DOCUMENT RESUME

ED 137 034 RC 009 812

AUTHOR	Sadler, Ronald A.; Ching, C. T. K.
TITLE	Determinants of Educational Quality in Nevada. Nevada Agricultural Experiment Station Bulletin, B-32, February 1974.
INSTITUTION	Nevada Univ., Reno. Agricultural Experiment Station.
SPONS AGENCY	Department of Agriculture, Washington, D.C.
PUB DATE	Feb 74
NOTE	29p.
EDRS PRICE	MF-$0.83 HC-$2.06 Plus Postage.
DESCRIPTORS	Academic Achievement; Correlation; Economic Status; *Educational Quality; *Expenditure Per Student; Rural Areas; *Rural Urban Differences; *School Districts; *Student Teacher Ratio; *Teacher Education; Test Results
IDENTIFIERS	ACT; American College Test; *Nevada; Regional Differences

ABSTRACT

The composite American College Test (ACT) scores of 7,928 Nevada students (University of Nevada Office of Counseling and Testing data for the years 1968, 1970, 1971, and 1972) were used as a measure of district educational quality to investigate the relationships between educational quality and various factors hypothesized to have an effect upon quality. Specifically, the relationships between educational quality and district wealth, teacher training, rural-urban characteristics of school districts, instruction costs per student, and student-teacher ratios were investigated. A statistical model with educational quality as the dependent variable was formulated and estimated by least squares. Major findings were: a significant positive relationship between educational quality and amount of teacher training; differences in the educational quality of rural, urban, and remote school district (rural schools had higher levels of educational quality than either urban or remote school districts); positive relationship between educational quality and the amount of money expended per student on classroom instruction; a negative relationship between educational quality and high student-teacher ratios. It was concluded that ACT scores do not measure all aspects of educational quality. (JC)

ACKNOWLEDGMENTS

The authors wish to thank Jack B. Selbig, Director, Office of Counseling and Testing, who, with his cooperation and assistance, made this study possible. Thanks is also extended to Dr. Edwin S. Dodson, College of Education, for his helpful insight and constructive criticism. Of course, any errors in presentation of facts or interpretation are the sole responsibility of the authors.

SUMMARY

This study utilizes ACT test scores as a measure of educational quality in Nevada school districts and analyzes the effects of various factors which are hypothesized to have an effect on quality. Specifically, relationships between educational quality and district wealth, teacher training, rural-urban characteristics of school districts, instruction costs per student, and student-teacher ratios were investigated. A statistical model with educational quality as the dependent variable was formulated and estimated by least squares.

Major findings are: First, results indicate a significant positive relationship between wealth of a district and quality of education achieved by that district. This finding might suggest a more centralized form of financing to those educators and administrators who feel that the quality of a child's education should be less dependent on the wealth of his family and neighbors. Second, results indicate a positive relationship between educational quality and amount of teacher training received by teachers. Results further indicate that upgrading teacher training requirements may be one of the more efficient ways to increase educational quality in Nevada school districts.

Third, results indicate a difference in educational quality between rural school districts and urban or remote school districts. Rural school districts achieve a significantly higher level of educational quality than either urban or remote rural school districts. Fourth, results indicate that educational quality is related to the amount expended per student on classroom instruction. Fifth, results indicate that educational quality declines once a certain student-teacher ratio is exceeded.

Throughout the study, it was apparent that ACT scores do not measure all aspects of educational quality. While ACT test results do reflect the quality of academic or college preparatory programs in Nevada school districts, they do not measure such items as the social development of students or the availability of vocational training opportunities and vocational student progress. A challenge exists for educators to develop more comprehensive measures of educational quality to facilitate the evaluation of relative strengths and weaknesses inherent in the educational programs of Nevada school districts.

DETERMINANTS OF EDUCATIONAL QUALITY IN NEVADA

By

Ronald A. Sadler and C.T.K. Ching[†]

I. Introduction

Educational quality is of increasing concern to large segments of our society. Most people find educational quality difficult to define explicitly, but, at the same time, want and expect quality education for their children. With increasing enrollments and inflation necessitating higher educational expenditures, taxpayers should receive the best return for each dollar. State legislators also need to be assured that state monies are buying a quality educational program, especially when state support to education is increased. Likewise, the Federal government should be able to justify the flow of its money into the educational process.

A. Basic Measures of Educational Quality

Society's concern with educational quality has resulted in numerous studies which define educational quality, identify the characteristics of educational quality, and detect and measure the presence of quality in the educational system. Most statistical investigations concerned with educational quality and its make up have adopted one of three basic approaches[1].

1. The use of some sort of accreditation developed by the State or the researchers themselves. Essentially, accreditation is a method of evaluating the effectiveness and quality of schools or school districts according to certain developed standards. These standards may vary somewhat, but they generally encompass such items as teacher, administrator, and staff qualifications; diversity and breadth of curricular offerings; adequacy of the school plant; availability of laboratory or training facilities; vocational offerings; and, student-teacher ratios.

[†]Graduate Research Assistant and Associate Professor, Division of Agricultural and Resource Economics, University of Nevada, Reno.

[1]See for example, White (1972), Voelker and Ostensen (1970), Rand Corporation (1971).

