooks, and other instructional materials) at the elementary level as defined by the Uniform Financial Accounting for Iowa Schools manual published by the Department of Public Instruction.

Sources of Data

The following sources of data were identified:

1. Data from the Iowa Tests of Basic Skills as compiled by Skaggs (42).
2. Financial reports of the Department of Public Instruction (DPI).

3. The Iowa Public School Employees Data Sheet (IPSEDS) submitted annually to the DPI by each Iowa school system.

4. Data from CARDPAK, an informational program started under the auspices of the DPI and the Measurement Center at The University of Iowa, as compiled by Skaggs.

5. Data from the Iowa Department of Revenue on income from each school district for years 1967, 1968 and 1969.

Delimitations

This survey was interpreted while mindful of the following:

1. Only Iowa public schools of less than 3000 enrollment operating during the 1967-1968 through 1969-1970 school years were surveyed.

2. Other Iowa schools were eliminated from the survey because:

   a. insufficient data were available.

   b. reorganization during the time span of the study rendered some data inappropriate.

3. Only elementary grade level inputs and outputs were considered within each district.

4. The output data represented only a portion of the total output of any given school system. While ITBS is widely accepted as a reliable measure of cognitive growth, many other less quantitative outcomes such as attitudes and values were not amenable to analyses for this survey.

CHAPTER II. REVIEW OF LITERATURE

The literature on efficiency of school system operation has increased in quantity quite rapidly over the past decade. In addition, a trend toward analyses on a systems basis, with the emphasis on more direct measures of input and output, has developed. While the working public concerned with education may not have grasped completely the relevance of such emphases, professional educators and economists, supported by funds from such sources as the U.S. Office of Education and the Carnegie Foundation, have instituted several investigations designed to better describe how schools may be evaluated in terms of efficiency.

Too often in years past and, in view of the current state of the "art" of systems analysis, even recently the term "cost per pupil" has been a kind of standard measure of school district effectiveness. Measuring school systems with this yardstick implies that it is only important that one look at what goes into the system. Output is ignored when the sole criterion is cost per pupil.

In the past, output was examined both quantitatively and qualitatively in terms of "indirect" measures such as teacher salary levels, teacher educational levels, recency of building construction, percent of pupils going on to college, etc. The trend more recently has been to examine more direct results such as achievement levels on standardized tests, attitudes toward learning, income levels and occupational success of students at various points following graduation.

It would appear that such analyses are indeed very recent. Woodhall (56), commenting on this concern in 1964, wrote:

> It is perhaps surprising that while so much attention has been focused on the economic arguments for increased investment in education, there has been little research on the internal productivity of the educational system or the relation between costs and quality in schools (56, p. 393).

Of course, some attempts to compare schools in terms of efficiency were made prior to the decade of the 1960's. Historically, interest in school system efficiency seems to have been most pronounced during the period from about 1915 through 1930, and again in the late 1950's to the present. An era of "scientific management" was ushered in during the early 1900's.

One of the most widely credited studies of that period was completed by Rice (38). He published a book entitled Scientific Management in Education, in which he described the results of his investigation involving some 50,000 pupils in more than thirty American cities. Arithmetic and language test results of these pupils were analyzed to find out how "efficiently" teacher and pupil time were being used.

While one might question his admittedly crude statistical treatment and analysis, it would have to be regarded as a singularly prodigious piece of work given the nature of the times and availability of resources with which to accomplish it. His basic findings boiled down to a suggestion that both teachers and pupils were wasting much time in acquiring certain skill levels.

Callahan (9) chronicled the 1915 to 1930 period rather caustically in his 1962 edition of The Cult of Efficiency. He was especially critical of those who proposed that the Taylor model be applied to school systems (9, p. 19). Callahan expressed two basic objections to the uses made of scientific management concepts during this period. The first was that the term had been wrongly interpreted to mean providing education at the losest possible cost, rather than the finest product--at the lowest cost (9, p. 244). The second was that educators seemed to have adopted, in wholesale fashion, the basic values and techniques of the business and industrial world (i.e. standardization, mass production, regimentation) without adapting them to what was a basically human system (9, p. 244).

Toward the end of the scientific management era of the early 1900's, the venerable George S. Counts (14) voiced concerns similar to those of Callahan. His term for analyses of this type was "mechanical efficiency". Counts cautioned educators that "...provided the ends are worthy there can of course be no objection to efficiency; but an efficiency of management should never be the intent of education" (14, p. 138).

Counts further noted with apparent dismay the proliferation of standardized tests. He took special note of what was evidently the guiding principle of those preoccupied with such devices, namely, "Whatever exists at all exists in some amount. And the natural inference is that whatever exists in some amount can be measured" (14, p. 146).

For a more complete review of earlier research and comment on the cost-quality analysis of school systems, the reader is directed to an annotated bibliography by Blaug (5), especially chapter three of his review.

There are many sides to the question of financial investment and expenditures made in education. Blaug has provided bibliographic evidence in several of these areas. Authors such as Schultz and Becker are widely recognized as leading thought and research in areas such as human capital development and return on investment in education.

This review was not directed to covering the broad spectrum of such work, but dealt more specifically with the narrower area of efficiency and productivity research in the economics of education.

Economists, as well as educators were interested in the efficiency with which governmental units provided services to the public. While many concentrated on municipal and other governmental units, economists such as Riew (39), Keisling (28), Welch (54) and Benson (4) were also concerned with schools.

Riew conducted a widely quoted study on the economies of scale (size) among high school systems. His data included a standardized test measurement of output in terms of pupil cognitive achievement and compared this measurement with cost per pupil data. He concluded that "economies of scale at this level of public education are very significant" (39, p. 287).

Keisling (28), on the other hand, using achievement data of a similar nature among elementary schools in New York, found that economies of scale were not really evident. Significantly, he concluded that costs per pupil were apparently poor measures of efficiency. He also defended the use of achievement test data as an output criterion, noting that they have been in constant use, and have undergone constant revision for over thirty years (28, p. 358). In addition, he argued that elementary tests of this nature were probably more valid than those at a higher level because basic skills were a greater portion of their content for elementary pupils.

Welch (54) used income of high school graduates as his output measure and analyzed its relationship to "quality" variables such as size of school, number of teachers (a kind of pupil/teacher ratio) and salaries of teachers. He found that pupils from larger schools which paid higher teacher salaries were most likely to produce students who earned the highest incomes after entering the job market.

Clark (12), in a report published as part of the Syracuse University series on the economics and politics of public education, reviewed some of the research in the economics of education devoted to resource utilization. In his summary, Clark proposed three steps that his review seemed to suggest as means to greater efficiency. The first was that students go to school more days each year, the second that the school day be lengthened and, thirdly, he suggested more homework be assigned at the secondary level (12, p. 50).

Most studies done earlier seemed to suggest similar solutions. Time, rather than fiscal resources was considered more amenable to influence for efficient output production. In addition to his suggestions for more efficient use of time, Clark believed that teaching machines and other technology would point the way to gains of from ten to twenty percent in learning growth given the same amount of time--and at less cost. The promise of technology's influence, while not quite living up to the expectations expressed in 1963 (12, p. 51), is still very much a part of the educational scene.

Recent Major Research

At about the same time as the Syracuse studies were being published, the U.S. Office of Education had funded studies designed to determine the relationship of school system characteristics to the efficiency of financial resource utilization. One of the most widely cited of these was done by James, Thomas and Dyck at Stanford University and published in June of 1963 (26).

The study by James, Thomas and Dyck was a continuation of earlier efforts by these authors to study financial aspects of school systems (27). The 1963 study was a three-part investigation designed to 1) formulate a rationale for the study of school finance and apply it to explain variations in expenditures associated with state efforts to equalize educational benefits and tax loads and with levels of state support, 2) examine the relationship of wealth to educational expenditures, the relationship of resource input to educational output, and the relationship of such output to economic growth, and 3) to analyze the effects of fiscal dependence versus independence in the relationship of local school districts to other governmental agencies.

Part two of the James study was most applicable to the problem examined by this survey. The investigators decided to use achievement test scores as their measure of school system output (26, p. 112). Independent variables of an input nature were included in three broad categories representing contributions by the school itself, the home and the community (26, p. 112).

The final sample included in the study by James included 206 high schools in 46 states (26, p. 118). They came from communities of 2500 to 25,000 in population.

School system variables consisted of such items as pupil/teacher ratio, teacher salaries, number of books in the library, age of the building, staff experience, and number of days in the school year (26, p. 115). Home and community variables were identified in terms of population, percent of unemployed workers, median family income, occupational levels of parents, delinquency rates, and strangely enough, the percentage of senior boys going on to college (26, p. 116). The latter variable could fit just as well in the school system category as in the home and community category (26, p. 113).

Significantly, the authors noted that they included no measure of the effect of genetic differences upon the outcomes as measured by achievement tests. "Our position is that we are probably so far from attaining the maximum possible levels of development of human ability that differences in innate capacity can, for practical purposes, be disregarded" (26, p. 107). It will be seen as this review continues, that other researchers agreed with this assumption.

James, Thomas and Dyck concluded, after submitting the criterion variables of outcome and the variables reflecting inputs from the school, home and community to multiple regression analysis, that the basic hypothesis--mean test scores are related to certain input characteristics--had been confirmed (26, p. 120). Some of the stronger relationships included teachers' beginning salary levels, median income, number of books in the library, condition of the housing in the community and occupational and educational levels of the population.

Syracuse University, in cooperation with the Carnegie Foundation, sponsored a study of an input-output nature directed by Burkhead (7). The systems studied were those of Chicago and Atlanta. Burkhead, an economist, occupied the chair of Maxwell Professor of Economics at Syracuse at the time of the study. The design is organized according to an economist's model.

The second chapter of Burkhead's description of the study discusses education as a production function. He notes several problems inherent in an attempt to view education in this light. The most "pervasive difficulty is that government product does not have a market price..." (7, p. 19). Another complicating factor is the lack of a learning theory so widely acceptable that research could be based upon such grounds. "Both learning theories and theories of child development tend to be descriptive of changes that occur, but not analytical with respect to how..." (7, p. 21).

Recognizing such limitations, Burkhead and his associates continued with their analysis which used achievement test scores as output and inputs similar to those included in the study described above. Postulating that an input-output analysis should seek to explain the effects of both added resources and alternative combinations of resources, they attempted to predict test scores by submitting empirical data to a multiple regression model.

The investigators recognized that "outputs are not a function of school inputs; there are complicating factors" (7, p. 12). First, outputs reveal relationships that are in some cases complementary, in other cases substitutable. Second, marginal products of joint inputs are hard to measure. Third, community and home influences affect both inputs and outputs of the school system.

Burkhead noted the untidiness of such empirical data and goes on to say, "There is now general agreement among educators that traditional I.Q. tests are so culture-bound that they measure little of 'innate' potentiality" (7, p. 13). He decided that "it is not possible to control satisfactorily for student inputs in the measurement of educational outcomes" (7, p. 13).

Editorially, it might be pointed out at this point that the study reported herein was undertaken with a similar point of view. Past research, as well as that of Burkhead, has repeatedly demonstrated that achievement tests and I.Q. are really measuring much the same thing. When one "controls" for I.Q., most of the characteristics of the home and community and the school which correlate highly with this measure lose their significance.

The Chicago and Atlanta data analyzed by Burkhead clearly demonstrated this phenomenon. When I.Q. was ignored, median family income correlated at more than (r = .80) with achievement scores. When I.Q. was "controlled", the effect of most other variables, including median family income, was largely dissipated (7, p. 53).

Burkhead summarized the Chicago portion of the study with the following conclusions, (among others): (7, p. 56).

1. Socioeconomic variables are most important in determining output differences.
2. Some inputs affect some outputs but not others. Newer buildings reduced the dropout rate, but had no influence on eleventh grade reading scores.

3. Reading scores were influenced by teacher experience.

4. The effect of school size, at least in Chicago, was not uniformly important to achievement results.

Another major study utilizing an input-output framework was recently completed by Mayeske (31). Using data from Coleman's Educational Opportunity Survey, and with the help of funds provided by the U.S. Office of Education, Mayeske attempted to arrange the data collected into a manageable series of matrices for analysis.

His criterion variables (output) were a) verbal ability, b) nonverbal ability, c) reading comprehension, d) mathematics achievement, and e) general information. The first two were measures of an "I.Q." nature; the latter three measures of achievement. All were administered at grade levels one, three, six, nine and twelve. To determine the extent to which these five measures were related, a correlation matrix was produced. Mayeske notes that the intercorrelations of the ability and achievement measures ran from .30 to .80. "They also appear to be high enough to suggest that, to a large extent, they were measuring a common attribute..." (31, p. 24).

