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ABSTRACT

The New York State Education Department conducts a Pupil Evaluation Program (PEP) in which each year all third, sixth, and ninth grade students in the state are given a series of achievement tests in reading and mathematics. The data accumulated by the department includes achievement test scores, teacher characteristics, building and curriculum data, and census data. This extensive data is organized so that analyses may be made at the building or district level. Using the data from grades three and six, a factor analytic study of the achievement data in reading and mathematics is discussed for each grade and the development of achievement criteria. Using these criteria and regression analysis, the variance among controllable and uncontrollable school characteristics is partitioned to study the independent contribution of specific variables of interest and nonlinear and interaction effects. (Author/DEP)

School Effects on Achievement[1]

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The last decade has seen a revolution in our thinking about the effectiveness of schools. Recall the optimistic euphoria in the early 1960's which led to the beginning of the Head Start program and the passage of the Elementary and Secondary Education Act of 1965. The education community eagerly and confidentially took on such major responsibilities as breaking the cycle of poverty and restoring American intellectual leadership in the world after the Russian sputnik. And seldom was head a discouraging word.

The first discouraging word came in 1966 with the publication of the Coleman Report and the disconcerting finding that no amount of reanalysis would make disappear. Home background was the major correlate of student achievement and when this was controlled schools had little additional effect.

In 1969 Arthur Jensen began an article with the statement that compensatory education had been tried and had failed. He was met with shocked disbelief and moral indignation.

In 1971 a group of five Rand Corporation researchers in an influencial review for the President's Commission on School Finance, entitled "How Effective is Schooling," concluded that no variant of the existing system has been shown to be consistently related to students' educational outcomes. They went on to point out that if all schools are equally effective but are not equally expensive, the prudent man might reach a fairly obvious conclusion.

Now on the tenth anniversary of the publication of the Coleman report one can say without anticipating much argument that individual differences in school

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achievement are due primarily to heredity or to the early home environment, so what the school does will make little difference.

Personally, I believe half of this statement. The evidence is convincing that in the United States differences in intelligence and in school achievement are determined largely by events occurring prior to the onset of formal schooling and that most of these events occur prior to birth. However, I don't think it follows from this that schools have little effect. What does follow is that the school effects are small relative to the effects of other factors, not that they are unimportant or uninteresting or of little value. If, for example, home backgrounds and genes were somehow homogenized until they produced only small individual differences, one might expect that schools would suddenly loom into view as a potent and varied source of individual differences in achievement.

The most beautiful music that comes from the radio is encoded as a relatively small signal on a powerful carrier wave. It seems probable that school effects are in a similar way superimposed as a small influence on a very large background variation, and as a result their detection and study pose very difficult research problems. At present we are at the crystal set stage and what we hear is mainly static. Step-wise multiple regression is an effective crystal which will detect the school signal from the background carrier wave, but we do not yet have a vacuum tube amplifier or effective filters for extraneous noise, and we are a long way from the superheterodyne circuit.

Before mentioning some possible amplifiers and filters let me first describe our recent crystal-set study. It is not materially different from other large school effects studies that have used the school as the unit of analysis. But perhaps the context for interpreting the results is now different. We will no longer be astonished to find school effects that are miniscule in comparison with home background effects and that are quite small relative even to the ambient noise level. This new perspective may enable us to listen more attentively for

the important message that we have every reason to believe is there.

The analyses I will describe use much of the same data discussed in this symposium by Swanson and Irvine. The Swanson analyses were done prior to those I will describe and did not have access to census data. They also included private schools as well as public schools. The Irvine analyses used the school district rather than the school building as the unit. Thus, our three papers represent somewhat different ways of looking at essentially the same data:

The School Effects Study.