This approach is indirect and assumes that the output (educational quality) of schools corresponds to the quality of the inputs. Such a system categorizes schools or school districts according to the adequacy of those factors which a consensus of educators feels to be desirable and necessary for a quality education. While an accreditation system does give recognition to many of the components of a quality education, it seems that the effectiveness of such inputs would be best tested by performance evaluations of the outputs (student progress and achievement) rather than the inputs themselves.

2. Another indirect approach uses some type of cost per pupil comparison, assuming that larger expenditures for educational inputs will purchase higher quality inputs. Instructional costs per student rather than total per student costs are usually conceded to be the best cost figure to utilize in studies of this sort. However, a difficulty often arises if no recognition is given to the possible existence of economies of scale - i.e., unit costs may not be indicative of quality. A large school may be able to provide the same quality of education at a lower per student cost than a small school. Teachers and facilities are used more efficiently, administrative overhead and maintenance costs are distributed over a broader base, and overall efficiency is probably higher in large schools.

3. The third approach uses achievement scores to measure the quality of educational output (student performance and achievement) directly. This approach assumes that the quality of educational inputs will be reflected by achievement. Researchers are then able to evaluate the effectiveness (quality) of various educational inputs and perhaps isolate specific socio-economic factors or other district characteristics which affect achievement. One criticism of this approach is that achievements tests are oriented toward white middle class students and might reflect a socio-economic bias. While this may be true to some extent, the authors feel this is the most relevant approach for this study.

B. Educational Quality - As Used in This Study

For this study, the definition of educational quality is restricted to one which readily applies at the district level. In this perspective, a practical definition of educational quality would be how well a school district accomplishes those goals it considers important. A well organized school district will have numerous goals and objectives which are explicitly recognized. However, one goal that most school districts have in common is the adequate preparation of students for college. This is not to imply that all students can or should go to college, but it does mean that students with the ability and motivation to continue academic studies should be properly prepared.

An objective evaluation of how well a district meets its commitment to college preparation necessarily involves the measurement of student ability and achievement at or near completion of high school. Currently the only standardized test of this nature for which statewide results are readily available is the American College Testing Program (ACT) test.

ACT scores must be filed with the University of Nevada before an applicant can be enrolled as a regular student. This requirement enabled the authors to acquire achievement scores of prospective students from all Nevada school districts.[2] These tests measure ability and achievement in four areas - English, mathematics, social sciences, and natural sciences. Individual scores, indicating student achievement in each category, and composite scores, indicating overall performance, are recorded for each student. The sample scores compiled for this study came from the University of Nevada Office of Counseling and Testing at Reno. A total of 7,928 individual observations were collected for 1968, 1970, 1971, and 1972. (Observations for 1969 were available but could not be incorporated due to a change in student supplied information for that specific year, i.e., it was not possible to determine the school district from which the student originated in that year.) ACT scores are a good indicator of college performance; however, there is a possible shortcoming in the use of these ACT scores as an indicator of educational quality within Nevada school districts. The University of Nevada would not necessarily receive ACT scores from those students considering attendance at out-of-state colleges and universities. Despite some possible bias of this sort, ACT scores are currently the best available indicator of educational quality in Nevada.

C. Objectives of This Report

This study uses composite ACT test scores[3] as a measure of district educational quality and investigates the relationship between quality and a number of factors which are likely to have a detectable influence on this quality.

The specific objectives of this report are to suggest answers to these questions concerning quality (represented by ACT test scores) in Nevada school districts.

1. Does the individual wealth of a school district influence the quality of education within Nevada school districts?

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[2]In Nevada, school districts have the same geographic boundaries as counties.

[3]Technically, the ACT test scores were converted to percentiles for comparative purposes. Thus, if a student had an ACT score of 60, it would indicate that he scored better than 60 percent of all students tested (based on national averages).

2. What effects do educational inputs such as teacher salaries, teacher training, and teacher experience have on educational quality in Nevada school districts?

3. Do locational differences (rural, urban, remote rural) have a detectable effect on educational quality in Nevada school districts?

4. Does the size of a school district or the size of high schools within that district have an influence on the educational quality of school districts in Nevada?

5. Has there been a significant change over time in educational quality (test score results) in Nevada school districts?

6. Does the educational level of adult residents have a discernable effect on educational quality in Nevada school districts?

7. Are per pupil expenditures related to educational quality in Nevada school districts?

8. What is the effect of classrom size (student-teacher ratio) on educational quality in Nevada school districts?

In summary, this study endeavors to identify those factors which have a statistically detectable influence on the educational quality of Nevada school districts. The authors are specifically measuring the quality of college preparatory training within districts and they believe that composite ACT test scores are currently the best available indicator of such quality. Identification and analysis of those variables which influence quality will be achieved through the formulation and estimation of a linear statistical (regression) model. A description of specific procedures follows.