In order to test whether they were measuring a common attribute, a principal components analysis was employed.

This analysis "aims to express what is common to a set of variables..." (31, p. 24). Mayeske discovered that the first principal components for grades twelve, nine and six accounted for more than 75 percent of the total variance at each grade level. "Since this is a relatively large percent for this kind of data, it indicates that a single index of achievement can be used..." (31, p. 26). Finally, he noted that a composite score developed with the use of component weights represented "general scholastic achievement" (31, p. 26).

Mayeske used a number of different statistical methods such as criterion scaling, commonality analysis and factor analysis. He applied these analyses in an effort to determine relationships among schools between the achievement and attitudes of pupils and school system variables. Eight basic hypotheses were investigated and the conclusions reached were (31, p. 327):

1. The influence of schools was bound up with the social background of the students.
2. The social background of the students...played a greater independent role in the development of all school outcomes than did the independent influences of the school--until the twelfth grade.

3. For achievement, school and social background had a common influence which increased the longer the pupil was in school, and this influence was greater than their independent contributions.
4. Schools that performed well on one outcome tended to perform well on all outcomes.
5. School personnel were the system's most important influence on outcomes.
6. Physical facilities, pupil programs and policies had little influence on outcomes.
7. Teacher salaries had little effect on outcomes--even in combination with other variables.
8. Experience of the teachers in racially imbalanced settings related highly to school outcomes.

The data base for this study included a disproportionate share of minority-group pupils. Forty percent of the pupils were from minority races. This had its effect on the conclusions (e.g. conclusion #8) thus rendering them somewhat suspect for applicability to the nation's schools at large.

The final study of this type selected for review was completed by Abt (1) for the U.S. Office of Education. It was the objective of this study to develop a model, using computer simulation techniques, that would help administrators predict probable outcomes and costs of Title I programs for the disadvantaged.

Five submodels were developed for use, including:

a. School

b. Instructional Process

c. Community Interactions

d. Cost

e. Cost-Effectiveness

As one might expect, many people and much money was required to amass the data for this study. Collection of data for the "community interactions" submodel required a sociologist with a rather high degree of training. An indication of the complexity of the model was the fact that five subroutines comprised the "school" submodel alone.

Abt's model represented sophisticated knowledge and use of the computer process. There are obvious drawbacks to such a comprehensive model for use in most local school situations, not the least of which is the expertise available to analyze and gather data of the kind required. In addition, few local schools have the money to conduct such analyses, and computer help is difficult to obtain as well.

The above concerns did not go unnoticed at a Paris conference of OECD (Organization for European Cooperation and Development) in January of 1967 (34). Several conferees questioned the applicability of such a model to local systems. One person noted that while the model was very comprehensive, its usefulness would be severely limited as a result (34, p. 19).

The studies cited above were selected for two basic reasons: 1) they were cited widely in literature and research concerning input-output analyses of school systems and, 2) they are representative of the techniques and kinds of variables included in the survey reported herein. Certainly, it is not argued here that such a review is exhaustive. Hickrod (21) reviewed a great many studies done in the 1960's having to do with various aspects of the economics of education. In recent years reviewers such as Bowman (6) and Thomas (50) have presented important findings of a wide range of studies having to do with several aspects of the economics and finance of school systems.

One other study of note should be mentioned. In 1972 a dissertation completed by Rose (40) reported results of a study using various regression analyses to study the effects of some thirty-five variables on productivity defined as standardized test achievement growth per educational dollar expended in two different states. He found only three variables commonly related to productivity in one state, but more than eight, of which all but one were different than those in the first state, significantly related to productivity in the second state. He concluded that his findings demonstrated a need to study each state separately because of regional and cultural differences.

The most commonly accepted finding among the studies reviewed in some detail above was that socio-economic variables are the most predictive variables within a given school system. Hickrod (21) concluded the same thing in his review, but noted that part of the problem has been the reliance of investigators upon cross-sectional data, rather than longitudinal data (21, p. 45). It might be best to study effects of various variables over time. The survey reported herein attempted to analyze effects over time.

Recent Iowa Studies

Five studies of a type similar to the one reported herein were carried out in Iowa in the period between 1963 and 1969. Three of these were completed at The University of Iowa by doctoral candidates in education. Two others completed by doctoral candidates in economics at Iowa State University, used data and methodology in much the same fashion as it was used in this survey.

Of the studies mentioned above, Chambers (11) was the only investigator who did not utilize output data. He used five measures of pupil expenditures as his criterion variables. Per pupil expenditures from the general fund, schoolhouse fund and a total of the two as received from local revenues, and per pupil expenditures from the general fund as well as total expenditures as received from local, state and federal sources were considered as dependent variables (11, p. 19).

Seventeen independent variables were identified by Chambers (11, p. 18). Among these were various data concerning assessed valuation of real, personal and corporate property and some demographic variables such as district geographic size, district population density, percent of pupils attending private schools and district enrollment.

Chambers utilized product-moment correlation, a multiple regression analysis and computation of and comparison of the coefficient of variation as his statistical methodology. First, the five dependent variables were tested for their relationship (linear or curvilinear) to each of the seventeen independent variables. A reduced set of independent variables was then used to determine their joint relationship with each of the five criterion variables. Chambers also examined the flexibility of seven line-item expenditures utilizing the coefficient of variation (11, p. 115).

Chambers, findings led, in part, to the following conclusions:

1. The variation in per pupil expenditures among school districts was not closely associated with assessed valuation; nor were they found to be associated with population density, enrollment or the number of pupils attending private schools (11, p. 215).
2. By implication, factors not studied such as income levels, educational level and aspiration of school patrons and parents, characteristics of the school staff and the board of education might influence expenditure levels (11, p. 216).
3. Chambers defined salary expenditures for "innovative practices" (11, p. 105) and examined their relationship to other variables. He found large variations in such expenditures among districts, but he also noted that his analysis seemed to indicate pupils in schools of less than 1300 were not providing personnel for these activities regardless of the "ability to pay" as determined by assessed valuation (11, p. 212).
4. Teachers salaries were more closely related to enrollment size than to "wealth" (or assessed valuation per pupil) (11, p. 215).

Rajpal (36) completed a study designed to "examine the relationship between selected measures of educational quality and expenditures in public secondary schools of Iowa, with the influence of school district size held constant" (36, p. 57).

Rajpal's findings generally showed that achievement levels were significantly related to both the qualifications of the staff and the number of units offered in the curriculum (36, p. 59). He also found staff qualifications and total units offered positively correlated with per pupil expenditures, while section size was negatively correlated with expenditures.

Rajpal was led to conclude that higher per pupil expenditures generally results in higher educational quality and that districts with smaller enrollments would be required to spend more per pupil to achieve given levels of quality, as defined in his study.

One might be led to question Rajpal's conclusion in view of the fact that his findings seemed to indicate no significant relationship existing between per pupil expenditures and level of achievement. Certainly, one would not want to argue that staff qualifications and a broad educational program are unimportant to a school system, but his conclusion is based primarily on evidence of a relationship between expenditures and these indicators, while apparently ignoring the fact that pupil achievement did not follow this trend. "Quality" is hardly adequately measured by teacher characteristics and course offerings. "Proof of the pudding" is more apt to lie in output--measureable pupil growth.

Of course, Rajpal's study did not measure growth, a measure of the difference in achievement from one point in time to another. If it had, one might have found a rather different picture of the "effects" a school system might have had upon pupil accomplishment.

Starler (44) studied resource allocation in three phases, including resource redistribution effects of state aid plans, the output effects of state aid plans, and specification of the relation between educational input and output. The latter topic was particularly applicable to the survey reported herein because the basic statistical method used was one of factor analysis--based largely on the Thurstone method as reported in Kerlinger (29).

Starler investigated three questions:

1. Does achievement-cost data conform to the assumptions of the regression model--especially homoscedasticity?
2. What are the effects of alternatve measures of the (output) variables (i.e., average versus individual observations) within the context of

the linear model?

3. What is there to be gained by using factor analysis as an alternative statistical instrument that focuses upon hypothesis searching or on the existence of relationships rather than on the magnitude or direction of relationships? (44, p. 99)

Regarding the first question, Starler concluded that, because urban schools evidence large within variations as against rural schools, there is some evidence supporting the notion that heteroscedastity may be part of the explanation for nonsignificant regression coefficients so commonly reported among input-output studies (44, p. 131). Further, he concludes that his findings support those who argue that average data may inflate the significance of coefficients when compared to the use of individuals in the same samples.

Using factor analysis, Starler concludes that it should be used more by educational researchers as a method for uncovering underlying relations between educational outputs and inputs (44, p. 131). He identified five factors as follows (44, p. 122):

1. A general factor which included teacher salaries as well as two measures of pupil achievement (pupil score level and growth over time).

   Median family income and percent of general fund to public education were also significantly and positively related to this factor.

2. A group of variables significantly related to the second factor were high school units offered, units required, size of school, teacher salaries, building value per pupil and instructional expenditures per pupil.

3. Expenditures of various kinds as well as school building assessed values could generally be grouped as a third factor.

4. Three measures of output were the only significant components of factor four.

5. Community setting variables, such as percent of the general fund to public education, median county income, and size of school were components of factor five.

In summary, Starler recommended further use of factor analysis as a method for discovering linkages between output and input measures in school systems (44, p. 128).

Starler's investigation did not include socio-economic variables such as occupational and educational levels of the population. One might conjecture that the inclusion of such variables would have resulted in a "sixth" factor including median income and correlated highly with achievement (or output) variables.

Cohn (13) working in the area of economics, completed a developmental study aimed at suggesting and testing some models for predicting a "maximal" output given certain characteristics of a system. He tried four models of the general form:

$$Y = f(X_1, X_2, \ldots X_n)$$

where Y denotes an index of school quality and the X's represent the various inputs of the school system.

Cohn defined two Y's or criterion measures. One measure was the achievement level of a twelfth grade class as measured by the mean composite scores attained on the ITED (Iowa Tests of Educational Development). The other was the difference between the twelfth grade average score and the tenth grade average score (13, p. 55).

Cohn then used some measures of district and staff characteristics as well as a set of "dummy" variables, six of which represented a particular area of the state of Iowa and four of which represented population characteristics (13, p. 57).

Unfortunately, Cohn found little explanatory or predictive power in his models. A few factors or characteristics were significantly related to growth (changes in level of achievement) such as teacher training level, number of assignments per teacher and teachers' median salaries (13, p. 92).

Cohn used multiple regression to perform his testing of the models empirically. Finally, the most significant statement that might have been made in this study was in his introduction of the second "model", at which point he noted, "The rationale for the use of the second model is, perhaps, at the core of the economics of education, namely, that not only factors which use...physical capital are of importance; the human element, as such, is also an important factor of production" (13, p. 72).

One interesting omission in this study was data of a socio-economic nature. Had Cohn used data of this nature and analyzed the data controlling for such variables, the results might have been more rewarding.

One additional finding in Cohn's work seems noteworthy. Throughout the process of model testing, teacher training level remained significantly, but negatively related to pupil achievement and growth (13, p. 73). This finding will be discussed briefly later as Skaggs' (42) work is reviewed, because that study found a similar relationship existing.

In summary, it might be said of this study that, while it attempted to relate growth in achievement to expenditure and staff variables, growth is produced over time but the other variables were measured at a "point in time" or in a cross-sectional manner. Perhaps measurement of a longitudinal nature, relating growth to expenditures over time or to variations in expenditures over time among districts would have been more productive.

The Skaggs study (42) was the last of the Iowa studies reviewed for purposes of this survey. Skaggs continued to use the regression model as the basic method of analysis. It was as unproductive as was the case in earlier examples, except that he used community characteristics of a socio-economic nature which other researchers have suggested are related to pupils' aspiration levels. These characteristics included occupational level and educational level of fathers. These data was compiled by Skaggs from information supplied on the Iowa Pupil Inventory (CARDPAK) and indexed to provide a quantitative value for purposes of the study (42, p. 44).

Skaggs used data from ITBS (Iowa Tests of Basic Skills) rather than ITED scores. His sample included 423 Iowa school systems and he used both achievement level and growth, as well as the variability of each, as his criterion variables. He used ten independent variables grouped as system, staff and community characteristics.

His system characteristics included enrollment (K-12), enrollment growth ratio, population density, annual expenditure per pupil for instruction, and the pupil/teacher ratio.

