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ABSTRACT

In 1988, a California study by Friedkin and Necochea confirmed an interaction between size and socioeconomic status such that large schools benefited affluent students, whereas small schools benefited impoverished students. This report describes a replication applying the model to West Virginia schools and school districts. In order to control for widely varying grade-span configurations, school size was defined as the fall 1990 enrollment in the grade-level cohort under analysis. Separate analyses were carried out on grades 3, 6, 9, and 11. Achievement was defined as composite basic skills scores on the Comprehensive Test of Basic Skills. Socioeconomic status was defined as (1) the proportion of students receiving free or reduced-price meals and (2) the proportion of the adult population with educational attainment less than grade 12. The results of bivariate correlational and multivariate regression analyses are similar to those of the California study, except that the pattern of effects derives in part from the fact that impoverished West Virginia students tended to be served by smaller schools. Small schools disrupted the usual negative relationship between socioeconomic status and student achievement. The size effect was absent in grade 3, was modest and indirect in grade 6, strengthened in grade 9, and was strongest and both direct and indirect in grade 11. The combined and indirect effects of size were strong, as well, across all grades in analyses at the school district level. That is, impoverished students appear to derive achievement benefits from attending small school districts. Since 1988 a consolidation scheme facilitated by the state has closed nearly 20 percent of West Virginia's schools, most of them small schools serving rural communities. The findings are interpreted with respect to this context. Contains 36 references, 9 statistical tables, and an appendix explaining regression equations used. (Author/SV)

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The Matthew Principle:A West Virginia Replication?

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The epigraph given at the beginning of this article came to my attention in a paper by William Turner, of Massey University, New Zealand. In a lecture titled "Does Reading Recovery Work?", Turner (1989, p. 2) noted: "I'm particularly concerned about children who encounter difficulty in acquiring literacy skills, especially in light of recent research on the consequence of literacy acquisition for further cognitive growth and academic achievement. The effects appear to be profound: relatively small differences in reading ability and literacy-related knowledge and skills at the beginning of school often develop into very large generalised differences in school-related skills and academic achievement. These effects have been referred to as Matthew effects, or rich-get-richer and poor-get-poorer effects, after a passage from the Gospel according to Matthew." At this point in the paper, Professor Turner supplies the apt passage.

ABSTRACT

This study extends and interprets a regression technique used to examine the possible role that socioeconomic status may have in regulating the effects of school and district size on student achievement. The original study (Friedkin & Necochea, 1988), with data from California, confirmed an interaction between size and SES such that large schools benefitted affluent students, whereas small schools benefitted impoverished students. This replication applies the model to a very different state, West Virginia. Results are similar, except that the pattern of effects is shown to derive in part from the fact that in West Virginia impoverished students were shown actually to attend small schools in 1990. Small schools are shown to disrupt the usual negative relationship between socioeconomic status and student achievement. These results would be cause for celebration except that since 1988 West Virginia has, under a successful consolidation scheme facilitated by the state, closed nearly 20 percent of its schools, most of them small schools that had served rural communities in this mostly rural state. The discussion interprets findings with respect to this context and interprets the practical significance of studying structural variables such as those used in the study.

The Matthew Principle: A West Virginia Replication?

For whosoever hath, to him shall be given, and he shall have more abundance: but whosoever hath not, from him shall be taken away even that he hath. (Matthew, 13:12)

This epigraph, revealed two thousand years ago, captures something of how the world works, the social world certainly, but perhaps also the natural world. For instance, Jesus's remarks may allude to the principles related to iterative processes that are now understood to account for much that natural science previously found obscure. In these "chaotic" processes small differences in initial states lead to great differences in final states.

But when the differences in initial social states are great, it should come as no surprise that differences in final social states can be dramatic. After two millennia, we can say with more certainty than ever that it takes money to make money, and also, that in this chaotic process of making money, the rich get richer and the poor get poorer. Schooling plays a part in postindustrial societies. As Christopher Jencks and others have noted, education has become the route through which the affluent bequeath their advantages to their children; education mostly bestows its advantages on the advantaged (cf. Jencks et al., 1979).