The New York State Education Department conducts a Pupil Evaluation Program (PEP) in which each year all third and sixth grade students in the state are given a series of achievement tests in reading and mathematics.[2] Student scores on these tests were aggregated for school buildings, which yielded summary measures for five subtests for the two grade levels for the years 1969 through 1972. A series of factor analyses of these data, using a sample of 829 schools revealed a large general factor accounting for about 80 percent of the variance among all the variables involving mean performance. Thus, there was a very definite tendency for schools to score generally high or generally low over both grades for all four years on all five subtests. There was, thus, ample justification for combining the means for the five subtests into a single general achievement score for each grade level for the 1972 tests for use as the achievement criterion for this study.

The factor analyses also revealed smaller factors identified with such dimensions as mathematics vs. reading test content, grade level, within school variability and skewness of score distributions and temporal change over four years. We have done studies of these other characteristics of test performance

[2]The ninth grade is also included in PEP, but was not used in this study because not all ninth grade students were tested during the years studied.

in a school, but will not report them here other than to say that correlations of school characteristics with these criteria were generally much lower than for general achievement and usually were not very informative. In this study our interest is in the general achievement level of the school.

A variety of additional information was available about the schools or their district for study in relation to the achievement criterion. These variables may be considered as falling into two broad categories: 1) input variables which describe the population of students attending the school and 2) treatment variables which relate to the educational program of the school.

The input variables were obtained from three sources.

1. Reports of characteristics of the students in the school by a school official to the State Education Department's Basic Educational Data System (BEDS).

2. The geographical location of the school.

3. Data from the 1970 U.S. census concerning the school district in which the school is located. Census data have been aggregated for the 734 School districts in New York State, and data for the district was applied to all schools in that district. Although New York City is one school district, census data were aggregated separately for 31 sub-districts in that city.

The treatment variables were of three general types all obtained from the Basic Educational Data System.

1. Characteristics of the educational program of the school.

2. Characteristics of the teachers in the school, aggregated from individual reports to the State Education Department by all teachers in the state.

3. Financial resources available to the school district in which the school is located.

The specific variables available in these categories are listed in Table 1.

The data were analyzed separately for 1701 third-grade schools and 1433 sixth grade schools. Almost all of the sixth grade schools were also in the third grade sample, but about 300 schools had a third grade and no sixth grade. This is essentially all the third and sixth grade public schools in New York State. Only a few were excluded because important data were missing. Although the PEP tests are also given in private schools, they were not used in this study because some of the other variables were not available for them.

The zero-order correlations of the four school achievement measures with the 24 school input variables and with the 24 school treatment variables are shown in Table 1. This table shows that the correlations of the input variables with achievement tended to be larger than were those of the treatment variables as we have learned to expect.

The largest input correlations were with indices of the economic status of the students' home. A school official's report of the proportion of children in the school from families on welfare correlated -.74 and -.76 with mean achievement. The correlations with the two census indices of the incidence of poverty were also substantial, but about ten points lower, probably because the census data apply to the school district rather than to the individual school and they were obtained two years earlier. The correlations with mean family income were still lower suggesting that the incidence of poverty is a more salient factor for achievement than is the general level of affluence.

This finding of a negative relationship between poverty and achievement is certainly not new, but the very high correlations observed on a state-wide basis should make us pause to consider the remarkable degree to which low achieving schools are located in poverty areas. Consider that .75 is about the test-retest reliability of our better personality inventories. This correlation is larger than those often reported for these variables because it is based on

school means rather than on individual students. Yet when we look at schools as the unit this is what we see. As one moves from the top five percent of the schools who report no poverty students to the lower five percent of the schools who report more than 70 percent poverty students average achievement goes from one-and-a-half standard deviations above the mean to one-and-a-half below.

Table 1 also shows a correlation of about .6 between the achievement level of the school and the educational level of the population of the district in which the school is located. This correlation was cut almost in half by statistical control for the economic variables, but it still remained a substantial and highly significant independent contributer to the achievement level of the school.

The high negative zero-order correlations of percentage Negro and percentage Spanish American students with school achievement that are shown in Table 1 were reduced to between -.2 and -.3 by control for the economic and educational variables, and most of this reduction was due to the economic variables. But with these controls the racial and ethnic correlations were still highly significant and were the third most important set of contributions to achievement after the economic and educational variables.