Staff characteristics included staff training, staff tenure and tenure of the superintendent. Community characteristics included mean father's occupation index (mentioned earlier) and mean father's education index (42, p. 5).

Skaggs found that achievement growth was related significantly to independent variables as follows:

1. Negatively to enrollment growth among schools of average enrollment and among schools with low expenditures per pupil.
2. Negatively to population density among schools of average enrollment and among schools with either high or low expenditures.
3. Positively to expenditures per pupil among small schools and schools in the low expenditure group.
4. Positively to the pupil/teacher ratio among large schools.
5. Positively to superintendent's tenure among low expenditure schools.
6. Positively to father's occupational level among schools of average enrollment and schools in both average and low expenditure groups (42, p. 213).

In summarizing his findings, Skaggs makes an indirect case for factor analysis of his data:

> The results of this study suggest that the relationship between 'product' measures of achievement and demographic variables often considered as indications of the quality of a school system are more complex than previous research has suggested. In many instances it was likely that an observed relationship may be mediated by a third variable or several other variables which in turn, are related in complex fashion" (42, p. 220).

Summary

The Skaggs study provided the basis upon which this survey was conducted. It was felt that additional treatment of these data, along with an extension of the kinds of variables used to examine the districts might provide more explanatory power for predicting relative district efficiency, as defined herein.

All of the work reviewed in this chapter was relevant to the survey and provided valuable insight as the methodology and data collection proceeded. Many areas of research which could be construed as relevant (i.e., that having to do with measurement per se, studies of the effect of education on economic growth, investigations of the worth of varying amounts of and investments in education) were not reviewed here.

The research reviewed studied output in terms of either cost per pupil, or on the basis of achievement (both the level of attainment, as well as growth in achievement), but none used the criterion of expenditure per unit of growth.

It was believed then, that some additional insight might be gained by both extending and varying the approaches to economic analysis of schools used earlier.

The following chapters are descriptive of the methods and procedures used to proceed with a further examination of the efficiency with which Iowa's school districts use financial resources to produce cognitive learning growth. While those studies reviewed here have generally dealt with methods of a cross-sectional nature, the survey described in Chapter III, forward, attempted to analyze the effects of various school, staff, and community variables over a three-year span of time.

CHAPTER III. METHOD OF PROCEDURE

The review of literature in the area of the economics of education demonstrated that interest in the efficiency with which schools utilize financial resources has been revived during the past decade. Most of those researchers concerned with input-output analyses used achievement level as their criterion measure of output. Some used growth, but failed to relate it to school system expenditures and other characteristics over time. Others simply used cost per pupil as a measure of efficiency.

A basic assumption of the study reported herein was that a more realistic comparison index of relative efficiency among schools would be one which included an element of output--what was accomplished by pupils as a result of the expenditures made. The measure chosen was instructional expenditures per unit of growth produced at the elementary level (K-8).

The time period selected for study here was from 1967-1968 through 1969-1970.

Identification of Variables

Criterion Variables: Two criterion variables were identified:

Y_1 = Cost/Unit of Growth Produced

Y_2 = Mean Annual Achievement Growth 1967-1968 through 1969-1970

Y_1 was defined as the basic criterion variable. It was computed by dividing total instructional expenditures over the time selected for study by the total units of growth produced (as measured by ITBS).

Y_2 was the mean annual achievement growth for the years 1967-1968 through 1969-1970.

Independent Variables: Independent variables were selected similarly to those of other studies for two reasons:

1. To determine whether the selection of Y_1 as the criterion variable would improve the relative predictability of these variables as contrasted with earlier investigation.
2. To determine whether the particular set of variables selected might better predict efficiency than other sets chosen for analysis by other writers.

<u>School District Characteristics</u>:

X_1 = Mean enrollment (K-8) 1967-1968 through 1969-1970

X_2 = Enrollment Growth Ratio

X_3 = Mean Teacher/Pupil Ratio

X_4 = Mean Number Special Teachers

X_5 = Mean Instructional Expenditure Change Ratio

X_6 = Mean Assessed Valuation/Pupil

X_7 = Mean Teacher Salary Change Ratio

<u>Staff Characteristics</u>:

X_8 = Mean Staff Training Level.

X_9 = Mean Staff Tenure

X_{10} = Mean Teacher Age Level

X_{11} = Mean Principal Tenure

<u>Community Characteristics</u>:

X_{12} = Mean Income/Pupil

X_{13} = Mean Income/Pupil Change Ratio

X_{14} = Mean Fathers' Occupational Level

X_{15} = Mean Fathers' Educational Level

District characteristics X_1 through X_7 are fairly self-explanatory. X_3 is the ratio of pupils to classroom teachers.

Staff characteristics (X_8 through X_{11}), in contrast to earlier studies, contain no mean teacher salary variable.

X_7 was included as the result of a suggestion by Cohn (13) in his study of Iowa high schools. Also, as a result of his work and that of Skaggs (42), special attention was paid to variables X_8 and X_{10}.

Community characteristics could just as well have been labeled socio-economic status. These data were lacking in other Iowa studies. It was hoped that such variables would add to the explanatory or predictive power of the regression model as well as provide for a smaller error term.

Sample Selection

The schools selected for study were those of less than 3000 in enrollment in Iowa during the years 1967-1968 through 1969-1970. The size delimitation resulted from observance of Cohn's findings regarding economies of scale at the high school level (13, p. 107). It was decided that his work had sufficiently demonstrated the efficiency of schools of more than 3000 in enrollment. A more interesting question for this study was the degree to which more "rural" districts in Iowa were different with respect to the criterion variable Y_1.

School districts of more than 3000 enrollment generally were found in cities of 15,000 or more. They were the schools with much different community, staff and district characteristics than were found in the smaller schools. Schools of less than 3000 enrollment were, for the most part, in communities highly dependent upon agriculture and having a rather significant percentage of farm-reared pupils. A question could have been logically derived as follows; to what extent do those schools with large rural enrollments differ in the efficiency with which they provide learning outcomes?

There were 454 public schools in Iowa in this period. 427 of these had enrollments of less than 3000 (K-12). Some of these schools were deleted from consideration in this study for the following reasons:

1. ITBS data were unavailable
2. Incomplete financial or personnel data were found

375 schools were included in the final sample.

Data Collection

The most important consideration was whether output data of an achievement nature could be obtained. Fortunately, ITBS data were available from nearly all Iowa schools and were obtained after a telephone conversation and a personal visit with the Director of the Iowa Testing Program, Dr. A. N. Heironymus of the University of Iowa.

It was agreed that the anonymity of the schools would be preserved regarding output data. Accordingly, the DPI code numbers for schools were changed to a substitute numerical code such that only the writer could identify individual schools for purposes of combining variables for analysis. 423 IBM cards containing achievement data and fathers' occupational and educational level were obtained from Dr. Heironymus.

Financial and personnel data were obtained from the Department of Public Instruction. Basic sources of this data included:

1. Superintendent's Annual Report
2. Secretary's Annual Report
3. Iowa Public School Employees Data Sheet

These data were coded where necessary, punched into IBM cards or transferred to tape provided by the Computation Center at Iowa State University. Data on income reported by taxpayers in each district was collected from the Iowa Department of Revenue.

Analyses

The analyses described briefly below were performed utilizing computer programs developed by the Statistics Department and the Computation Center at Iowa State University using a recently acquired tool called SPSS (32). Because this programmatic manual is well known and becoming widely used, no attempt was made here to repeat the concepts presented.

It was postulated that efficiency as defined by Y_1 and growth (Y_2) were functions of district, staff and community characteristics. The form:

$$(3\text{-}1) \qquad Y = f\ (X_1, X_2, X_3, \ldots X_{19})$$

was representative of this assumption.

A multiple regression model was utilized to test the hypothesis that no statistically significant relationships existed between efficiency (Y_1) and growth (Y_2), and selected district, staff and community characteristics. The general form of the model used in the SPSS subprogram for this study was:

$$(3\text{-}2) \qquad Y_i = b_0X_{i0} + b_1X_{i1} + b_2X_{i2} + \ldots b_kX_{ik} + e;$$

$$(i = 1, 2, \ldots, n)$$

A variation of this subprogram provided a "standardized" beta weight which assumed b_0 equal to zero. The standardized beta (referred to in Tables 4-3 and 4-5 in Chapter IV as B') gave a better indication of the relative "strength" of an independent variable's predictability than did the more normal coefficient produced in simple linear regression models of the form described above. It is possible to study relative values of the B' coefficient reported in this study and to "predict" whether a given variable might be significant at a 5 percent level of confidence with a fair degree of success.

The conclusions as to rejection or acceptance of the null hypotheses associated with the analyses in this study were reached applying criteria developed as a result of reviewing results of other research in this general topic area. Results of regression analyses suggest that when R^2 values are more than 0.50 the relative predictability is worthy of some confidence. It was also noted that some characteristics (independent variables) were significantly related and worthy of inclusion for predictive purposes while others were not.

The criteria for rejection of the null hypotheses postulated for this study were as follows:

1. The R^2 value would be 0.50 or larger, and
2. There would be at least five of the independent variables significantly related to the criterion variable of efficiency.

CHAPTER IV. ANALYSIS OF THE DATA

Three hundred seventy-five school districts in Iowa are represented in the analyses that follow. Elementary expenditures per unit of achievement growth produced (dollars/GE unit) were considered to measure efficiency among the districts studied. This was designated Y_1. Pupil enrollment varied from less than 150 to more than 2000. The questions to answer included whether size variances were significantly related to efficiency in addition to other school, staff and community characteristics.

Data collected represented a period of three school years. The years selected were 1967-1968 through 1969-1970. Fifteen (15) input variables were selected that appeared likely to affect efficiency. It was decided that additional variance among schools might be explained by using various sizes of schools, higher and lower occupational strata and higher and lower educational levels among parents of school children. A set of "dummy" (i.e., zero-one) variables was constructed, two of which may be classified as size variables, one as an occupational variable and another as an educational variable. Table 4-1 provides a description of all the variables including average values for the 375 schools represented.

A correlation matrix has been provided as a reference to

Table 4-1. Description of variables used in regression equations

Variable	Mean	Standard Deviation	Cases	Description
Criterion Variables:				
Y_1	42.2053	7.4237	375	Cost/Unit of Growth
Y_2	9.4216	0.6828	375	Annual Growth in Achievement
District Characteristics:				
X_1	619.5226	430.3369	375	Average Enrollment
X_2	1.0010	0.0541	375	Enrollment Growth Ratio
X_3	22.9251	4.2502	375	Pupil/Teacher Ratio
X_4	6.1182	3.5969	375	No. of Special Teachers
X_5	1.1898	0.1005	375	Expenditure Change Ratio
X_6	19526.7312	6569.1506	375	Assessed Valuation/Pupil
X_7	1.1014	0.0356	375	Teacher Salary Change Ratio
Staff Characteristics:				
X_8	120.1698	11.1480	375	Average Teacher Training Level
X_9	5.6907	2.6167	375	Average Staff Tenure
X_{10}	42.6747	3.9984	375	Average Teacher Age
X_{11}	4.2309	5.6351	375	Average Principal Tenure
Community Characteristics:				
X_{12}	12103.0008	31111.3755	375	Average Income/Pupil
X_{13}	1.0894	0.0671	375	Income/Pupil Change Ratio
X_{14}	4.6477	0.4743	375	Average Father's Occup. Level
X_{15}	3.5763	0.3266	375	Average Father's Educ. Level
"Dummy" Variables:				
X_{16}	0.5333	0.4996	375	Size >500 = 1, All else = 0
X_{17}	0.2267	0.4192	375	Size <500>750 = 1, All else = 0
X_{18}	0.4320	0.4960	375	Occup. Level > 4.6 = 1, All else = 0
X_{19}	0.4533	0.4985	375	Educ. Level > 3.6 = 1, All else = 0

note the degree and direction in which the variables are related to each other in Table 4-2. Generally, low linear relationships appear to exist. Most relationships appear as one would intuitively suspect. X_1 appears to correlate highly with X_3 and X_4. The only other relationship of .50 or larger appears to be a negative one between X_3 and X_6. This suggests that districts with high per pupil assessed valuations have low pupil teacher ratios. Upon reflection, this would be a normal expectation. Districts with high assessed valuations per pupil are generally sparsely settled and have much land area per school pupil. Schools with lower enrollments tend to have smaller classes, hence lower pupil-teacher ratios.

Table 4-3 and Table 4-5 were designed such that if one removed them from the thesis and laid them side by side according to corresponding equation numbers, the results would appear in their totality for better comparative viewing. The first four pages in each table include equations I through V. The second four pages include VI, VII and VIII and the last four pages include equations IX through XII inclusive.