II. Procedure

To test the relationships between educational quality and its determinants, the following model was formulated:

(1) $Y = f(X_1, X_2, \ldots, X_8)$

Where: Y = educational quality of the district

X_1 = wealth of the district

X_2 = quality of the educational inputs in the district

X_3 = rural-urban character of the district

X_4 = size of the district

X_5 = specific year of observation (trend)

X_6 = socio-economic characteristics (educational level) of the residents in the district

X_7 = instruction-related expenditures of the district

X_8 = intensity of instruction within the district

A. Discussion of Variables

The dependent variable (Y) in this study is defined as the average composite ACT score of the district. In other words, for each year ACT scores of all students in the district taking the ACT test are added together and divided by the number of students taking the test. ACT scores for 1968, 1970, 1971, and 1972 were available at the Office of Counseling and Testing, University of Nevada, Reno. This office receives ACT score results from Nevada high schools and also administers tests to students who wish to attend the University but have not taken an ACT test previously. These ACT scores are assumed to be indicative of educational quality on a district basis.

Community wealth (X_1) was defined as the total assessed value of property in the school district divided by the number of students in average daily attendance (Nevada Tax Commission). A positive coefficient is expected for this variable, reflecting a direct relationship between a school district's educational quality and the community's ability to support the school system.

Quality of educational inputs (X_2) is measured by a pair of variables which would logically be expected to reflect instructional input quality. This set included average years of teaching experience and average years of teacher training. Both of these figures were compiled on a county school district basis. The coefficients of both of these input quality variables are expected to be positive indicating that high quality education requires highly qualified teachers.

The rural-urban character of the school district (X_3) is included to account for educational quality differences between urban, rural, and remote rural school districts. This classification of school districts directly follows the scheme used in the Governor's Report of 1972 (Davis et.al., 1972). More precisely, rural-urban character is measured not by a single variable but by a set of zero-one variables (dummy variables). The first variable in this set, for example, would correspond to urban school districts and if a particular observation consisted of an urban school district, it would be coded as a one and zero if otherwise.

Similarly, the second variable in the set would correspond to rural districts and if a particular observation corresponded to a rural district, this variable would be coded one and zero if otherwise. Finally, the third variable in the set would correspond to remote rural districts and if a particular observation corresponded to a remote rural district, this variable would be coded one and zero if otherwise. A positive coefficient is expected for the urban variable and negative coefficients for the rural and remote rural variables. These expectations are based on the belief that urban districts are able to provide greater course diversity, more specialization, better facilities, and hire more experienced teachers than those in rural and remote rural areas.

Since there is a statistical problem involved in using these zero-one variables (rank condition), a more specific discussion of how the coefficients to these variables should be interpreted is left for a section in which the results of the statistical analysis are presented.

School district size (X_4) was defined as the number of students in average daily attendance (State of Nevada, Department of Education). The number of students in ADA was used rather than the number of students enrolled since the former figure more nearly reflects actual attendance. A positive coefficient for this variable is expected - i.e., quality of education should increase with an increase in district size. Again, this is possible mainly because larger districts are able to provide a wider range of curricular offerings.

Time (X_5) will be incorporated into the analysis to measure changes in educational quality over the 1968-1972 period. As in the case of measuring rural-urban character, time is measured not by a single variable but by a set of four zero-one variables. Note that there are only four trend variables since the observations of ACT scores could not be used for the 1969 academic year. The authors are optimists and expect the signs of these coefficients to be positive, reflecting increasing educational quality in Nevada over time.

Socio-economic characteristics (X_6) are measures of the level of education achieved by residents of the district. More specifically, the education level was defined as the median number of school years completed by males 25 years of age and over in each school district (United States Bureau of Census, Census of the Population, 1970). An alternative measure of the social characteristics of the school district with respect to educational level would be the proportion of the population of the district that has completed high school (United States Bureau of Census, Census of Population, 1970). Both measures of education level will be considered individually in the statistical analysis below. A positive coefficient is expected, reflecting the hypothesis that districts with a high level of formal education are more conducive to a high level of educational quality than districts with lower levels of formal education. Districts with a high level of formal education may provide a better environment for quality education.

Instruction-related expenditures of the school district (X_7) are defined as total expenditures specifically related to the instructional process divided by the number of students in ADA. Instructional expenditures rather than the total expenditures of the school district are used since they appear to be more relevant to educational quality than total expenditures which would include fixed charges and other expenses of a noninstructional nature. A positive sign for this coefficient is expected. In other words, the authors hypothesize that districts exhibiting a high level of educational quality are also likely to exhibit a high level of instructional costs per student in average daily attendance.

Intensity of instruction in the district (X_8) is defined as the ratio of students to teachers. As noted above, educational quality is measured by ACT scores in this particular study. The ACT score is primarily high school student oriented and as such is consistent with the authors' attempt to use information which related to high schools of the district rather than the entire district. Accordingly, intensity of instruction is defined as the ratio of high school students in average daily attendance to the number of high school teachers. A negative coefficient is expected, reflecting the hypothesis that a high student-teacher ratio is not conducive to or consistent with a high level of educational quality.

B. Statistical Procedures

The suggested model of educational quality and its determinants, equation (1), has been stated generally because linear as well as nonlinear forms of this equation were considered in the statistical analysis. Although a linear form of the equation is perhaps the simplest form, past experience has indicated that nonlinear forms, especially logarithmic transformation, result in better fits and more reliable coefficients[4]. In either case, however, the method of least squares was used to estimate the coefficients of the variables contained in equation (1).