After control for the economic, educational and racial-ethnic variables, no other input variable had a partial correlation with achievement as high as .1. Although several were statistically significant because of the large sample, these were not consistent across the two grade levels.

One additional background variable deserves comment, if only because New York City has had more than its share of bad press recently. The correlation in Table 1 of about -.3 of the New York City dummy variable with achievement shows that low achieving schools tend to be concentrated in the city. However, after control for economic, racial-ethnic and educational variables this correlation was reversed in sign and was significantly positive for third grade schools.

Thus, the relatively low achievement level in New York City can be attributed to social factors that are already well known and does not represent the discovery of a new problem for the beleagured city. Alas, the same reversal did not hold for the upstate center cities.

The multiple correlation with school achievement of all input variables that contributed significantly to the equation was .84 for third grade and .85 for sixth grade. These multiple correlations are shown in Table 2. Thus, we can account for a whopping 70 percent of the variance in mean achievement level of school buildings on the basis of the background characteristics of students in the school, primarily the economic, educational and racial-ethnic status of the students' homes.

We now move to the relationship of mean achievement to the school treatment variables. The zero-order correlations in Table 1 show that the largest relationship was with operating expenditure per pupil, followed by a group of related variables reflecting the age, experience and salary of the teachers in the school. However, these school characteristics were also correlated with the economic educational and racial-ethnic predictors of achievement. It is, thus, necessary to control these background factors to study more directly the effects of school variables on achievement.

Our crystal for detecting small school effects in the presence of large background variation is step-wise multiple regression analysis. We allow the program to build up a regression equation by adding input variables one at a time until no additional input variable contributes significantly to prediction of achievement. Essentially the same results are obtained by forcing all input variables into regression at one step, but the final equation is somewhat neater with the stepwise procedure and the individual steps provide additional interesting information. We then look at the partial correlations of the treatment variables

with achievement controlling for the significant input predictors. At this point we have a choice of three coefficients to represent these residual relationships:

1. The beta weight the treatment variable would have if added to the equation with the input variables. This is the relationship of the treatment variable as is to the criterion as is independent of all the input variables. These are the path coefficients used in path analysis.

2. The part correlation. This is the relationship between that part of the treatment variable that is independent of the input variables with the criterion as is.

3. The partial correlation. This is the relationship between two sets of residuals with the input variance taken out of both the treatment variable and the criterion.

When the input variables account for a large amount of variance, as they usually do in school effect studies, the difference between these three coefficients is substantial. In the present analysis the beta weights and the partial correlations differed by as much as a factor of three or four. Thus, if one wishes to make the school effects look small he should use the partial correlation. If he wants them to look miniscule he should use the beta weight. The part correlation is an intermediate choice.

Since our school effects need all the help they can get, we chose the partial correlation to represent them in Table 3. These coefficients, thus, represent the correlation to be expected between treatment and achievement variables with the greatly reduced variance they would have if the input variables were held constant.

Table 3 shows that operating expenditure per pupil, which had a large zero-order correlation with achievement, was not significantly related after control

for student input. The cluster of variables representing teacher experience, age and salary, however, remained significantly related to achievement in both third and sixth grade.

In addition, academic orientation of the school as might be inferred from traditional classroom arrangement and use of rooms for academic purposes were significantly related to achievement after control for student input.

The significant negative partial correlation of the presence of compensatory programs with achievement probably reflects the fact that these programs tend to exist where they are needed to an extent that was not completely washed out by our input controls. At least this seems a more reasonable interpretation than attributing some detrimental influence to such programs. However, there is a cost of making such a felicitous interpretation. To do so, we must admit that our input controls leave something to be desired, and, to be consistent, we must extend the same interpretation to the positive partial correlation of achievement with the presence of programs for the academically talented.