This article derives from doctoral research in which the findings tend to confirm both the wisdom of the Gospel and the wisdom of common sense. The inferential statistics reported here (regression analysis), however, are conventional, straightforward, and solidly based on the literature about two key structural variables related to schooling: socioeconomic status (a most salient contextual variable) and school size (a most salient institutional variable). The analysis replicates a widely cited California study (Friedkin & Necochea, 1988), which, curiously, has not been replicated until now. Its findings may have been too disturbing, or its methodology may have been a little obscure.

The original study found that socioeconomic status systematically influences the effects of school and district size on aggregate student achievement. Large schools and districts (in California) benefit affluent students moderately, whereas small schools and districts benefit impoverished students to an even greater extent than the large schools benefit the affluent. The opposite relationship is true as well: Large schools compound the negative effects of being impoverished, whereas small schools reduce the advantages that affluence normally brings. Small schools, on this basis, might not serve students from affluent communities particularly well, at least on average.

Despite the fact that the original study is widely cited, its possible and likely implications have not been considered. Should school buildings be designed to match the socioeconomic characteristics of communities? What should happen to buildings as residential areas change character? Should all schools be smaller, as school reformers like Sizer, Boyer, Husen, and Sergiovanni recommend (despite the apparent damage done to the achievement of affluent students)? The implications would indeed challenge the capacity of educational policymaking, which is so often a matter of compromise, if not expedience. Complicated findings are not usually appreciated.

The most suggestive inference from the original study--one that emerges in this replication as well--is that we must consider the probable fact that large schools are not just dysfunctional for impoverished students. Instead, large schools dramatically compound the educational disadvantages confronted by impoverished students. A long line of historical research, beginning at least with Michael Katz's The Irony of Early School Reform (1968), suggests that educational policy has aimed, perhaps covertly, at improving the advantages of affluence. Part of the irony is that we can now surmise that such improvement (for the affluent) may represent a simultaneous disservice to the disadvantaged.

Such a surmise motivated this study. The original 1988 study has been widely shared with educators, policymakers, and citizens in West Virginia, and, yet, beginning in 1988, the state has laid plans to close many small schools, schools that have served a population made historically destitute because of the way in which the state's natural resources (salt, timber, coal, oil, and natural gas) have been developed and exploited (Whisnant, 1980). Mostly, the land is controlled by large corporations with headquarters outside the state (Appalachian Land Ownership Task Force, 1981, 1983; DeYoung, 1995; Gaventa, 1980).

The fact that the state maintained many small schools, however, was not considered a cause for celebration in West Virginia. Teacher salaries were low, buildings were in bad--even illegal--shape in some places, and the race for the cachet of high-tech pioneer was one the state would lose if something did not happen to reorder priorities and reallocate resources. Between 1988 and 1995, the state forced the closure of about 20 percent of its schools, mostly small schools in rural areas, the bulk of closures occurring after 1990. Teacher salaries rose, teachers and administrators were RIFed, new schools replaced old (with much contention and antagonism at the local level), and a variety of large-scale computer initiatives were undertaken by the state. For the most part, closures were resisted by local citizens and embraced by professionals. Some professionals have balked, but for the most part professionals had little choice, since the state (perhaps arbitrarily) imposed "economies of scale" that ruled out the possibility of building new schools that were small. The so-called economies of scale were really just requirements for building size; whether they were more economical or not, or on what basis, no one knew. State officials did not care; they were merely exercising power via duly constituted legal authority.

As districts applied for state-supplied construction funds, their plans had to meet the perhaps arbitrary economy-of-scale standards. At any rate, the state has not defended its size standards, nor has the basis of standards per se been challenged in any court action. Indeed, I am not aware of any reputable or currently valid research on which the standards could be defended. Leading researchers have roundly discredited the notion that there is any "standard," "best," or "optimal" size for a school.

The West Virginia effort is one of the more successful consolidation efforts authorized by any state in recent years. Similarly ambitious efforts appear to be underway at present not only in Pennsylvania, Iowa, Illinois, Missouri, and other U.S. states that operate large numbers (e.g., $n>300$) of school districts, but also in Canadian provinces, where a major recent goal in many provinces is to reduce the number of local education agencies.