Data for the variables in equation (1) were available for fiscal years 1968, 1970, 1971, and 1972. Using these data, least squares estimates of the parameters corresponding to the variables in equation (1) were computed. These estimates, under assumptions of both linear and nonlinear functional forms, are presented in Appendix Tables 1 and 2. Generally, these estimates indicate low statistical reliability, low proportions of the variance in the dependent variable explained by regression, and unreasonable signs for some of the statistically reliable coefficients. In particular, the trend variables (X_5) were found to be statistically insignificant. This suggests that when other independent variables in the equation are held constant, educational quality has been invariant over time. Thus, the trend variables were deleted from the analysis and the data base was reduced to one which was strictly cross-sectional.

[4] See, Ching and Detering (1973).

In estimating parameters for the cross-sectional model, observations for Esmeralda County were deleted for two reasons. First, only six ACT test results were available for the four years under study. Consequently, the authors could not put much confidence in a district average computed from so few observations. Second, Esmeralda County has no high school and all secondary students are bussed to Nye County. Thus, the ACT test scores obtained would not be indicative of educational quality within the Esmeralda School District. The cross-sectional model thus refers to the remaining 16 school districts in Nevada. A summary of estimated parameters for cross-sectional model is presented in Appendix Table 4.

The high intercorrelations among some of the independent variables suggest that some independent variables be deleted from the analysis (see correlation matrix in Appendix Table 3). For example, the variables total ADA and student-teacher ratio have a correlation coefficient of .86. Thus, one of these variables could be deleted from the analysis to improve the statistical reliability of the remaining variables. The end results of this deleting procedure, which in the judgment of the authors best describes the relationship between educational quality and some of its determinants, are presented in the following section. Accordingly, best in the context used here involves statistical reliability as well as reasonableness of interpretation.

III. Results

A. Model Selected for Analysis

The model which best describes the relationship between educational quality and its determinants is:

$$(2) \quad Y = e^{-16.095} \underset{(0.057)}{X_1^{0.238}} \underset{(1.747)}{X_2^{3.978}} \underset{(0.068)}{X_3^{0.217}} \underset{(0.088)}{X_{3'}^{-0.012}} \underset{(0.292)}{X_7^{0.598}} \underset{(0.246)}{X_8^{0.849}}$$

$R^2 = 0.88$ $\qquad F = 10.98$

$\bar{R}^2 = 0.80$

where: Y = ACT score of the district

X_1 = community wealth

X_2 = quality of educational input (average years of training of teaching faculty)

X_3 = zero-one variable corresponding to rural districts

$X_{3'}$ = zero-one variable corresponding to remote rural districts

X_7 = instructional cost per student in the district

X_8 = student-teacher ratio in high schools

e = irrational number equal to 2.71828 (base of natural logarithms)

Figures in parentheses are standard errors of the regression coefficients. This equation which is linear in logarithms indicates that approximately 88 percent of the variation in educational quality has been explained by variations in the independent variables included in the equation. However, the R^2 is a somewhat misleading measure of the goodness of fit when there are a limited number of observations relative to the number of coefficients to be estimated. Therefore, a corrected coefficient of determination ($\bar{R}^2$) has been calculated to provide a more realistic indication of the proportion of the variation of Y explained by the independent variables.[5] Accordingly, when the limited number of observations is explicitly considered, about 80 percent of the variation in ACT scores have been explained by regression.

The coefficients of the variables wealth of the community (X_1), teacher training (X_2), and the student-teacher ratio (X_8) are statistically reliable at the one percent level of confidence. Instructional costs (X_7), however, are significant at the 10 percent confidence level. Finally, the coefficient of the zero-one variable corresponding to remote rural districts (X_3,) is not statistically reliable at an acceptable level of confidence.

Most importantly, signs of these coefficients are generally consistent with prior expectations and lead to seemingly logical interpretations:

1. Wealth of the community: the coefficient (exponent) of community wealth is 0.238. Given this particular functional form (linear in logarithms) and the cross-sectional nature of the data, the coefficient may be interpreted as a percentage change in ACT scores related to a one percent change (difference) in community wealth. More specifically, a ten percent change in community wealth was related to a 2.38 percent change in ACT scores. The coefficient is a partial regression coefficient in the sense that is is assumed all other variables in the equation are held constant.

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[5] $\bar{R}^2 = R^2 - \frac{K}{T-K-1}(1 - R^2)$

where: T = the number of observations
K = the number of regressors

2. Average years of training of teaching faculty: the coefficient of this educational quality input variable is 3.978. This particular variable has an interpretation similar to the wealth of the community variable just discussed. A one percent increase in the average years training of teaching faculty was related to a 3.98 percent increase in the ACT score of the district. Thus, this particular coefficient indicates that if the input to education is of a higher quality, then the output of the educational system, as measured by ACT scores, would be higher.

3. Zero-one variables corresponding to rural districts and remote rural districts: these zero-one variables must be interpreted together rather than separately. As noted in the section "Discussion of Variables," there are actually three zero-one variables used to measure the impact of urban, rural and remote rural locations on educational quality. In order to satisfy the rank requirement of the least squares model, however, it is necessary to delete one of these variables and interpret the coefficients of the remaining two in terms of the variable deleted. In this case, the variable deleted is the zero-one variable corresponding to urban districts. Thus, the coefficients to X_3 and X_3, must be interpreted relative to the urban areas.