This suggestion of incomplete control for input might be dismissed as inconsequential if the partial correlations with other treatment variables were relatively large, but they were not. The largest possible effects accounted for only one or two percent of the residual variance in achievement. Thus, the problem of input control is serious. Since input accounts for about 70 percent of the total variance in achievement, controls for input that were as much as 90 percent effective could still leave uncontrolled input effects about as large as the school effects that are likely to be observed. It is extremely important to control as much of the input variance as possible, but it seems inevitable that a background noise will remain that is almost as loud as the signal. Like the early crystal set listeners we must strain our ear to separate the meaningful signal from the annoying static.

The finding that the cluster of related teacher variables -- experience, age, education and salary -- was positively related to achievement after input controls at a high level of significance at both grade levels seems to me to be a meaningful signal that stands out from the noise. Similar findings emerged from the analyses reported in this symposium by Swanson and by Irvine. Although these analyses were based on essentially the same data the approaches were different. The input-output studies covered by the review by the Rand Corporation researchers frequently reported positive effects for teacher experience and rarely reported negative effects.

Perhaps all of this is beginning to form a meaningful pattern, but the pattern is represented in a signal so weak that it is difficult to perceive. What is needed is an amplifier. The extreme groups approach used by Swanson very effectively amplifies the findings, but it also amplifies the noise so we are not much better off. However, the extreme groups approach facilitates an additional step, as Swanson suggests, which will amplify the signal and not the noise. It is not the age or the experience or the salary of the teachers in a school that promotes student achievement. It is something that impenges much more directly on the students and that is very imperfectly represented by these gross indicators. The results so far suggest hypotheses about what the more salient variables are likely to be. The outlier approach makes it feasible to collect additional data from extreme schools to test these hypotheses.

In conclusion, I hope you will permit me to carry the radio analogy one step further and suggest that the controlled experiment is an effective filter, which selectively enhances the signal and attenuates the noise. Yet it regretably has serious limitations for the study of school effects in the real world. It is expensive, it is politically difficult to implement, and it must be precisely turned to the specific effects to be detected. Thus, the most appropriate research strategy at present seems to be to continue the broad-band-width but static-ridden regression and outlier studies until strong inferences are available that are worthy of experimental manipulation.

Tables to accompany School Effects on Achievement by Robert C. Nichols
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Table 1

Correlations of School Characteristics with School Mean PEP Achievement Scores at Third and Sixth Grade for New York State Schools

School Characteristic	Mean[a]	Standard Deviation[a]	Correlation with Mean Achievement: Grade 3 (N = 1701)	Correlation with Mean Achievement: Grade 6 (N = 1433)
Student Population				
Total enrollment	589.15	288.02	-.24	-.18
% American Indian	.21	2.58	-.02	-.03
% Oriental	.60	2.64	-.02	-.02
% Negro	12.13	22.22	-.62	-.65
% Spanish American	5.63	14.52	-.58	-.56
% Children from families on welfare	11.80	20.30	-.74	-.76
School Location Dummy Variables				
New York City	.09	.65	-.32	-.31
Center city other than New York	-.10	.64	-.16	-.21
Suburb of large city	.14	.81	.26	.23
1970 Census Characteristics of School District				
Mean family income	12.72	4.21	.46	.48
% Foreign stock	27.60	12.25	-.05	-.01
% Spanish language	4.29	8.87	-.53	-.51
% Born in state	73.20	10.27	.44	.44
% In same house in 1965	60.21	7.60	.14	.18
% Students in public schools	84.46	10.57	.21	.21
% Students in parochial schools	13.20	9.25	-.20	-.21
% Students in private schools	2.33	3.03	-.13	-.10

Con't.

Table 1 (Cont.)