It is past time that those who advise policymakers begin to articulate the complexity associated with issues of school size. Though states can reallocate funds by closing schools and consolidating operations, the question is who benefits as a result, and the evidence suggests that the Matthew principle governs the outcome. This article is particularly aimed at researchers in the hope that related investigations will be undertaken elsewhere. For this reason, results and analysis are reported in detail. Investigators interested to collaborate on similar work are invited to contact me directly. Similar work might well include multilevel analyses (e.g., classes within schools within districts). Other state-based replications are needed as well, however.

Units of Analysis and Subjects

The units of analysis in this investigation are schools and school districts in West Virginia. Four relevant hypotheses are tested with variables from West Virginia and federal data sets. The West Virginia data set provides the dependent achievement

variable at four grade levels (i.e., aggregate scores at the third, sixth, ninth, and eleventh grades).

Subjects of this study include (1) the universe of West Virginia schools with a third grade, a sixth grade, a ninth grade, or an eleventh grade and, at the district level, (2) the universe of West Virginia districts. At the school level, each group of schools serving a given cohort (e.g., grades three or six) comprises a distinct, but not necessarily mutually exclusive, group. Some schools, for instance, house both third and sixth grades; a few house third, sixth, and ninth grades; and there are a small number of K-12 schools in the state. At the district level, subjects include the universe of county districts (all districts are county districts in West Virginia).

Definitions

Variables of interest in the subsequent statistical analyses are (1) school size, (2) achievement, and (3) socioeconomic status. For the school-level analyses the following definitions apply:

- School size is defined as fall 1990 enrollment in the grade-level cohort that is the subject of analysis (e.g., total number of third-grade students in the school or county when third grade achievement is the dependent variable.)

This procedure is common in school-size studies (e.g., Fowler & Walberg, 1991; Friedkin & Necochea, 1988) because it controls for the effects of variation in the grade-level configurations of schools (e.g., K-4, K-6, K-8). The definition allows one to distinguish size effects independent of the grade span encompassed by a school.

- Achievement is defined as composite basic skills scores achieved by regular education students on the spring 1991 administration of the Comprehensive Test of Basic Skills (CTBS) in grades three and six and the fall 1990 administration of the CTBS in grades nine and eleven, aggregated to the school level.

Standardized norm-referenced achievement scores on group tests such as the CTBS are common measures of student learning (e.g., Anderson, 1991) and are comparable to those used by Friedkin and Necochea (1988). CTBS test scores are a perpetual concern in West Virginia (e.g., Probation, 1990; Student Test Scores, 1994; W.Va Student, 1993), in part because they are among three measures (also including attendance and dropout rates) used by the West Virginia Department of Education to determine a district's effectiveness. Districts judged to be ineffective are subject to the direct intervention of the state (Scores, 1995).

- Socioeconomic status is defined as the proportion of students at each school receiving free or reduced lunches in the school-lunch program during the fall of 1990, as reported by the West Virginia Department of Education to the National Center for Education Statistics.

Though commonly used, free and reduced-price lunch rates exhibit an increasingly weak relationship to student achievement as grade level rises, possibly because older students are less likely than younger students to file applications for assistance. Unfortunately, at the school level, there are in West Virginia no good alternatives (see, however, the discussion of an alternative measure used in the district-level analyses).

The availability of more suitable measures of socioeconomic status may explain one of the anomalies of recent studies of school size effects (e.g., Plecki, 1991; Walberg & Fowler, 1987; Fowler & Walberg, 1991; Friedkin & Necochea, 1988). The best studies are frequently conducted in two very urban states,

California and New Jersey. Part of the reason for this choice may well be the availability in those states of comprehensive measures of socioeconomic status at the school level (cf. Friedkin & Necochea, 1988; Walberg & Fowler, 1987). Given the weak nature of the school-level socioeconomic status variable, then, the availability of an alternative measure for the county-level analyses provides an additional test of the hypotheses.

When the county district is the unit of analysis, the following definitions apply:

- School size is defined as total enrollment in fall 1990 for the subject cohort in the county district.
- Achievement is defined as individual composite basic skills scores achieved by regular education students on the spring 1991 (grades three and six) or fall 1990 (grades six and eleven) administration of the CTBS aggregated to the county district level.
- Socioeconomic status is defined as the proportion of students in each county receiving free or reduced lunches in the school-lunch program during the fall of 1990.

In addition, the county-level analyses also use an alternative measure of socioeconomic status, as follows:

- Alternatively, at the county level, socioeconomic status is defined as the proportion of county residents at least 20 years old who, according to the 1990 decennial census, had not completed high school (grade twelve).