The coefficient of the zero-one variable corresponding to rural districts is 0.217. A technical explanation of how these coefficients can be interpreted is noted in the Appendix. This particular coefficient indicates that rural districts, holding all other variables constant, have ACT scores which averaged 24 percent greater than urban districts. Similarly, the coefficient of the zero-one variable corresponding to remote rural districts indicates that ACT scores in remote rural districts are approximately one percent lower than ACT scores of districts in urban areas. However, it should be noted that the coefficient of the zero-one variable corresponding to remote rural districts is not statistically reliable. This simply means that its standard deviation is considerably larger than the coefficient itself. Thus, the coefficient of the zero-one variable corresponding to rural districts indicate that rural districts have a higher educational quality level than urban districts. Remote rural and urban districts are statistically indistinguishable with respect to educational quality.

4. Instructional costs per student: the coefficient of the instructional cost variable (X_7) indicates that a ten percent increase in instruction costs was related to a six percent increase in ACT scores. Simply interpreted, this indicates that higher expenditures, holding all other independent variables constant, are directly related to higher levels of educational quality.

5. Student-teacher ratio in high schools: the coefficient of the student-teacher ratio (X_8) is 0.849. The sign of the coefficient is positive and casual observation might lead one to conclude that increasing student-teacher ratios will necessarily increase achievement scores. The authors consider this an unreasonable interpretation which requires qualification for two reasons. First, the range of class sizes observed is rather narrow -- ranging from about 12 students per class to a high of about 30 per class (on the average) per district. We feel that within this rather restricted range of classroom sizes it is quite possible for educational quality to be increasing. All this really indicates is that class sizes are not large enough for the negative effects of overcrowding to become apparent. Second, there is a mathematical shortcoming in the functional form assumed in the estimating procedure. The logarithmic transformation fits the data well, but the nature of a logarithmic function precludes a relationship which is positive over a certain range from becoming negative. A logarithmic curve can be nearly horizontal at its upper limits, but can never slope downward. Further inquiry into the nature of student-teacher ratios led the authors to an additional functional form for an alternative explanation.

It was hypothesized that student-teacher ratios would be positively sloped over a certain range and negatively sloped after a certain "optimal" class size was reached. Accordingly, the authors investigated the statistical properties of a polynomial model to test this hypothesis. The polynomial function which gave the best results with respect to statistical reliability has assessed valuation (X_2), the student-teacher ratio (X_8), and the student-teacher ratio squared (X_8^2) as independent variables. Least squares estimates of the coefficients are:

$$Y = -86.115 + .0004X_2 + 10.307X_8 - .194X_8^2$$

$$(.0001) \quad (2.590) \quad (.056)$$

$$\text{and } R^2 = .710 \qquad F = 9.81$$

$$\bar{R}^2 = .638$$

The coefficients of assessed valuation (X_2), student-teacher ratio (X_8) and student-teacher ratio squared (X_8^2) are all reliable at the one percent level of confidence. In terms of overall statistical reliability and reasonableness of interpretation, the logarithmic model previously discussed gives the best results. However, the impact of the student-teacher ratio on quality is best explained in the polynomial model. Holding all other variables constant, educational quality (ACT scores) increases up to an "optimal" class size of about 27 students per teacher (see Figure 1). Quality declines with higher ratios,