School Characteristics	Mean[a]	Standard[a] Deviation	Grade 3 (N = 1701)	Grade 6 (N = 1433)
% Males 25+ yrs. with 4 yrs. of High School	54.95	12.88	.61	.60
% Males 25+ yrs. with 4 yrs. of College	15.80	10.78	.44	.44
% Females 25+ yrs. with 4 yrs. of High School	56.12	12.45	.66	.66
% Females 25+ yrs. with 4 yrs. of College	9.34	5.89	.40	.41
% Families with incomes of $5000 or under	15.10	8.47	-.63	-.62
% Persons in families below the poverty level	6.94	5.52	-.63	-.62
% Children 16-17 years old enrolled in school	91.84	7.58	.34	.33
Characteristics of School Programs				
Student/Teacher ratio	22.36	3.43	.13	.15
Program for the academically talented[b]	.14	.35	-.06	-.05
Compensatory program[b]	.28	.45	-.23	-.21
Students/total rooms ratio	17.90	4.08	-.11	-.09
Students/regular classrooms ratio	28.42	9.17	-.07	-.09
% Rooms used for academic purposes	93.44	16.13	.10	.16
Classroom arrangement traditional[b]	.96	.20	.01	.03
Classroom arrangement cluster[b]	.12	.33	-.06	-.06
Classroom arrangement open[b]	.17	.38	-.01	.01
Corrective reading program[b]	.80	.40	.04	.07
Corrective speech program[b]	.78	.41	-.00	.02
Characteristics of Teachers in the School				
% Uncertified	3.56	6.06	-.04	-.08
% With less than Bachelors degree	2.30	4.01	.04	.03
% Bachelors degree only	48.84	19.45	.02	-.04
% With Masters and 30 hours or Doctorate	8.83	9.81	-.08	-.02
% Occupation other than teaching last year	6.51	6.74	.00	-.01
% Tenured	63.85	16.57	.13	.21
% Full-time	96.94	4.36	-.02	.01
Mean degree status	5.90	.45	.00	.06
Mean number of years experience in this district	8.56	2.71	.19	.21
Mean number of years teaching experience	10.98	3.06	.29	.32
Mean salary	12,090.70	1,909.47	.10	.14
Mean age	37.41	4.43	.25	.28

Cont.

Table 1 (Con't.)

School Characteristics	Mean[a]	Standard[a] Deviation	Grade 3 (N = 1701)	Grade 6 (N = 1433)
Financial Status of School District				
Per pupil expenditure	996.15	516.00	.49	.46

[a]Means and standard deviations are for the third grade schools. Values for sixth grade schools are very similar.

[b]Present = 1, Absent = 0

Note: Correlations of .06 and .07 are significant at the .01 level for third and sixth grades respectively.

Table 2

Multiple Correlation of School Input Variables with Mean Achievement

	Grade 3 (N = 1701)	Grade 6 (N = 1433)
Number of significant predictors	12	9
Multiple correlation	.84	.85
Squared multiple correlation	.70	.72

Table 3

Partial Correlations of School Treatment Variables with Mean PEP Achievement Score Controlling for School Input Variables

School Characteristic	Partial Correlation Grade 3 (N = 1701)	Grade 6 (N = 1433)
Characteristics of School Programs		
Student/Teacher ratio	.03*	.04*
Program for the academically talented	.05*	.11
Compensatory program	-.07	-.02
Students/total rooms ratio	.01	.01
Students/regular classrooms ratio	-.03*	-.04*
% of rooms used for academic purposes	.05	.07*
Classroom arrangement traditional	.04	.05
Classroom arrangement cluster	-.01	-.01
Classroom arrangement open	.04	.01
Corrective reading program	.01	.04
Corrective speech program	.00	.03
Characteristics of Teachers in the School		
% Uncertified	-.03	.00*
% with less than Bachelors degree	.04*	.06*
% Bachelors degree only	-.06	-.09
% with Masters + 30 hours or Doctorate	-.01*	.02
% Occupation other than teaching last year	-.05*	-.03*
% Tenured	.07	.10
% Full-time	.03	.02*
Mean degree status	.04*	.06*
Mean number of years experience in this district	.09*	.12*
Mean number of years teaching experience	.08*	.13*
Mean salary	.08*	.09*
Mean age	.09	.13
Financial Characteristics of School District		
Per pupil expenditure	-.02	.00

*p <.05