This census measure is available because all West Virginia's school districts are county districts and the decennial census reports population statistics at the county level in all states. Data for this measure were taken from the School District Data Book (National Center for Education Statistics, 1995).

Design

This study employs bivariate correlational and multivariate regression analysis to test hypotheses about the relationship between size of educational units (schools and districts) and aggregate student achievement in West Virginia. This design is appropriate for studies seeking to establish relationships between constructs operationalized, as in this case, with interval-level data.

Hypotheses. Null hypotheses are used to examine the following two questions, each at the school and district level ($p < .05$): (1) What is the (zero-order) relationship between school size and student achievement in West Virginia schools? and (2) Does socioeconomic status regulate the relationship of school size and student achievement in West Virginia? For the second question, the hypotheses test the significance of the interaction term in the regression anlaysis. Ancillary analyses explore the results of hypothesis testing in greater depth.

Bivariate analysis. At the beginning of the 20th century, it was widely believed that school size would be positively related to achievement in a straightforward fashion (e.g., Cubberley, 1922; Stemnock, 1974). The assumption behind this hypothesis was in fact quite reasonable, given the absence of data, methods, and experience needed actually to judge the situation appropriately. Why should educators of that time have believed anything else but that larger schools would make possible the provision of better equipped classrooms, better prepared teachers, and more effective administration and that such provision would improve student learning? This common-sensical view not only prevailed through the early 1960s (e.g., Conant, 1959), it has been widely reiterated by government officials and their supporters in West Virginia (e.g., Governor's Committee on Education, 1990), including the editorial staffs of

both state newspapers, the Charleston Gazette and the Charleston Daily Mail (e.g., Consolidation, The State Isn't Wrong, 1993; Consolidation, Yes, 1992; Marsh, 1992). The various traditional arguments in favor of creating large schools have only recently begun to be debunked by such organizations as the Carnegie Foundation and leading reformers (e.g., Boyer, 1995; Goodlad, 1984; Sergiovanni, 1993)

This circumstance, in particular, provides a reason to report the various zero-order correlations between achievement and school size. Zero-order correlations will be developed to test hypotheses at all four grade levels.

Multivariate analysis. This study employs a very simple regression model, with an interesting methodological innovation. The model was developed and applied by Noah Friedkin and Juan Necochea (1988) to a California data set. The study is widely cited in the school size literature, but it has never been replicated (Noah Friedkin, personal communication, March 2, 1994).

The Friedkin and Necochea model involves regressing achievement aggregated to the school and district levels on size, SES, and the product of SES and size (interaction term). The innovation involves differentiation of the regression equation to provide a basis for determining possible effect sizes of size in communities of differing socioeconomic status. The partial derivative is calculated and standardized to obtain the net effect of size on achievement at chosen SES intervals. Any use of calculus in educational studies is unusual, and hence merits careful explanation, which is provided in Appendix A.

Friedkin and Necochea justified their model as an application of systems theory. In brief, schools (either individual schools or districts) constitute open systems that interact with a wider environment that may facilitate or constrain the operation of the system. In particular, community socioeconomic circumstances have this facilitating or constraining effect on school systems. On this basis, the researchers hypothesize a previously unconsidered circumstance, namely, that school size (a system variable) interacts with socioeconomic status (an environmental variable) to determine achievement (a measure of system performance). The hypothesized effects are analogous to the familiar concept of aptitude-treatment interactions. This comparison is perhaps invidious, however, given the meritocratic ideology of American culture (in which poverty is widely believed to be the just reward of inaptitude).

Systems theory nonetheless underestimates many of the advantages of this sort of analysis. In particular, one may ask what is the advantage of a parsimonious model over more complex production function models. A common view is that size represents "nothing magical" in itself, and that only processes count when educational improvement is the goal. The concluding section of this article considers related issues and offers a stronger defense of the model.

Analysis

Because two units of analysis are employed in this study (school and district), two separate datasets comprising the focal variables were constructed. Among elementary and middle schools, 21 cases (or about 3 percent) exhibited missing values for free and reduced-price lunch rates. Among junior and senior high schools, 13 (or about 8 percent) exhibited missing values for this variable. The reason these values are missing is that they were not reported; in all likelihood, it was the school that originally did not report the data to the state. These data are regarded as sensitive information in some localities, but their absence is another indication that free and reduced-price lunch rates are weaker proxies for socioeconomic status than one could desire.