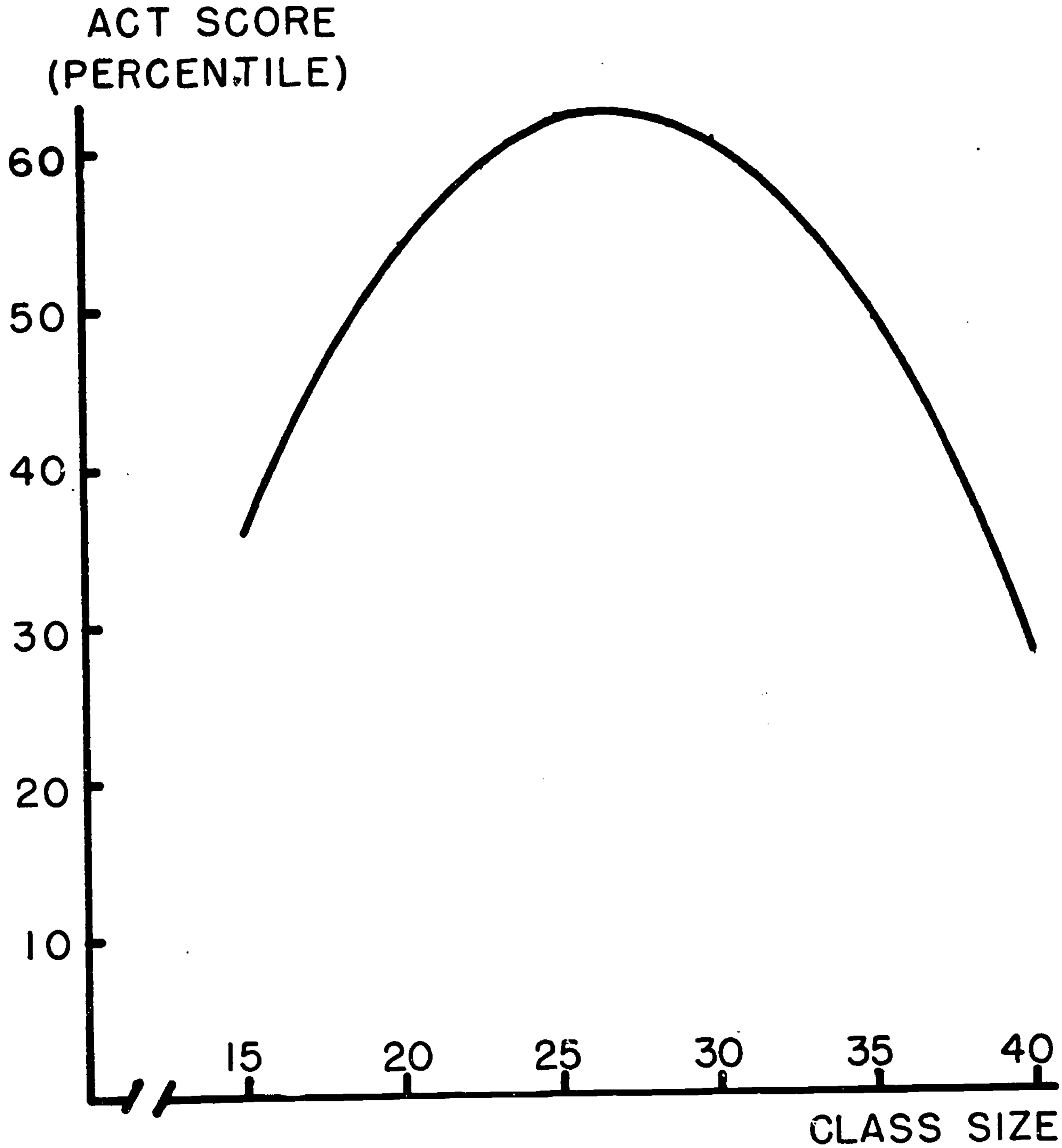

FIGURE I. STUDENT ACHIEVEMENT RELATED TO CLASS SIZE (NUMBER OF STUDENTS PER TEACHER) probably as a consequence of less individual student attention by the teacher. Accordingly, the authors feel that the student-teacher ratio coefficient in equation (2) must be interpreted with these qualifications in mind. In other words, quality appears to increase as student-teacher ratios increase. However, after a certain point (about 27 students per teacher), quality declines.

IV. Conclusions

A. Objectives and Purpose

This study uses achievement tests administered near the completion of high school as a measure of educational quality. Specifically, the authors attempted to identify factors which have a detectable influence on educational quality (achievement results) in Nevada school districts. Identification and analysis of these factors were achieved by the formulation and estimation of linear statistical (regression) models.

B. Findings and Implications

The statistical results presented above have implications for educational administrators and planners in Nevada. First, results show a positive relationship between community wealth and the quality of its education. This relationship, if it is true, and it appears to be so from the results presented above, has implications with regard to financing education. In particular, this relationship recalls the Serrano vs. Priest decision of the California Supreme Court. This court ruled that funding education on the basis of a real property tax is unconstitutional because it makes the quality of a child's education dependent upon the wealth of his parents and neighbors. As such it violates the Fourteenth Amendment (Equal Protection Under the Law).

Since then the United States Supreme Court has overturned a similar case in Texas (Rodriguez et. al. vs. San Antonio). However, this does not preclude states from adopting legislation which prescribes equal educational opportunity as long as the Fourteenth Amendment is not used for justification. For Nevada this relationship suggests that if a higher and more equitable level of educational quality is desired by its people, then a more centralized form of financing education (recognizing that Nevada is already far along with respect to centralized financing) deserves intensive study.

Second, results indicate a positive relationship between educational quality and the years of teacher training. As such, this can have significant policy implications with regard to educational quality. Most obvious is that if a high level of educational quality is desired, then efforts should be taken to increase or improve training received by the teaching faculty. Of special interest is the magnitude displayed by the coefficient of the years of training variable (3.978). This coefficient suggests that a one percent increase in the years of training received by the teaching faculty was associated with a nearly four fold increase in ACT scores. Accordingly, programs designed to improve the training of teaching personnel may be one of the more efficient ways to increase educational quality (at least for college preparation) in Nevada school districts.

Third, results indicate a disparity in educational quality among urban, rural and remote rural school districts. However, contrary to what some might hypothesize *a priori*, urban school districts do not display higher quality than rural school districts or remote rural school districts. On the contrary, results indicate that rural school districts exhibit considerably higher quality of education than do urban and remote rural districts. Also, there is no statistical distinction between quality in urban and remote urban districts. One possible reason for this latter result is that remote rural districts simply do not have the resources or educational demand to warrant a breadth of curricula sufficient to generate a high level of educational quality; while urban districts may be plagued with overcrowding or other problems typical of high population density areas. Another possibility is that urban schools have placed more emphasis on social problems (e.g., sex and drug education) whereas rural and remote rural districts still incorporate a more traditional approach to education and place greater emphasis on cognitive learning and achievement (the three R's).

Fourth, results indicate that educational quality is related to the amount expended per student on classroom instruction. Thus, there seems to be some support for individuals who feel that increased expenditures are necessary to improve educational quality. The magnitude of the coefficient to this variable, however, indicates a less than proportionate increase in achievement as costs increase, e.g., a ten percent increase in costs was related to a six percent increase in achievement. Moreover, the relationship between cost and educational quality must be tempered somewhat by the fact that this coefficient is statistically reliable at only the ten percent confidence level.