Table 4-3 presents the results of multiple regression analyses which were carried out using a model of the general form:

(4-1) $$Y = f\ (X_1 + X_2 + X_3 \cdots X_n)$$

Table 4-2. Pearson product moment correlations of all variables (N = 375)

	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8
X_1	1.0000	.1329	.6300	.5970	-.0457	-.4293	-.0641	.3802
X_2		1.0000	.1526	.0824	-.1214	-.1791	-.0046	.0564
X_3			1.0000	.2570	-.0448	-.5174	.0124	.2554
X_4				1.0000	-.0606	-.1863	-.0782	.2965
X_5					1.0000	-.0293	.0426	-.0720
X_6						1.0000	-.0613	-.0720
X_7							1.0000	-.0474
X_8								1.0000
X_9								
X_{10}								
X_{11}								
X_{12}								
X_{13}								
X_{14}								
X_{15}								
Y_1	-.1329	-.1179	-.4295	.0240	-.0720	.3787	.0096	.1977
Y_2	-.0170	-.1021		-.0081	-.0197	.1666	-.0263	-.0418

Table 4-2 (Continued)

	X_9	X_{10}	X_{11}	X_{12}	X_{13}	X_{15}	X_{15}	Y_1
X_1	.0334	-.1192	.2876	.2624	.1293	-.0443	.2804	
X_2	-.0483	-.1065	.0594	.1581	.1400	-.0485	-.1033	
X_3	.1161	-.0166	.0902	.0943	.0877	-.0974	.1033	
X_4	-.1137	-.2305	.2243	.1888	.1543	.0020	.1868	
X_5	-.0247	.0678	-.0380	-.0871	.0392	-.0649	-.0510	
X_6	-.0058	-.0136	-.0467	.2329	-.1106	.0959	-.0468	
X_7	.1236	.1852	-.0880	-.0403	.0234	.1091	.0024	
X_8	-.0749	-.2824	.1543	.2376	.0525	.0086	.3240	
X_9	1.0000	.4745	.1759	-.0283	-.0562	-.0393	-.0844	
X_{10}		1.0000	-.0462	-.1756	-.0040	-.0514	-.1020	
X_{11}			1.0000	.1908	.0011	.0710	.0728	
X_{12}				1.0000	-.2297	.1470	.2646	
X_{13}					1.0000	-.0465	.0044	
X_{14}						1.0000	.1799	
X_{15}							1.0000	
Y_1	-.0609	-.0130	-.0685	.0798	.0125	-.0662	.0388	
Y_2	-.0330	-.1188	.0645	.0645	-.0102	.2139	.0797	-.3048

Table 4-3. Multiple regression equations utilizing 375 Iowa school districts to determine whether selected characteristics influence cost/unit of growth (Y_1)[a]

Equation	Intercept		X_1	X_2	X_3	X_4	X_5
I	35.37200	B	0.00457	-8.71003	-0.93965	-0.05510	-8.16025
		SeB	(0.00193)	(6.30890)	(0.11408)	(0.13308)	(3.16429)
	Zero	B'	0.26517	-0.06352	-0.53797	-0.02670	-0.11048
		F	5.647*	1.906	72.332**	0.171	6.651*
III	39.83074	B	0.00358	-9.06810	-0.90375	-0.01995	-7.93162
		SeB	(0.00146)	(6.28974)	(0.10712)	(0.13249)	(3.16675)
	Zero	B'	0.20735	-0.06613	-0.51742	-0.00967	-0.10739
		F	5.998*	2.079	71.174**	0.023	6.273*
III	40.57828	B					
		SeB					
		B'					
		F					
IV	41.54444	B					
		SeB					
		B'					
		F					
V	42.24194	B					
		SeB					
		B'					
		F					

[a]See Table 4-1, page 51, for descriptions of values reported for $X_1, X_2, X_3 \ldots X_{19}$.

*Denotes significance at an .05 level of confidence.

**Denotes significance at .01 level of confidence.

Table 4-3 (Continued)

Equation		X_6	X_7	X_8	X_9	X_{10}	X_{11}
I	B	0.00028	11.37465	0.20978	-0.08274	0.15576	-0.06010
	SeB	(0.00006)	(9.10553)	(0.03278)	(0.14213)	(0.09521)	(0.06113)
	B'	0.24923	0.05460	0.31503	-0.02916	0.08389	-0.04562
	F	19.136**	1.561	40.960**	0.339	2.677	0.967
II	B	0.00025	10.87435	0.20642	-0.10074	0.15120	-0.04985
	SeB	(0.00006)	(0.05164)	(0.03279)	(0.14197)	(0.09517)	(0.05999)
	B'	0.22336	0.05220	0.3097	-0.03551	0.08144	-0.03784
	F	15.932**	1.443	39.620**	0.503	2.524	0.691
III	B						
	SeB						
	B'						
	F						
IV	B						
	SeB						
	B'						
	F						
V	B						
	SeB						
	B'						
	F						

Table 4-3 (Continued)

Equation		X_{12}	X_{13}	X_{15}	X_{15}	X_{16}	X_{17}
I	B	-0.00001	3.74365	-1.36454	-0.93522	-.29519	1.92959
	SeB	(0.00013)	(5.00730)	(1.05395)	(1.64103)	(1.63487	(1.35880)
	B'	-0.00588	0.03381	-0.08718	-0.04115	0.01986	0.10897
	F	0.012	0.559	1.676	0.325	0.033	2.017
II	B	-0.00001	4.47346	-2.04360	-0.87066		
	SeB	(0.00013)	(5.11314)	(0.68867)	(1.08685)		
	B'	-0.00432	0.04041	-0.13057	-0.03831		
	F	0.007	0.799	8.806**	0.642		
III	B					2.76039	0.68316
	SeB					(0.93164)	(1.11013)
	B'					0.18575	0.03858
	F					8.779**	0.379

Table 4-3 (Continued)

Equation		X_{18}	X_{19}	R^2	$\bar{R}^2$	F	Standard Error of Estimate
I	B	0.87513	-0.10045	0.37899	0.34759	11.40245**	6.00470
	SeB	(0.99166)	(1.01750)				
	B'	0.05847	-0.00675				
	F	0.779	0.010				
II	B			0.36889	0.34434	13.98899**	6.10952
	SeB						
	B'						
	F						
III	B			0.02770	0.02509	5.29840*	7.33981
	SeB						
	B'						
	F						
IV	B	1.52987		0.01045	0.01045	3.93852*	7.39469
	SeB	(0.77088)					
	B'	0.10222					
	F	3.939					
V	B		-0.08073	0.00003	0.00003	0.01096	7.43352
	SeB		(0.77110)				
	B'		-0.00542				
	F		0.011				

Table 4-3 (Continued)

Equation	Intercept		X_1	X_2	X_3	X_4	X_5
VI[b]	33.34012	B	0.01169	-10.43768	-1.32824	-0.28800	-3.50059
		SeB	(0.00728)	(10.92523)	(0.25512)	(0.38074)	(4.59926)
		B'	0.13591	-0.05902	-0.51287	0.05883	-0.04545
		F	2.576	0.913	34.810**	0.572	0.590
VII[c]	71.93006	B	-0.01856	-2.25918	-0.76557	-0.10900	-9.03827
		SeB	(0.01086)	(11.63929)	(0.19361)	(0.32550)	(7.26877)
		B'	0.18590	-0.02415	-0.44024	-0.03689	-0.14209
		F	2.921	0.038	15.636**	0.112	1.546
VIII[d]	53.51555	B	0.00512	-3.19697	-0.93574	-0.05110	-20.01059
		SeB	(0.00173)	(10.48634)	(0.16752)	(0.11743)	(5.77481)
		B'	0.34857	-0.02652	-0.47620	-0.04363	-0.27894
		F	8.771**	0.093	31.202**	0.189	12.007**

[b]Represents schools with less than 500 pupils enrolled (N=200).

[c]Represents schools with at least 500 pupils but less than 750 pupils enrolled (N=85).

[d]Represents schools with 750 or more pupils enrolled (N=90).

Table 4-3 (Continued)

Equation		X_6	X_7	X_8	X_9	X_{10}	X_{11}
VI[b]	B	0.00021	16.66097	0.15496	-0.15304	0.20450	-0.04000
	SeB	(0.00009)	(12.08376)	(0.04645)	(0.17922)	(0.14061)	(0.08767)
	B'	0.16846	0.08136	0.21229	-0.05720	0.10105	0.02886
	F	5.225*	1.901	11.127**	0.729	2.115	0.208
VII[c]	B	0.00023	-20.67328	0.28505	0.70720	-0.01992	-0.01706
	Seb	(0.00019)	(23.28396)	(0.07544)	(0.46143)	(0.21794)	(0.15991)
	B'	0.15658	-0.10206	0.44183	0.22684	-0.01237	-0.01242
	F	1.519	0.788	14.277**	2.349	0.008	0.011
VIII[d]	B	0.00019	16.97618	0.34605	-0.54146	0.23228	-0.12938
	SeB	(0.00012)	(19.41311)	(0.05855)	(0.38782)	(0.18993)	(0.09252)
	B'	0.16520	0.07951	0.51433	-0.17459	0.14848	-0.11167
	F	2.489	0.765	34.934**	1.949	1.496	1.956

Table 4-3 (Continued)

Equation		X_{12}	X_{13}	X_{14}	X_{15}
VI[b]	B	0.00029	4.64589	-2.15026	0.54707
	SeB	(0.00021)	(7.56835)	(0.91215)	(1.53859)
	B'	0.09594	0.03677	-0.14179	0.02152
	F	1.885	0.377	5.557*	0.126
VII[c]	B	-0.00013	7.15483	-1.35657	-1.41619
	SeB	(0.00032)	(11.74748)	(1.91667)	(2.82407)
	B'	-0.04969	0.07279	-0.08520	-0.06015
	F	0.160	0.371	0.501	0.251
VIII[d]	B	-0.00019	-4.98952	-3.29112	-4.00700
	SeB	(0.00017)	7.81636	(1.46957)	(1.90624)
	B'	-0.1436	-0.05983	-0.20349	-0.22535
	F	1.260	0.407	5.015*	4.419*

Table 4-3 (Continued)

Equation	X_{18}	X_{19}	R^2	$\bar{R}^2$	F	Standard Error of Estimate
VI[b]			0.39565	0.34992	8.03061**	6.56550
VII[c]			0.35705	0.22846	2.55452**	6.05083
VIII[d]			0.59877	0.52387	7.36216*	4.02473

Table 4-3 (Continued)

Equation	Intercept		X_1	X_2	X_3	X_4	X_5
IX[e]	23.15708	B	0.00657	0.54242	-1.03256	-0.17743	-8.86970
		SeB	(0.00245)	(10.01988)	(0.19406)	(0.21073)	(5.98718)
		B'	0.32797	0.00373	-0.49859	-0.08310	-0.09673
		F	7.179*	0.003	28.311**	0.709	2.195
X[f]	57.22296	B	0.00193	-13.24570	-0.83247	0.09622	-7.35864
		SeB	(0.00189)	(8.53142)	(0.13081)	(0.17640)	(3.78214)
		B'	0.12623	-0.10279	-0.54647	0.04857	-0.11692
		F	1.039	2.411	40.499**	0.298	3.785
XI[g]	46.93191	B	0.00626	-5.85539	-0.92025	-0.19155	-4.15646
		SeB	(0.00263)	(8.81152)	(0.19320)	(0.22479)	(4.85091)
		B'	0.26983	-0.04625	-0.46113	-0.07964	-0.05758
		F	5.639*	0.442	22.689**	0.726	0.734
XII[h]	41.35107	B	0.00218	-19.44981	-0.86324	0.08228	-12.80834
		SeB	(0.00176)	(10.19891)	(0.13005)	(0.16364)	4.39774
		B'	0.14928	-0.12466	-0.54663	0.04457	-0.16879
		F	1.533	3.637	44.063**	0.253	8.483**

[e]Represents districts with occupational levels less than 4.6 (N=162).

[f]Represents districts with occupational levels more than 4.5 (N=213.

[g]Represents districts with educational levels less than 3.6 (N=170).

[h]Represents districts with educational levels more than 3.5 (N=205).