Rather than eliminate these cases, values were imputed for schools with missing data. The per-pupil weighted mean of other

schools at the same level (i.e., other elementary, middle, or secondary schools) in the same district was substituted for the missing value. This procedure constitutes a form of mean substitution based on the district mean. Substitutions accomplished in this fashion are probably less biased than would be the case had the usual method of substituting the overall mean for the variable (the most common form of mean substitution) been used.

Bivariate analyses. With data set construction and data entry completed, bivariate correlations at the school and district level were calculated. Two-tailed tests of significance were applied to test the null hypothesis ($p < .05$).

Multivariate analyses. Multivariate analysis constructed the specified regression equation with backward stepwise entry of variables (i.e., size, SES, and interaction term). Backward stepwise methodology assumes that the original model will apply and adjusts the model on the basis of characteristics of the data (e.g., a weakness of the SES variable) that might reduce the significance of one or more of the variables of interest. Statistically nonsignificant variables are available for removal from the equation at each step.

The full model as given in the Friedkin and Necochea study (see equation 1 in Appendix A) was entered and then variables were removed in descending order of nonsignificance (probability level for removal was $p = .05$ or greater). Variables were removed in this fashion until all remaining variables left in the equation were significant at $p < .05$.

A significant interaction term (i.e., a statistically significant regression coefficient for the product of size and socioeconomic status) in any equation indicated the presence of an interaction effect of size and socioeconomic status. In practical terms, any resulting regression equation would be available and eligible for differentiation (see equation 2 in Appendix A) to assess an interaction effect at varying levels of socioeconomic status if one of the following three conditions were to apply:

(1) all three independent variables were significant; or

(2) (a) the size or the socioeconomic status term and (b) the interaction term were significant; or

(3) only the interaction term were significant.

In the first of these three cases, both size and socioeconomic status variables would exhibit a direct effect as well as an interactive effect of size on achievement. In the second of these cases, only one variable would show a direct effect but the two variables together would show an interactive effect of size on achievement. In the third case, neither variable would exhibit a direct effect, but the data would exhibit an interactive effect. If the interactive term were not significant in regression analyses, then the null hypothesis would be confirmed.

For the regression analyses, a final criterion applied. The partial derivative was calculated if the regression equation had an F-value significant at $p = .05$ or less. To transform the equations into a form that gives effect sizes, both sides of the equation are multiplied by the ratio of the standard deviation of size to the standard deviation of achievement (see equation 3 in Appendix A).

For all regression equations meeting these criteria, illustrative values of effect size are calculated for different socioeconomic levels. The effect sizes for different levels of socioeconomic status serve to translate the findings given by the final form of the regression equations into a more easily interpretable form.

Bivariate Results

Two hypotheses present the relationships to be tested in bivariate analysis, as follows:

(1) The zero-order relationship between school size and student achievement in West Virginia schools is not statistically different from zero at $p < .05$.

(2) The zero-order relationship between school size and student achievement in West Virginia schools, aggregated to the district level, is not statistically different from zero at $p < .05$.

Each hypothesis entails the correlation of the specified achievement and size variables at three grade levels--3, 6, 9 and 11. Box-plot analyses were completed prior to testing the hypotheses, and outliers on size identified by the box-plot analysis were eliminated from the subsequent bivariate analyses. Identified outliers in all cases were those which exhibited largest enrollments. No outliers were identified in box plots among units of analysis exhibiting the smallest enrollments. For any analysis at the school level, no more than five cases were dropped. For the county-level analyses only the state's largest district--among the top 100 districts in the nation on enrollment--was eliminated.

School-level results. Table 1 presents the results of the test of the school-level hypothesis (hypothesis 1).

Table 1

Zero-order Correlation of Size and Achievement (School-Level Analysis)

	Grade			
statistic	3a	6b	9c	11c
r	.11(.01)	.03(.44)	.00(.96)	.18(.07)
N	628	508	196	106

Note. Two-tailed tests of significance; $p < .05$; significance levels are given in parentheses.
aOutliers (grade 3 enrollment > 140) removed.
bOutliers (grade 6 enrollment > 382) removed.
cNo outliers.