Fifth, results indicate that educational quality will decline when a certain student-teacher ratio is exceeded. While the authors cannot determine what class size is appropriate for specific courses or individual teachers, there is some indication that educational quality begins to decline after about 27 students per teacher. This would put the upper limit on recommended class size around 30 students per teacher. Additional investigation in this area would be necessary to determine those courses which could be effectively taught using higher student-teacher ratios and those courses which necessitated smaller student-teacher ratios.

Other relationships investigated yielded inconclusive results. For instance, no reliable relationship could be shown between sizes of school districts or high schools and educational quality. Attempts made to identify significant social characteristics affecting educational quality were also inconclusive. Additionally, trend analysis of achievement scores did not disclose any significant changes in educational quality in Nevada school districts during the five year period observed in this study. Additionally, when teacher salaries, instructional costs, and all variables other than time were held constant, no significant changes in educational quality could be detected in Nevada school districts for the 5-year period observed in this study.

A-1. ZERO-ONE VARIABLES UNDER LOGARITHMIC TRANSFORMATION

In order to use zero-one variables under logarithmic transformation, a prior transformation of variables was necessary — zeros were set equal to ones; and, ones were set equal to "e" or 2.71828. Then, under logarithmic transformation, the zero-one status of the time variables was preserved. Because of the transformation, interpretation is somewhat different than the usual zero-one variable interpretation. Consider, for example, the coefficients of the time variables in equation (1) of Appendix Table 1. The coefficients for 1970, 1971, and 1972 are all relative to 1968. Accordingly, to evaluate the effect of 1970 on educational quality, set the value of the variable corresponding to 1970 equal to 2.71828 and evaluate the term $(2.71828)^{-4.044}$ since -4.044 is the coefficient for 1970. Using natural logarithms to evaluate this term reduces to finding the anti-log of -4.044, which is approximately 0.01. If this coefficient were reliable, it would indicate that in 1970, educational quality was 99 percent lower than in 1968. This coefficient, however, was not statistically reliable.

A-2. DEFINITION OF SPECIFIC VARIABLES PRESENTED IN CORRELATION MATRIX TABLES (TABLES 3 AND 4)

Z_1 = Instruction Costs Per Student (Total Instruction Costs divided by Total ADA)

Z_2 = Assessed Valuation Per Student

Z_3 = District Size (Total ADA)

Z_4 = Average District ACT Scores (For each of the four years under study)

Z_5 = Median School Years of District (Males over age 25)

Z_6 = Percentage of High School Graduates in District (Males over age 25)

Z_7 = Urban Dummy

Z_8 = Rural Dummy

Z_9 = Remote Rural Dummy

Z_{10} = Average Years Teacher Experience

Z_{11} = Average Years Teacher Training

Z_{12} = 1968 Trend Variable

Z_{13} = 1970 Trend Variable

Z_{14} = 1971 Trend Variable

Z_{15} = 1972 Trend Variable

Z_{16} = Average High School Size

Z_{17} = Student-Teacher Ratio

Z_{18} = Average High School Teacher Salary

Z_{19} = Combined Average District ACT Scores (Used in Cross-Sectional Regression Analysis)

Appendix 2

TABLE 1

ESTIMATED LINEAR REGRESSION COEFFICIENTS WITH COMPOSITE ACT TEST SCORES AS DEPENDENT VARIABLE, NEVADA SCHOOL DISTRICTS, 1968, 1970, 1971, 1972[a]

General Variables Related To Educational Quality	Specific Variables Used In Analysis	Equation Number 1	2	3
Educational expenditures	Instruction costs per student	-.025 (.033)	-.054** (.021)	-.053* (.017)
Wealth of district	Assessed valuation per student	.000 (.000)	.000 (.000)	.000 (.000)
Size of district	Total ADA	.000 (.000)		
	Average high school size		-.016*** (.008)	-.015** (.007)
Social characteristics	Percent of male high school grads (over age 25)		-38.415 (40.986)	
	Median school years of male population (over age 25)	-11.841 (16.236)		
Location	Rural dummy	3.385 (11.550)		
	Remote-rural dummy	-3.676 (12.484)		
Input quality	Years of teaching experience	-.817 (.986)		
	Years of teacher training		31.765* (11.642)	30.402* (11.381)
	Average high school teacher salary	.004** (.001)	.002*** (.001)	.003** (.001)
Trend variables	1970 relative to 1968	-4.044 (5.230)		
	1971 relative to 1968	-9.801 (6.191)		
	1972 relative to 1968	-6.804 (7.781)		
Intensity of instruction	Student-teacher ratio (high school)	.485 (.613)	.461 (.587)	
Intercept		179.388	-427.960	-421.379
R^2		.464	.482	.466
F		3.969	7.963	10.821

[a]Figures in parentheses beneath the estimated regression coefficients are standard deviations of corresponding coefficients.

*Statistically reliable at one percent level of confidence.