Table 4-3 (Continued)

Equation		X_6	X_7	X_8	X_9	X_{10}	X_{11}
IX[e]	B	0.00026	24.76900	0.24282	-0.32957	0.17989	-0.09374
	SeB	(0.00010)	(14.60161)	(0.05508)	(0.20646)	(0.15724)	(0.10050)
	B'	0.21196	0.11674	0.33116	-0.11437	0.08202	0.06447
	F	6.400*	2.884	19.435**	2.548	1.309	0.874
X[f]	B	0.00023	-1.71288	0.16300	0.17266	0.05827	-0.02195
	SeB	(0.00009)	(12.23971)	(0.04302)	(0.21429)	(0.12766)	(0.07703)
	B'	0.21537	-0.00853	0.26792	0.06245	0.03594	-0.01813
	F	6.824**	0.020	14.355**	0.649	0.208	0.081
XI[g]	B	0.00026	-2.12783	0.19689	-0.21302	0.16989	-0.01968
	SeB	(0.00010)	(15.48490)	(0.05552)	(0.22472)	(0.15575)	(0.10880)
	B'	0.23180	-0.00953	0.25727	-0.07836	0.08605	-0.01387
	F	6.254*	0.019	12.576**	0.899	1.190	0.033
XII[h]	B	0.00023	18.23886	0.20619	0.02470	0.14068	-0.07811
	SeB	(0.00009)	(11.44899)	0.04115	(0.20677)	(0.12690)	(0.07612)
	B'	0.20152	0.09324	0.33156	0.00824	0.07958	-0.06208
	F	7.328**	2.538	25.105**	0.014	1.229	1.053

Table 4-3 (Continued)

Equation		X_{12}	X_{13}	X_{14}	X_{15}	X_{16}	X_{17}
IX[e]	B	0.00008	-1.88088	-2.77344	-0.87450		
	SeB	(0.00025)	(8.49956)	(2.15026)	(1.72002)		
	B'	0.02528	-0.01656	-0.08990	-0.03720		
	F	0.113	0.049	1.664	0.258		
X[f]	B	-0.00001	6.81602	-1.42654	-0.63162		
	SeB	(0.00016)	(6.50591)	(1.23052)	(1.51115)		
	B'	-0.00438	0.06366	-0.07235	-0.02854		
	F	0.003	1.098	1.344	0.175		
XI[g]	B	0.00013	3.27559	-0.72624	-2.74253		
	SeB	(0.00023)	(8.13634)	(1.11077)	(2.21006)		
	B'	0.04693	0.02995	-0.04691	-0.07776		
	F	0.314	0.162	0.427	1.194		
XII[h]	B	-0.00009	3.76388	-2.71134	2.06308		
	SeB	(0.00016)	(6.71754)	(0.92740)	(2.32228)		
	B'	-0.04283	0.03352	-0.16767	0.05626		
	F	0.343	0.314	8.547**	0.789		

Table 4-3 (Continued)

Equation	X_{18}	X_{19}	R^2	$\bar{R}^2$	F	Standard Error of Estimate
IX[e]			0.42185	0.36679	7.10205**	6.39468
X[f]			0.34737	0.30122	6.99046**	5.77574
XI[g]			0.36175	0.30410	5.81896**	6.59611
XII[h]			0.41904	0.37623	9.08828**	5.57546

The Y_1 variable was used as a measure of efficiency of Iowa schools in producing growth in achievement by elementary pupils over time. Table 4-3 presents the results of the regression equations by listing four values for each independent variable obtained from each analysis. The tabled values for independent variables $(X_1, X_2 \ldots X_{19})$ are as follows:

B = the regression coefficient

SeB = the standard deviation of B

B'= a "standardized" form of B where the intercept = 0

F = an indication of the significance of the variable as a predictor of Y_1

Following tabulations of values for variables in each equation, Table 4-3 includes R^2, $\bar{R}^2$, F and standard error of the estimate for the total equation.

Relationships Associated with Efficiency

Equation I was a "full model" including all independent variables, and "dummy" variables for size, occupational level and educational level. R^2 was 0.37899. This was less than had been hoped, but, if one considers Iowa studies reviewed earlier in Chapter II, this value is quite high. The F was highly significant and several variables appeared significantly related to Y_1 including X_1, X_3, X_5, X_6, X_8, X_{10} and X_{17}. In other words, district characteristics such as size, pupil-teacher ratio, expenditure change, and assessed valuation appeared to be related in some way with cost per unit of growth (Y_1). Pupil-teacher ratio was negatively, but very significantly related. Also negatively related to Y_1 was the expenditure change ratio (X_5). Assessed valuation per pupil, (X_6), was associated significantly with efficiency in a positive way suggesting high costs per unit of growth are related to high assessed valuation per pupil.

A rather surprising result, which will be dealt with more in the following chapter was the significantly positive relationship between efficiency and school size. If one is to believe the results of this study, one might be led to conclude that as the size of the school increases, the cost of producing a unit of growth also increases.

Staff characteristics significantly related to Y_1 included X_8 and X_{10}. X_8, teacher training level, was very positively related. Teacher age was positively related also, suggesting that cost per unit of growth increases as the average age of teachers increases.

X_{17} was significantly related to Y_1 also. This "dummy" variable assumed schools less than 750 but more than 500 in size equal to a value of one and all others zero. Using Equation I, this was simply an interesting finding. In Equation VIII, the reason for this finding appeared more clearly.

Equation II removed all "dummy" variables from the model. In addition to variables which appeared the most highly related to Y_1 in Equation I, variable X_2 which measured enrollment change and fathers' occupational level, X_{14}, appeared significantly related to Y_1. However, the amount of variance explained was not a great deal less than the total model. Removal of the "dummy" variables (only one of which appeared related to Y_1) did not detract from the explanatory power of the model to any significant degree.

The term $\bar{R}^2$ might be profitably explained at this point; the technique is one found in Cohn (13, p. 70). It is called a "shrunken R^2" and is defined as the coefficient of determination corrected for the degrees of freedom. Cohn credits R. J. Wheery with development of this term. R^2 is normally considered a measure of the "power" of a model to predict accurately the values of Y given different values of $X_1 \ldots X_n$. It measures how much of the variance associated with Y is explained by the independent variables included in the model. $\bar{R}^2$, or "shrunken R^2", is a more conservative estimate. Let $\bar{R}$ be the estimated correlation obtaining in the universe, R the observed multiple correlation coefficient, M the number of independent variables, and N the number of observations. Then the corrected R^2 is the result of:

$$(4\text{-}3) \qquad \bar{R}^2 = \frac{(N-1)\ R^2 - (M-1)}{N-M}$$

Appropriate values for $\bar{R}^2$ were calculated for each equation in Table 4-3 and are reported in Table 4-4. The "real" difference between R^2 for Equation I and R^2 for Equation II becomes only 0.00325 instead of 0.01010 as would have been thought had the $\bar{R}^2$'s not been computed.

Equations III, IV, and V were loaded with "dummy" variables for size, fathers' occupational level and fathers' educational level respectively. The R^2 indicated little additional explanatory power. X_{16} appeared as a significant variable in relation to Y_1 in this equation.

School enrollment, X_1, appeared to be significantly related to efficiency in terms of cost per unit of growth produced over the three-year span of time. It was determined that an analysis of the effect of school size could be made by comparing results of schools with less than 500 enrolled with schools of between 500 and 750 pupils and schools with over 750 pupils enrolled. Equations VI, VII and VIII were used to assess the results of grouping by size of school.

Equation VI measured the factors related to efficiency in 200 schools of less than 500 elementary pupils. Occupational level, X_{14}, was significantly related to

Table 4-4. R^2 and $\bar{R}^2$ values of equations shown in Table 4-3 and the difference between equation I values and values for all other equations

Equation	R^2	$\bar{R}^2$	Difference between I and others	
			R^2	$\bar{R}^2$
I	0.37899	.34759		
II	.36889	.34435	-.01010	-.00324
III	.02770	.02509	-.35129	-.32250
IV	.01045	.01045	-.36854	-.33714
V	.00003	.00003	-.37896	-.34756
VI[a]	.39565	.34992	+.01666	+.00233
VII[b]	.35705	.22346	-.02194	-.11913
VIII[c]	.59877	.52387	+.21978	+.17628
IX[d]	.42185	.36679	+.04286	+.01920

[a]Represents schools with less than 500 pupils enrolled (N=200).

[b]Represents schools with at least 500 puills but less than 750 pupils enrolled (N=85).

[c]Represents schools with 750 or more pupils enrolled (N=90).

[d]Represents districts with occupational levels less than 4.6 (N=162).

Table 4-4 (Continued)

Equation	R^2	$\bar{R}^2$	Difference between I and others R^2	$\bar{R}^2$
X^e	.34737	.30122	-.03162	-.04637
XI^f	.36175	.30410	-.01724	-.04349
XII^g	.41904	.37523	+.04005	+.02864

[e]Represents districts with occuaptional levels more than 4.5 (N=213).

[f]Represents districts with educational levels less than 3.6 (N=170).

[g]Represents districts with educational levels more than 3.5 (N=205).

efficiency in small districts in a negative direction. The training level of teachers was also highly significant. As in the case of nearly all other equations, pupil teacher ratio was highly significant in a negative fashion and assessed valuation per pupil significant in a positive direction. For the total equation among small schools, the F value was highly significant. In Table 4-4, the $\bar{R}^2$ of Equation VI was shown to be 0.34991, a difference of only +0.00232 from Equation I, and not explanatory to the degree one would hope to achieve when predicting efficiency among small schools. Equation VI only allows a predictability slightly better than "chance" and is not significantly better suited to the purposes here than the full model which included 375 schools of all sizes.

Equation VII measured the same variables and their relationship to efficiency in 85 schools of between 500 and 749 elementary pupils. It proved even less useful as a predictor of efficiency than Equation I. The $\bar{R}^2$ value among middle-sized schools dropped 0.11913 to only 0.22846. As can be seen in Table 4-4, the difference is much more pronounced between values of $\bar{R}^2$ than those of R^2 in this case.

Equation VIII was the most fruitful analysis of the study. Table 4-3 values suggest six independent variables significantly related to efficiency among the 90 Iowa schools with 750 or more elementary pupils. Fathers' occupational level (X_{14}) and educational level (X_{15}) were both negatively and significantly related to expenditures per unit of growth. Other negatively related variables which appeared highly significant predictors in this equation included teacher training level (X_8), pupil-teacher ratio (X_3) and the expenditure change ratio (X_5). Enrollment (X_1) among this group was positively related to Y_1. The R^2 for this equation was 0.59877. The calculation of $\bar{R}^2$ only reduced this value to 0.42387 and Table 4-4 indicates a significantly higher amount of the variance explained among this group of schools using the variables described than Equation I, which included 375 schools of all sizes. The mean for Y_1 (cost per unit of growth) for Equation VIII was the lowest of any group of schools measured in this survey.

Table 4-3 also included equations which included schools grouped first according to occupational level and then according to educational level of pupils' fathers. In general, the results were unproductive in terms of explanatory value and improved predictability.

Equation XI included 162 schools with occupational levels less than 4.6. Enrollment (X_1) and training level of teachers (X_8) were highly significant as predictors and positively related to Y_1. Assessed valuation per pupil (X_6)

was significant at a .05 level of confidence. Again, pupil-teacher ratio was highly significant, but negatively, as a predictor in this equation. The $\bar{R}^2$ was 0.36678 which improved on Equation I by 0.01919.

Equation X measured 213 schools with mean father's occupational levels of more than 4.5. The $\bar{R}^2$ was 0.04637 less than Equation I. Enrollment (X_1) was not a significant factor as it was in schools with lower occupational levels.

Equation XI measured 170 schools in which the mean fathers' educational level was less than 3.6. Explanatory value did not improve over Equation I. Only two variables, pupil teacher ratio and assessed value per pupil, were significant predictors in this equation and the $\bar{R}^2$ was 0.30410, or 0.04349 less than Equation I.

Equation XII improved only slightly upon the full model by measuring 205 schools with a mean fathers' educational level of more than 3.5. Teacher training level (X_8) and enrollment (X_1) were again significant predictors of Y_1 along with X_3 and X_6 as before. The $\bar{R}^2$ value of 0.37623 was not significantly better than $\bar{R}^2$ for Equation I.

Tables 4-3 and 4-4 depicted the regression analysis of the effect of selected independent variables upon cost per unit of growth, or Y_1. Equation I was only improved upon in a significant way by the analysis of schools with 750 or more elementary pupils. Most of the equations produced a highly significant F value, but relatively low R^2 values. It was considered relevant to this study to determine whether the same independent variables might predict achievement growth as measured by the ITBS, and this dependent variable was labeled Y_2 and studied the same way as was Y_1.