The data reported in Table 1 confirm the null hypothesis at the school level (hypothesis 1) in three cases out of four. The third grade results are the only statistically significant correlation at $p < .05$. The preponderance of the literature indicates that the zero-order correlation between size and achievement is near zero, not that it is always zero, and the third grade correlation is within the range of values typically reported in the literature. In the regression results reported in a subsequent section of this study, the correlation between size and achievement at the third grade level does not remain significant once the socioeconomic status variable enters the equation. At the school level, therefore, the null hypothesis (hypothesis 1) is accepted. In West Virginia schools, among regular education students, the zero-order correlation between achievement and school size is assessed as neither practically nor statistically significant.

County-level results. Table 2 presents the results of the test of the county-level hypothesis (hypothesis 2):

Table 2

Zero-order Correlation of Size and Achievement (County-Level Analysis)

statistic	Grade 3a	6b	9c	11c
r	.08(.58)	.03(.85)	-.15(.27)	-.03(.82)
N	54	54	54	54

Note. Significance level = .05; two tailed tests of significance;significance levels are given in parentheses. aOutliers (Kanawha County) removed.

The data reported in Table 2 indicate confirmation of the null hypothesis at the county level (hypothesis 1) in all cases. The observed magnitudes of the nonsignificant relationships are, one may note, similar to those reported for the school-level analysis. In West Virginia districts, among regular education students, the zero-order correlation between achievement and district size is assessed as neither practically nor statistically significant.

Multivariate Results

Two hypotheses (i.e., hypotheses 3 and 4) present the relationships to be explored in multivariate analysis, as follows:

(3) In regression analysis, the multiplicative term signifying the interaction of socioeconomic status and school size is not statistically significant at $p < .05$.

(4) In regression analysis, the multiplicative term signifying the interaction of socioeconomic status and school size, aggregated to the district level, is not statistically significant at $p < .05$.

As with the bivariate analyses, each hypothesis entails the correlation of the specified achievement and size variable at three grade levels--3, 6, 9 and 11. Elimination of size outliers was the same as for the bivariate analyses. At the county level, as previously discussed, the analysis employed an alternative measure of socioeconomic status. The alternative measure was employed because of concerns about the adequacy of using free and reduced-price lunch rates as a test of the Friedkin and Necochea model. Such an alternative, as previously noted, was available only for the district level analyses. Using census data aggregated to the zip code level was attempted but proved to be an inadequate proxy for SES.

School-level results. Table 3 presents the final equations derived from the backward stepwise regression analysis at the school level (with free and reduced-price lunch rates for the school, grade-level enrollment at the school, and the product of the two values as independent variables and the school's CTBS expanded scale scores for the relevant grade level as the dependent variable; see "equation 1" in Appendix A..) For the backward stepwise analysis, all three variables in the Friedkin and Necochea model were entered first, followed by backward stepwise removal of the least significant variable. Removal was stopped when all remaining variables were significant at $p < .05$.

Table 3

Summary of Hierarchical Regression Analysis for the Friedkin and Necochea Model Among Regular, Operational West Virginia Schools

Grade Level	Variables in the Equation	B	SE B	
3[a]	free/reduced lunch	-66.47	3.61	-.37
6[b]	free/reduced lunch	-25.28	2.84	-.37
	interaction term	- .094	.04	-.10
9[c]	free/reduced lunch	-15.97	4.01	-.28
	interaction term	- .072	.03	-.15
11[d]	grade 11 enrollment	.026	.01	.33
	interaction term	- .084	.04	-.21

Note. All regression coefficients significant at $p < .05$; all equations have F significant at $p < .05$; residuals are normally distributed;
Durbin-Watson statistics vary between 1.6 and 1.8.
[a]Outliers removed (grade 3 enrollment > 140); $N = 628$; $R^2 = .14$.
[b]Outliers removed (grade 6 enrollment > 382); $N = 508$; $R^2 = .17$.
[c]No outliers identified by boxplot; $N = 196$; $R^2 = .13$.
[d]No outliers identified by boxplot; $N = 106$; $R^2 = .09$.