**Statistically reliable at five percent level of confidence.

***Statistically reliable at ten percent level of confidence.

Appendix 3

TABLE 2

ESTIMATED LOGARITHMIC REGRESSION COEFFICIENTS WITH COMPOSITE ACT TEST SCORES AS DEPENDENT VARIABLE, NEVADA SCHOOL DISTRICTS, 1968, 1970, 1971, 1972[a]

General Variables Related To Educational Quality	Specific Variables Used In Analysis	Equation Number 1	2	3
Educational expenditures	Instruction costs per student	-1.230 (.786)	-.866 (.600)	-.450 (.564)
Wealth of district	Assessed valuation per student	.190 (.139)	.124 (.128)	.229*** (.115)
Size of district	Total ADA			
	Average high school size	-.026 (.175)	-.068 (.170)	
Social characteristics	Percent of male high school grads (over age 25)	-1.042 (.871)		
	Median school years of male population (over age 25)			
Location	Rural dummy	.233 (.212)	.261 (.210)	.334 (.202)
	Remote-rural dummy	.062 (.308)	.049 (.307)	.243 (.255)
Input quality	Years of teaching experience			
	Years of teacher training	15.888 (7.188)	14.195** (6.659)	11.159*** (5.853)
	Average high school teacher salary	.241** (.113)	.203*** (.103)	
Trend variables	1970 relative to 1968	-.095 (.155)		
	1971 relative to 1968	-.131 (.163)		
	1972 relative to 1968	.063 (.187)		
Intensity of instruction	Student-teacher ratio (high school average)	-.204 (.431)	-.042 (.406)	.577* (.120)
Intercept		-36.118	-32.597	-28.392
R^2		.633	.609	.583
F		7.890	11.492	14.242

[a]Figures in parentheses beneath the estimated regression coefficients are standard deviations of corresponding coefficients.

*Statistically reliable at one percent level of confidence.

**Statistically reliable at five percent level of confidence.

***Statistically reliable at ten percent level of confidence.

Appendix 4

TABLE 3

CORRELATION MATRIX OF SELECTED VARIABLES USED IN CROSS-SECTIONAL ANALYSIS

	Z_1	Z_2	Z_3	Z_5	Z_6	Z_7	Z_8	Z_9	Z_{10}	Z_{11}	Z_{16}	Z_{17}	Z_{18}	Z_{19}
Z_1	1	.66	-.77	-.23	-.28	-.31	-.53	.76	-.40	-.54	-.88	-.87	-.64	-.55
Z_2		1	-.61	.19	.19	-.18	-.45	.59	-.56	-.36	-.69	-.82	-.36	-.22
Z_3			1	.15	.17	.76	.20	-.72	.42	.64	.86	.86	.61	.50
Z_5				1	.98	.33	-.14	-.08	-.41	.24	.23	.06	.07	.09
Z_6					1	.33	-.14	-.08	-.40	.29	.23	.09	.14	.12
Z_7						1	-.38	-.29	.12	.45	.51	.45	.37	.15
Z_8							1	-.77	.35	.10	.44	.41	.30	.58
Z_9								1	-.45	-.41	-.81	-.73	-.56	-.71
Z_{10}									1	.23	.55	.57	.44	.42
Z_{11}										1	.65	.59	.05	.57
Z_{16}											1	.88	.56	.58
Z_{17}												1	.64	.58
Z_{18}													1	.31
Z_{19}														1

TABLE 4

ESTIMATED LOG COEFFICIENTS OF CROSS-SECTIONAL REGRESSION MODEL WITH COMPOSITE ACT TEST SCORES AS DEPENDENT VARIABLE, NEVADA SCHOOL DISTRICTS[a]

General Variables Related To Educational Quality	Specific Variables Used in Analysis	Equation Number 1	2	3	4	5
Educational expenditures	Instruction costs per student	.326 (.388)	-.015 (.318)	.333 (.395)	.475 (.286)	
Wealth of district	Assessed valuation per student	.301* (.075)	.305* (.052)	.231* (.060)	.287* (.063)	.220* (.061)
Size of district	Average high school size	-.014 (.064)	-.084 (.052)	-.054 (.070)		
Location	Rural dummy	.165 (.085)	.106 (.067)	.172** (.085)	.192** (.066)	.170** (.073)
	Remote-rural dummy	-.0778 (.117)	-.158 (.092)	-.072 (.118)	-.046 (.085)	-.001 (.010)
Social characteristics	Median years of education	-1.455 (2.179)				
Input quality	Years of teaching experience		.266** (.107)	.160 (.136)		.169 (.126)
	Years of teacher training	1.303 (2.736)	1.133 (1.979)	4.715** (1.980)	1.377 (2.390)	3.889** (1.930)
	Average high school teacher salary	-.953 (.641)	-1.299** (.489)		-.842 (.564)	
Intensity of instruction	Student-teacher ratio	1.095** (.310)	1.043* (.227)	.744** (.270)	1.087* (.280)	.475** (.219)
Intercept		4.334	6.549	-16.040	-1.478	-10.972
R^2		.914	.954	.901	.906	.853
F		7.086	13.937	7.928	11.018	8.721

[a] Figures in parentheses beneath the estimated regression coefficients are standard deviations of corresponding coefficients.

* Statistically reliable at one percent level of confidence.

** Statistically reliable at five percent level of confidence.

*** Statistically reliable at ten percent level of confidence.

Appendix 6

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