Relationships Associated with Growth

Table 4-5 presents data relating to equations using pupil achievement growth, Y_2, as the dependent variable in regression analyses similar to that shown in Table 4-3 for Y_1.

Only a part of these equations were included for illustrative purposes because, as the reader can readily see upon viewing the table, R^2 values are very small. In general, it can be seen that these analyses were quite unproductive.

There were some independent variables in these analyses which were significantly related to achievement growth which didn't appear to be so for Y_1. Teacher age was one of these. In Equation I_2, teacher age is negatively significant. Later, in Chapter V, this finding is discussed briefly.

It is also worth noting that pupil-teacher ratio was not a significant factor in Equation II_2. This was true of other analyses in this series as well. However, fathers' occupational level (X_{14}) and assessed valuation per pupil (X_6) were both highly significant factors related to achievement

Table 4-5. Multiple regression equations utilizing 375 Iowa school districts to determine whether selected characteristics influence growth in achievement (Y_2)[a]

Equation	Intercept		X_1	X_2	X_3	X_4	X_5
I_2	11.14682	B	0.00007	-1.17500	0.01178	-0.01020	-0.07932
		SeB	(0.00021)	(0.68549)	(0.01200)	(0.01446)	(0.34382)
		B'	0.04346	-0.09316	0.07330	-0.05375	-0.01168
		F	0.109	2.938	0.962	0.498	0.053
II_2	10.52425	B	0.00009	-1.15384	0.01850	-0.00918	-0.02446
		SeB	(0.00016)	(0.68552)	(0.01168)	(0.01444)	(0.34514)
		B'	0.05382	-0.09148	0.11516	-004834	-0.00360
		F	0.288	2.833	2.511	0.404	0.005
III_2		B					
		SeB					
		B'					
		F					
IV_2		B					
		SeB					
		B'					
		F					
V_2		B					
		SeB					
		B'					
		F					

[a]See Table 4-1, page 51 for descriptions of values reported for $X_1, X_2, X_3, \ldots X_{19}$.

Table 4-5 (Continued)

Equation		X_6	X_7	X_8	X_9	X_{10}	X_{11}
I_2	B	0.00002	-0.38601	-0.00686	0.00519	-0.02618	0.00495
	SeB	(0.00001)	(0.93936)	(0.00356)	(0.01544)	(0.01304)	(0.00694)
	B'	0.21829	-0.02014	-0.11196	0.01987	-0.15328	0.04088
	F	10.519**	0.152	3.707*	0.113	6.403*	0.556
II_2	B	0.00002	-0.63681	-0.00708	0.00317	-0.02483	0.00559
	SeB	(0.00001)	(0.98654)	(0.00357)	(0.01547)	(0.01037)	(0.00654)
	B'	0.20511	-0.03323	-0.11557	0.01214	-0.14541	0.04616
	F	9.563**	0.417	3.922*	0.042	5.732*	0.732
III_2	B						
	SeB						
	B'						
	F						
IV_2	B						
	SeB						
	B'						
	F						
V_2	B						
	SeB						
	B'						
	F						

*Denotes significance at an .05 level of confidence.

**Denotes significance at .01 level of confidence.

Table 4-5 (Continued)

Equation		X_{12}	X_{13}	X_{14}	X_{15}	X_{16}	X_{17}
I_2	B	-0.00001	0.06465	0.12502	0.19176	-0.05578	0.14666
	SeB	(0.00001)	(0.54407)	(0.11452)	(0.17831)	(0.17764)	(0.14764)
	B'	-0.04132	0.00635	0.08684	0.09173	0.04081	0.09005
	F	0.432	0.014	1.192	1.157	0.099	0.987
II_2	B	-0.00001	0.15353	0.28251	0.11329		
	SeB	(0.00001)	(0.54529)	(0.07506)	(0.11846)		
	B'	-0.02692	0.01508	0.19624	0.05419		
	F	0.180	0.079	14.167**	0.915		
III_2	B					0.01789	0.13654
	SeB					(0.08664)	(0.10324)
	B'					0.01309	0.08383
	F					0.043	1.749
IV_2	B						
	SeB						
	B'						
	F						
V_2	B						
	SeB						
	B'						
	F						

Table 4-5 (Continued)

Equation		X_{18}	X_{19}	R^2	$\bar{R}^2$	F	Standard Error of Estimate
I_2	B	-0.19164	0.04246	0.13338	0.08956	2.87568*	0.65244
	SeB	(0.10775)	(0.11056				
	B'	-0.13921	0.03100				
	F	3.163	0.147				
II_2	B			0.11385	0.07939	3.07485*	0.65607
	SeB						
	B'						
	F						
III_2	B			0.00593	0.00326	1.10932	0.68262
	SeB						
	B'						
	F						
IV_2	B	-0.31841		0.05350	0.05350	21.08398**	0.66519
	SeB	(0.06935)					
	B'	-0.23130					
	F	21.084**					
V_2	B		-0.09762	0.00508	0.00508	1.90401	0.68200
	SeB		(0.07075)				
	B'		-0.07126				
	F		1.904				

Table 4-5 (Continued)

Equation	Intercept		X_1	X_2	X_3	X_4	X_5
VI_2[b]	11.91212	B	-0.00034	-1.55581	0.00645	-0.00643	-0.05265
		SeB	(0.00080)	(1.19988)	(0.02472)	(0.04182)	(0.50072)
		B'	-0.04264	-0.09619	0.02725	-0.01436	-0.00748
		F	0.176	1.681	0.068	0.024	0.011
VII_2[c]	6.23587	B	0.00168	-0.98537	0.04451	-0.01762	-0.39061
		SeB	(0.00114)	(1.22246)	(0.02033)	(0.03419)	(0.76343)
		B'	0.17767	-0.11121	0.27028	-0.06298	-0.06484
		F	2.169	0.650	4.792*	0.266	0.262
$VIII_2$[d]	8.75472	B	0.00016	-0.71042	0.00098	-0.01154	-0.05715
		SeB	(0.00023)	(1.39809)	(0.02233)	(0.01565)	(0.76989)
		B'	0.11390	-0.06050	0.00512	-0.10117	-0.00818
		F	0.500	0.258	0.002	0.543	0.006

[b]Represents schools with less than 500 pupils enrolled (N=200).

[c]Represents schools with at least 500 pupils but less than 750 pupils enrolled (N=85).

[d]Represents schools with 750 or more pupils enrolled (N=90).

Table 4-5 (Continued)

Equation		X_6	X_7	X_8	X_9	X_{10}	X_{11}
VI_2^b	B	0.00003	-0.80917	-0.00712	0.00396	-0.03445	0.00766
	SeB	(0.00001)	(1.32711)	(0.00510)	(0.01968)	(0.01544)	(0.00963)
	B'	0.23648	-0.04321	-0.10660	0.01620	-0.18617	0.06040
	F	7.139**	0.372	1.945	0.041	4.978*	0.633
VII_2^b	B	0.00004	3.75350	-0.00974	-0.03671	-0.01215	0.01152
	SeB	(0.00002)	(2.44548)	(0.00792)	(0.04846)	(0.02289)	(0.01679)
	B'	0.31375	0.19565	-0.15942	-0.12432	-0.07966	0.08853
	F	4.959*	2.356	1.511	0.574	0.282	0.471
$VIII_2^d$	B	0.00002	-1.10721	-0.00890	-0.01757	-0.00337	0.00264
	SeB	(0.00002)	(2.58812)	(0.00781)	(0.05170)	(0.02532)	(0.01233)
	B'	0.22443	-0.05324	-0.13576	-0.05816	-0.02212	0.02336
	F	2.452	0.183	1.299	0.115	0.018	0.046

Table 4-5 (Continued)

Equation		X_{12}	X_{13}	X_{14}	X_{15}	X_{16}	X_{17}
VI_2[b]	B	-0.00002	0.83412	0.18796	0.04661		
	SeB	(0.00002)	(0.83120)	(0.10018)	(0.16898)		
	B'	-0.08304	0.07219	0.13553	0.02005		
	F	0.979	1.007	3.521	0.076		
VII_2[c]	B	0.00002	-0.73206	0.15333	-0.12075		
	SeB	(0.00003)	(1.23382)	(0.20130)	(0.29661)		
	B'	0.06505	-0.07863	0.10168	-0.05415		
	F	0.223	0.352	0.580	0.166		
$VIII_2$[d]	B	-0.00001	-0.25302	0.69707	0.19730		
	SeB	(0.00002)	(1.04206)	(0.19592)	(0.25415)		
	B'	-0.10182	-0.03115	0.44253	0.11393		
	F	0.451	0.059	12.659**	0.603		

Table 4-5 (Continued)

Equation		X_{18}	X_{19}	R^2	$\bar{R}^2$	F	Standard Error of Estimate
VII_2[b]	B			0.12840	0.06244	1.80702*	0.72106
	SeB						
	B'						
	F						
VII_2[c]	B			0.20930	0.05116	1.21761	0.63551
	SeB						
	B'						
	F						
$VIII_2$[d]	B			0.24817	0.10783	1.62846	0.53657
	SeB						
	B'						
	F						

Table 4-5 (Continued)

Equation	Intercept		X_1	X_2	X_3	X_4	X_5
IX_2[e]	11.63104	B	0.00011	-0.94860	-0.02378	-0.00275	0.74449
		SeB	(0.00028)	(1.15324)	(0.02234)	(0.02425)	(0.68909)
		B'	0.05973	-0.06924	-0.12209	-0.01370	0.08631
		F	0.159	0.677	1.134	0.013	1.167
X_2[f]	10.19436	B	-0.00005	-1.41422	0.03756	-0.00898	-0.30017
		SeB	(0.00019)	(0.84139)	(0.01290)	(0.01740)	(0.37300)
		B'	-0.03720	-0.12331	0.28828	-0.05296	-0.05576
		F	0.068	2.825	8.478**	0.266	0.648
XI_2[g]		B	0.00017	-1.31219	-0.01875	-0.00401	0.10532
		SeB	(0.00029)	(0.96404)	(0.02114)	(0.02459)	(0.53072)
		B'	0.08061	-0.15474	-0.10159	-0.01801	0.01577
		F	0.360	3.534	0.787	0.027	0.039
XII_2[h]		B	-0.00000	0.33405	0.04159	-0.00777	0.00028
		SeB	(0.00019)	(1.09695)	(0.01399)	(0.01760)	(0.47300)
		B'	-0.00031	0.02706	0.28951	-0.04626	0.00004
		F	0.000	0.123	8.341**	0.195	0.000

[e]Represents districts with occupational levels less than 4.6 (N=162).

[f]Represents districts with occupational levels more than 4.5 (N=213).

[g]Represents districts with educational levels less than 3.6 (N=170).

[h]Represents districts with educational levels more than 3.5 (N=205).

Table 4-5 (Continued)

Equation		X_6	X_7	X_8	X_9	X_{10}	X_{11}
IX_2[e]	B	0.00002	-2.64094	-0.00828	0.00688	-0.02072	0.01996
	SeB	(0.00001)	(1.68057)	(0.00634)	(0.02376)	(0.01810)	(0.01157)
	B'	0.16080	-0.13104	-0.12012	0.02537	-0.10043	0.14560
	F	2.460	2.469	1.708	0.084	1.311	2.976
X_2[f]	B	0.00002	0.91212	-0.00769	-0.00672	-0.02213	-0.00487
	SeB	(0.00001)	(1.20711)	(0.00424)	(0.02113)	(0.01259)	(0.00760)
	B'	0.19691	0.05311	-0.14776	-0.02840	-0.15958	-0.04705
	F	4.291*	0.571	3.284	0.101	3.091	0.411
XI_2[g]	B	0.00000	0.00711	-0.00249	0.01680	-0.03815	-0.00225
	SeB	(0.00001)	(1.69415)	(0.00607)	(0.02459)	(0.01704)	(0.01190)
	B'	0.04798	0.00034	-0.03512	0.06681	-0.20891	-0.01717
	F	0.192	0.000	0.168	0.467	5.011*	0.036
XII_2[h]	B	0.00003	-1.03408	-0.01051	-0.00541	-0.01341	0.01223
	SeB	(0.00001)	(1.23140)	(0.00443)	(0.02224)	(0.01365)	(0.00819)
	B'	0.31964	-0.05811	-0.18580	-0.01984	-0.08340	0.10689
	F	13.186**	0.705	5.639*	0.059	0.966	2.233

Table 4-5 (Continued)

Equation		X_{12}	X_{13}	X_{14}	X_{15}
IX_2[e]	B	-0.00001	1.00637	0.41522	-0.06886
	SeB	(0.00003)	(0.97826)	(0.24748)	(0.19797)
	B'	-0.03548	0.09420	0.14308	-0.03114
	F	0.149	1.058	2.815	0.121
X_2[f]	B	-0.00000	-0.30506	0.04972	0.28695
	SeB	(0.00002)	(0.64163)	(0.12136)	(0.14903)
	B'	-0.01206	-0.03331	0.02948	0.15157
	F	0.017	0.226	0.168	3.707
XI_2[g]	B	0.00001	0.28483	0.19201	-0.02370
	SeB	(0.00002)	(0.89017)	(0.12153)	(0.27462)
	B'	0.02277	0.02816	0.13409	-0.00727
	F	0.053	0.102	2.496	0.007
XII_2[h]	B	-0.00002	0.22732	0.31213	0.43591
	SeB	(0.00002)	(0.72251)	(0.09975)	(0.24977)
	B'	-0.10317	0.02225	0.21220	0.13069
	F	1.426	0.099	9.792**	3.046

Table 4-5 (Continued)

Equation	X_{18}	X_{19}	R^2	$\bar{R}^2$	F	Standard Error of Estimate
$IX_2{}^3$			0.13445	0.05202	1.51188	0.73600
$X_2{}^f$			0.13241	0.07107	2.00436*	0.56962
$XI_2{}^g$			0.10696	0.02630	1.22970	0.72166
$XII_2{}^h$			0.18780	0.12795	2.91343**	0.59967

growth. Teacher age (X_{10}) and training level (X_8) were significant, but negatively related suggesting that as these two staff characteristics increase, achievement growth decreases. The F value in this equation was highly significant but R^2 was only 0.11385, too small to be very explanatory.

Equations III_2, IV_2 and V_2 were not very productive except that fathers' occupational level produced a highly significant value of F at 21.08398. However, the R^2 for Equation IV_2 was only 0.05350.

The regression equations following in Table 4-5 were in the same form as those for Y_1 in Table 4-4. R^2 and $\bar{R}^2$ values show these equations to be quite unproductive in explaining the variance among schools in achievement growth. Again, the most explanatory equation was that for schools of over 749 pupils. But the $\bar{R}^2$ value reduced the power of the model in Equation $VIII_2$ a great deal, negating any apparent gains. The F value was not significant in this equation and the only significant variable appeared to be fathers' occupational level (X_{14}).

Some independent variables used in the equations shown in Table 4-4 and Table 4-5 were quite unproductive in explaining the variance among schools for cost per unit of growth produced and achievement growth. The least productive variables in equations shown in Table 4-4 relating to cost per unit of growth were X_2, X_4, X_7, X_9, X_{10}, X_{11}, X_{12} and X_{13}.

X_2 was an enrollment growth ratio value which was included with the thought that rate of enrollment growth might affect the efficiency of a district as measured by Y_1. The number of special teachers (X_4) was not a significant factor in any equation. X_7, another ratio of change, this one for teacher salary levels, was also quite unproductive.

Three of the four variables labeled staff characteristics were not really helpful in explaining efficiency as measured by Y_1. Staff tenure (X_9), teacher age (X_{10}) and principal tenure (X_{11}) were never significant values in any of the equations. On the other hand, teacher training level (X_8), the fourth staff characteristics variable, was a significant predictor in every equation in Table 4-3.

X_{12} and X_{13}, each of which was derived from income per pupil in the school district, were not significant predictors of relative efficiency as measured by Y_1 in any of the equations of Table 4-3.

The other two socio-economic variables, fathers' occupational level (X_{14}) and fathers' educational level (X_{15}) were better predictors of efficiency in some of the equations, although occupational level was apparently more strongly related to Y_1 than was educational level.

Of course, in Table 4-5, one can quickly see that pupil-teacher ratio (X_3) was not as much a factor in predicting Y_2 as it was in the prediction of Y_1. The direction of the relationship also changes from a basically negative one in the case of Y_1 to a positive one in predicting Y_2. The district characteristic most often found significant was assessed valuation per pupil (X_6) in Table 4-5. There appeared to be a strongly positive relationship between X_6 and achievement growth.

Staff characteristics such as training level (X_8) and teacher age (X_{10}) also were significant in some equations in Table 4-5. Each of these was negatively related to growth in most equations. The findings here support those of some earlier studies cited in Chapter II. This and other studies seem to indicate a relationship suggesting a decrease in achievement growth as teacher training level and age increase.

The only community characteristic which appeared to be at all significant to pupil achievement growth in Table 4-5 was fathers' occupational level (X_{14}).

Ten of the independent variables included in the equations shown in Table 4-5 were never listed as significant to a prediction of pupil achievement growth. The R^2 values of these equations were quite small, and indicated little reliance could be placed on any of these equations for accurately predicting achievement growth among Iowa elementary schools.

Summary

The findings reported here indicated that Table 4-3 equations were productive of some significant relationships between efficiency and selected characteristics of Iowa school systems. Equations I and II contained a full set of variables and measured all of the 375 school districts. The variance explained ($\bar{R}^2$) was not high, but encouraging in comparison with earlier Iowa studies.

Equations VI, VII and VIII analyzed various sizes of schools for the relationship between efficiency (Y_1) and selected characteristics of Iowa school systems. Equation VIII, which represented results among schools with 750 or more pupils enrolled was the most predictive. $\bar{R}^2$ yielded a value of 0.52387 and this was cited as evidence of rather high predictive power.

Equations IX, X, XI and XII were not particularly powerful in predictive power and yielded few significant relationships between Y_1 and the independent variables. X_6 and X_8 were significant in each of these equations.

Throughout the analyses reported in Table 4-3 it was evident that pupil-teacher ratio (X_3) and assessed valuation (X_6) played an important role in efficient operation. Pupil-teacher ratio was highly significant in each equation and accounted for nearly 25 per cent of the variance explained in Equation VIII.

In Table 4-5, pupil achievement growth (Y_2) was found related to assessed valuation (X_6) and to teacher training level (X_8) in Equations I_2 and II_2. Throughout the analyses reported in this table, $\bar{R}^2$ values were quite low limiting the predictive potential to little better than chance for most of the equations shown.

CHAPTER V. CONCLUSIONS AND DISCUSSION

Conclusions

The conclusions drawn as a result of the foregoing analyses were as follows:

1. Ho_1: Rejected. There were significant differences among Iowa schools in the efficiency with which they produced achievement growth. All equations had an F value significant at the .05 level or higher.

2. Ho_2: Accepted. Five of the selected characteristics of Iowa school systems selected for this study (size, pupil-teacher ratio, assessed valuation, teacher training level, and fathers' occupational level) were found to be significantly related to efficiency, but the $\bar{R}^2$ value was only 0.34759.

3. Ho_3: Accepted. Among schools of less than 500 in elementary enrollment, four selected characteristics (pupil-teacher ratio, assessed valuation, teacher training level, and fathers' occupational level) were found to be significantly related to efficiency and the $\bar{R}^2$ value was 0.34992.

4. Ho_4: Accepted. Among schools of between 500 and 750 in elementary enrollment, two selected characteristics (assessed valuation and teacher training level) were significantly related to efficiency and the $\bar{R}^2$ value was 0.22846.

5. Ho_5: Rejected. Among schools with more than 750 enrolled in elementary school, six selected characteristics (size, pupil-teacher ratio, expenditure change ratio, teacher training level, fathers' occupational level and fathers' educational level) were significantly related to efficiency and the $\bar{R}^2$ value was 0.52387.

6. Ho_6: Accepted. Among schools where fathers' occupational level was less than 4.6, four selected characteristics (size, pupil-teacher ratio, assessed valuation and teacher training level) were significantly related to efficiency and the $\bar{R}^2$ value was 0.36679.

7. Ho_7: Accepted. Among schools where fathers' occupational level was more than 4.5, three selected characteristics (pupil-teacher ratio, assessed valuation and teacher training level) were significantly related to efficiency and the $\bar{R}^2$ value was 0.30122.

8. Ho_8: Accepted. Among schools where fathers' educational level was less than 3.6, four selected characteristics (size, pupil-teacher ratio, assessed valuation and teacher training level) were significantly related to efficiency and the $\bar{R}^2$ value was 0.30410.

9. Ho_9: Accepted. Among schools where fathers' educational level was more than 3.5, five selected characteristics (pupil-teacher ratio, expenditure change ratio, assessed valuation, teacher training level and fathers' occupational level) were significantly related to efficiency, but the $\bar{R}^2$ value was 0.37623.

10. Where Y_2 was concerned, a similar group of hypotheses could have been postulated and conclusions of a similar nature drawn, but they would not have been central to the intent of this study and would have been much more suspect because of low R^2 values. The basic conclusion which could be drawn from the analyses of the effect of selected characteristics of Iowa school systems upon achievement growth (Y_2) was that the characteristics did not seem to affect Y_2 in such a way that confidence could be placed in the predictive efficiency of the equations presented in this study.

11. Pupil-teacher ratio (X_3) was a very significant predictor of efficiency in every equation. As the pupil-teacher ratio increased. efficiency increased.

12. Assessed valuation (X_6) was found to be significant in most equations and was concluded to be significantly related to efficiency. As assessed valuation per pupil increased efficiency decreased.

13. In school districts which had 750 or more pupils enrolled in elementary school, the equation presented here explained over 50 per cent of the variance in efficiency among them. It was concluded that the equation could be relied upon to predict efficiency among schools of this size in Iowa with a fair degree of success.

14. Conclusions of a negative nature were also possible:
    a. Staff characteristics such as age and tenure were not significantly related to efficiency in Iowa schools.
    b. Income per pupil, designated a community characteristic in this study, was not related to efficiency.
    c. District characteristics such as enrollment growth ratio, teacher salary change ratio and the number of special teachers were not significantly related

to efficiency among Iowa schools.

It should be emphasized, as a cautionary note, that rejection of the null hypotheses was based on the original statements which postulated "no significant relationships" existed between the independent variables included in this study and efficiency. The only equation which explained more than 50 per cent of the variance was VIII including schools with 750 or more enrolled in elementary grades. No conclusions were drawn which claimed predictive efficiency for any equation as a whole other than Equation VIII. The foregoing conclusions were based on significant relationships existing between efficiency, as defined in this study, and five of the fifteen selected characteristics represented as independent variables in the regression equations and an R^2 value of 0.50 or more.

The purposes of this study, as stated in Chapter I, were achieved to a degree. It was demonstrated that an analysis of Iowa school districts on the basis of cost per unit of growth produced resulted in more explanatory power than had been the case in earlier Iowa studies. R^2 values were higher. Except for Equation VIII, however, the equations were not predictive enough to warrant their use in analyzing Iowa schools generally.

It was not possible to conclude that the model used would predict relative efficiency among <u>all</u> Iowa school districts. It was possible to conclude that the model would predict relative efficiency among larger rural-oriented Iowa schools with a fair degree of confidence.

The effects of community characteristics such as occupational and educational levels and income levels were not successfully demonstrated. The results of this study did not show added explanatory power when varying levels of occupation and education were used to group Iowa school districts.

Limitations

Conclusions drawn in this study were based on results from analyses of 375 Iowa school districts. The conclusions are only applicable subject to the following limitations:

1. The efficiency variable (defined as cost per unit of growth produced) in this study included only instructional expenditures for reasons of uniformity. School systems vary considerably in their expenditures for such things as operation and maintenance, transportation, capital outlay and fixed charges. Application of these results must be tempered with the knowledge that further variances among districts in expenditure levels would be evident. It was considered that fair comparison among schools could not be based on total expenditures including the items listed above.

2. The results of this study could not be applied to schools in states other than Iowa. Regional and cultural differences, organizational differences and legal constraints restrict the applicability, for reasons of homogeneity, to Iowa schools of less than 3000 in enrollment.

3. Much local control was possible in Iowa school systems during the time span selected for study (1967-1968 through 1969-1970). Since the collection of data and analyses of this study began, Iowa finance laws have changed drastically. Some constraints based on these changes would be necessary inclusions in similar equations applied to Iowa elementary schools after that time.

4. Application of the results of this study would best be limited to schools of 750 or more in elementary enrollment among those with less than 3000 in total enrollment. The highest predictability was achieved in schools of this size.

Discussion

The first part of the discussion portion of this study concentrates mainly on the reasons for including the independent variables and what might have been expected as against what the results of this study demonstrated.

X_1, school size, was expected to be significantly related to efficiency as defined by Y_1. It was thought that the study might indicate larger schools to be more efficient. This did not appear to be true, but results of Equations VI, VII, and VIII seemed to indicate that a quadratic equation might have been more appropriate where size is concerned.

In Equation III, size was a significant factor. Following this finding it seemed logical that the schools in Iowa were divided into groups with the smallest represented by Equation VI in a group of up to 500 enrolled. Between 500 and 750 represented by Equation VII were enrolled in the middle group of districts and those over 750 were in the largest group analyzed using Equation VIII. The relationship of size was negative in Equations VI and VII indicating that as size went up, values of Y_1 went down. This would have seemed to corroborate the expectation that larger schools were more efficient, but in Equation VIII the relationship was positive indicating that the smaller the enrollment among this group, the more efficient the school as defined by Y_1.

This leads to the conclusion that a quadratic equation might be a more appropriate measure where size is concerned. It is possible to conjecture that as Cohn (13) found in his study of high schools there is an "optimum" size in relation to efficiency among elementary schools as well.

X_2, enrollment growth ratio, was included to allow a weighting which was thought might be important to schools which were growing rapidly or losing students in the same fashion. Large enrollment changes might be expected to affect pupil-teacher ratio and expenditure levels. It was not a significant predictor in any of the equations reported in Table 4-3, however, and apparently could have been left out of the equations without serious effect.

Pupil-teacher ratio (X_3) seemed to be the dominant independent variable in all the analyses of this study. In Table 4-3 it was seen that X_3 was significantly related to Y_1 in each equation. If one were to choose a single factor most responsible for obtaining efficiency, as defined in this study, pupil-teacher ratio would be that factor. Of course, the relationship to efficiency is a negative one mathematically. As X_3 values go up, values of Y_1 go down. In this study, dollars (input) expended per unit of growth produced (output) were very much related to pupil-teacher ratio, commonly referred to in elementary schools as class size. In prior studies, this ratio was not as significantly related to cost per pupil or to achievement growth itself, but X_3 is definitely a factor in efficiency.

Where achievement growth alone (Y_2) was considered, pupil-teacher ratio was only strongly related in communities where occupational and educational levels were above average. In Table 4-5, X_3 is positively related to achievement growth in Equation X_2 and Equation XII_2. In each case, as the class size increased, growth increased. In communities where educational and occupational levels were lower, the relationship of class size to achievement growth was not significant, but tended to be negative.

The equations applied in this study yielded $\bar{R}^2$ values of less than 0.5 except in the case of Equation VIII in Table 4-3. For that reason, it is not possible to say much about the effect of any independent variable upon efficiency without a qualifying statement concerning the values of $\bar{R}^2$. Equation VIII allows more room for statements of a rather positive nature. With an $\bar{R}^2$ value of 0.52387, it appears this group of school districts "fits" the model applied in this study quite well. Pupil-teacher ratio (X_3), was responsible for more than 25 percent of the total variance explained in Equation VIII.

The number of special teachers in a school (X_4) was included because it seemed logical to expect these teachers, added to a regular staff, might raise salary expenditures with a corresponding effect on efficiency. The results were disappointing in this regard. X_4 was not found to be a significant factor in predicting efficiency in any of the equations. A more appropriate measure of this variable might have been salaries of special teachers. If the dollar outlay for such personnel had been used instead of simple numbers of people, the results might have been more rewarding.

X_5 was defined as an instructional expenditures change ratio. Somewhat related to increasing or decreasing enrollment, and certainly affected by annual salary increases, which varied from school to school during this period in Iowa, this variable was expected to be related to relative efficiency among schools. In four of the equations found in Table 4-5 this was true. Among larger schools X_4 was highly significant as a predictor. It was less significant, but still very much a factor when all schools were studied together such as in Equations I and II. In other cases, it was only found to be significant where educational levels were high. Interestingly enough, the relationship was a negative one. In other words, as the ratio of change grew larger, values of Y_1 tended to be smaller. In districts of 750 or more enrolled, as this ratio increased, efficiency was improved.

Assessed valuation per pupil (X_6) was found to be significant as a predictor of efficiency among small schools in Iowa, but not among schools of over 500 in enrollment. It was also a more significant factor among districts with higher educational and occupational levels. The relationship of this variable to efficiency was exactly as expected. Districts with high assessed valuations tended to be less efficient than those with lower valuations. When one has more money available, the tendency is to spend more - whether it can be justified by improved output or not.

Rather than include teacher salaries, which were "scheduled" and not very different among the schools included in this study, it was decided that a measure of change in teacher salaries might better reflect a district's relative efforts in this regard. X_7 was labeled teacher salary change ratio. This variable did not appear as a significant factor in any equation. Evidently, the rate at which teacher salaries were raised by districts in Iowa during this time was not important to a combination of dollars expended per unit of growth.

Four variables called staff characteristics were included in the analyses presented in Tables 4-3 and 4-5. Teacher training level (X_8), tenure (X_9) and age (X_{10}) were included along with principal tenure (X_{11}).

Teacher training level (X_8) was found to be very much related to efficiency. X_8 was found to be significantly related to Y_1 in every equation in which it was included. It was positively correlated with Y_1, which meant that districts with teachers whose mean training levels were lowest were the most efficient. A very interesting question might be posed as a result of this finding. Is it possible that an optimum level of training might be found that would maximize efficiency? Schools have offered teachers salary incentives to obtain more training for several years now. However, it appears that the output per dollar of input measure used in this study would dictate a quite different approach to teacher salaries.

Currently, lower salaries are paid to teachers with only a BA degree than to those with an MA. Usually, salary schedules contain one or two "steps" such as BA + 15 hours of university credit or BA + 30 hours of credit between the BA pay scale and the MA scale. Theoretically it has been argued, the more training the teacher has, the better the students will learn.

If the above statement were true, it would seem that the results of this analysis should have been the reverse of what was found. More teacher training should have improved learning growth among pupils which would have offset the higher salary expenditures required for such training. Obviously, among the 375 Iowa schools studied here, this was not the case.

The results for each equation reported in Table 4-3 show teacher training level positively related to Y_1. The bold suggestion follows that boards of education might do well to base salary increases on something other than acquisition of more college credit by teachers if they wish to be "efficient" in producing achievement growth.

Staff tenure (X_9) had little apparent effect on the results of this study. It was not a significant factor in the prediction of efficiency. This was a mild surprise because salary schedules are based on an experience factor for upward movement and it was expected this fact might cause districts with a long-tenured teaching corps to be less efficient as defined herein. Apparently, teacher training level is more of a factor and overshadows experience in this analysis.

X_{10}, teacher age, was not found to be significant where efficiency was considered, but was significant to Y_2, achievement growth. Apparently, age and tenure were not highly related and neither were of much significance where efficiency was concerned. Teacher age was found to be a significant factor in Equation II_2 and Equation VI_2 of Table 4-5. It was also an important factor in Equation XI_2. The relationship was a negative one in all cases, indicating that, in the districts studied, as teacher age increased, achievement growth for pupils decreased.

The above statements give rise to some interesting questions, but because the amount of variance explained (R^2) is so small in these equations no conclusions can be drawn. As found by Skaggs (42) and Cohn (13), the apparent negative relationship of teacher age and pupil achievement prompts questions such as whether a cause and effect relationship exists. Are older teachers less well trained, or do they have higher training levels? Do these factors contribute to changes in pupil learning? It is suggested that further research into this apparent discrepancy between theory and practice might be fruitful. Currently, rationale for teacher salary schedules recognizing time on the job as worthy of additional wages is based on the assumption that a teacher does better at helping pupils learn as the teacher becomes more experienced.

Average principal tenure was related to achievement in some studies reviewed and included here as a result. Represented by X_{11} in the equations presented, principal tenure was not a factor of any consequence where efficiency or growth were concerned.

X_{12} and X_{13}, which dealt with income per pupil, were probably the most disappointing observations produced. In studies of pupil achievement, socio-economic variables such as income were very important. It was postulated that this variable would lead to some definitive relationships between cost per unit of growth and relative wealth, but did not affect the results of this study.

The data was laboriously gathered and included as a variable called income per pupil. It was speculated that richer districts might tend to spend more on education. If this happened, a corresponding rise in learning growth among pupils also occurred which offset any negative effect this might have had on efficiency.

Average fathers' occupational level (X_{14}) and average father's educational level were a bit more explanatory and significant to the predictive equations shown in Chapter IV than were income levels. These community characteristics were both significant in Equation VIII where 90 larger schools were measured for efficiency. The amount of variance explained by each was quite small in each instance. X_{14} and X_{15} were probably more important in larger districts because the differences among Iowa communities of this size were greater. The other 285 schools were so rural in character as to differ only slightly in educational and occupational levels.

Assessed valuation, (X_6) produced an unexpected result in the group of equations measuring the effects of independent variables on achievement growth (Y_2). It was originally included because assessed valuation is a measure of relative wealth and it was believed would have an effect on school district spending as it affected efficiency. It did bear out the logic of such reasoning. However, X_6 seemed also to be much related to achievement growth. In most equations measuring Y_2, assessed valuation was found to be a significant predictor.

It can only be conjectured as to why the above results occurred. Apparently, in more wealthy districts, the "quality" of education was higher if measured by pupil achievement growth. It could be suggested that districts with more tax dollars available were able to provide better teachers and more materials leading to improved pupil performance.

Pupil teacher ratio (X_3), was not significant, but was related in a positive way to achievement growth. This finding was in sharp contrast to generally accepted beliefs among educators that smaller pupil-teacher ratios would lead to better pupil achievement. In Equation X_2 and XI_2, which measured districts with relatively high occupational and educational levels respectively, high pupil teacher ratios were significantly related to higher achievement growth. The question might be pursued in later research as to whether socio-economic characteristics of districts might affect the way higher pupil teacher ratios contribute to more achievement growth.

It seems important to discuss briefly and finally the findings of Equation VIII. The variables selected for inclusion seemed to be among the most important contributors to efficiency for this group of 90 larger school districts. It was quite predictive and explanatory of the variance among schools in this category. The results among these districts suggests that wherever more than 750 pupils were enrolled in the elementary schools in Iowa, a prediction equation such as this one would be helpful in determining whether it might be "efficient" as defined in this study.

The finding of a group of schools for which a regression analysis could be applied to demonstrate likely outcomes in terms of efficient production of pupil achievement growth appears to be a first in Iowa. It could prove to be a stepping stone to more definitive work by future researchers in this field.

The goal of elementary schools is not only to be efficient of course, but to help pupils learn the basic skills as completely as possible. To do this, a certain amount of financial resources are necessary for materials, facilities and personnel. Financial resources are finite. Schools may not act as though dollars are unlimited. Trade-offs are inevitable in this case. Maximizing learning is not possible with limited resources. A balance of learning growth at a reasonable cost is sought.

Analysis of districts across Iowa using a criterion variable called efficiency defined as cost per unit of growth was found to be predictive only in schools with 750 or more elementary pupils enrolled. Smaller districts cannot be compared using the equations shown in Chapter IV with the same degree of confidence. In larger schools it appears that the smaller among them with higher pupil teacher ratios, lower teacher training levels, and higher educational and occupational levels are producing the most pupil achievement growth per dollar of educational expenditure. In other words, a school in Iowa meeting the above criteria would be classified as among the most efficient districts in the state.

As budget dollars become more difficult to come by, administrators and boards of education must find ways to maximize learning with fewer dollars. Striving to match the above characteristics as much as possible may be part of the answer to tight money problems.

Suggestions for Further Research

This study was concerned with predicting efficiency and was not overly successful in demonstrating a relationship of efficiency to size. There were indications that a non-linear relationship might exist between size and efficiency. Further research should attempt to determine the true nature of this relationship. The objective of such investigation would be to determine an optimum elementary enrollment level associated with efficiency as defined in this study.

Further investigation of the contribution to efficiency of teacher age and training should be conducted. It appeared that efficiency declined as teacher training level increased.

Data on a more limited number of schools including a more complete breakdown of costs associated with elementary instruction might yield better results in terms of explaining the differences among smaller Iowa schools. A sampling technique might be used and more complete data collected for each school included in the sample.

More states should encourage comparisons of schools on an input-output basis such as cost per unit of growth produced. Cost per pupil is not really indicative of the results of educational effort.

Future research should be directed to defining operations done internally within school systems to affect learning outcome efficiency which would have economic consequences. Many of the characteristics found significant in the study reported herein were not inputs which could be changed by boards of education or administrators. Obviously, much of the unaccounted for variance would be the result of decisions made and actions taken which weren't included in this study. Some method of quantification of these decisions and actions might yield results which would allow real predictability models to be utilized for planning and decision-making on a local basis.

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