Table 3 provides evidence that a practically and statistically significant interaction effect operates in West Virginia at the school level to regulate the effects of school size. The interaction term is significant in three of the four grade-level equations (i.e., at grades 6, 9, and 11). At the third grade level, of the three independent variables only free and reduced-price lunch rates remain statistically significant after application of the backward stepwise analysis to the basic model. With these data, then, no interaction effect is detectable at the third grade level. At the sixth and ninth grade levels, however, free and reduced-price lunch rates and the interaction term are both statistically significant. At the eleventh grade level free and reduced-price lunch rates are eliminated by the backward stepwise analysis, and grade 11 enrollment and the interaction term remain in the equation as statistically significant.

Based on this analysis, hypothesis 3 is accepted for three of the four grade levels examined. Three of the four equations, therefore, are eligible for calculation of the partial derivative to assess the effect of school size on student achievement at differing levels of socioeconomic status. The relevant effect sizes appear in Table 4. Please note that the SES values given are the values of y used in the differentiated equations given in footnotes a-c; they do not represent observed data values.

Table 4

Effect Sizes of School Enrollment on CTBS Composite Basic Skills Achievement Test Scores for Varying Levels of Socioeconomic Status

	free & reduced lunch rate									
Grade	5%	15%	25%	35%	45%	55%	65%	75%	85%	95%
6a	-.01	-.02	-.03	-.03	-.05	-.06	-.07	-.08	-.09	-.11
9b	-.03	-.09	-.15	-.20	-.26	-.32	-.37	-.43	-.50	-.56
11c	+.28	+.17	+.06	-.04	-.15	-.26	-.37	-.48	-.58	-.69

Note. At grades 6 and 9 there is no direct effect of size. Only at grade 11 there is a direct, positive effect of size (in addition to an interactive effect), and this difference between the equations for grades 6 and 9 versus grade 11 accounts for the positive effects among schools with low rates of free and reduced-price lunches. Effect size equations, which follow in footnotes a-c, are based on equation 3 as given in Appendix A; that is, effect size $(a + cy)(s(x)/s(z))$, where x denotes the size variable and z denotes the achievement variable. Values are calculated from the partial derivative of the regression equation and are not observed values.

a es = $(-.094y)(21.73/18.33)$
b es = $(-.072y)(78.23/9.64)$
c es = $(.026 - .084y)(112.24/8.75)$

In Table 4 the disparate effects of size on student achievement can be assessed at three grade levels. Because size does not exert a direct effect on achievement at grade 6 and grade 9, the interaction effect (which exhibits a negative directionality, cf. Table 3) varies from near zero when socioeconomic status is high (i.e., when values of the free and reduced-price lunch variable are low) to negative when socioeconomic status is low (i.e., when values of the free and reduced-price lunch variable are high).

At grade 6 this negative effect on achievement is tantamount to depressing achievement scores by 1/10 of a standard deviation unit of achievement for every change in a standard deviation unit of size. This is a comparatively modest negative effect.

At grade 9, however, the negative effect on achievement is greater than 1/2 standard deviation unit of achievement for every change in a standard deviation unit of size. That is, at grade 9, the effect of large school size on students in the poorest communities is negative and substantial. Gene Glass, the originator of meta-analysis, provides a rough rule-of-thumb for assessing the practical implications of achievement effect sizes. According to him, an effect size of 1.0 is equivalent to about one year of learning. Thus, the negative effects of size among the very poorest communities are equivalent to about a half year at grade nine.

At grade 11 the data exhibit a direct as well as an indirect effect of size. The net result is a positive correlation of size and achievement at high levels of socioeconomic status and a negative correlation of size and achievement at low levels of socioeconomic status. These results more nearly parallel those discovered by Friedkin and Necochea (1988) in California. The positive effect in communities where socioeconomic status is high is equivalent to approximately 1/4 of a year of learning and the negative effect in communities where socioeconomic status is low

is about 2/3 of a year of learning.

The finding most salient to the hypothesis, however, is not so much the discovery of a significant interaction effect, but the pattern of relationships that characterizes students' experience at increasing grade levels. The data reveal neither a direct nor indirect effect of size at grade 3, once socioeconomic status is accounted for. A modest indirect effect appears at grade 6 and by grade 9 appears to strengthen. At grade 11 the size effects are stronger still, with the final regression equation exhibiting both direct as well as indirect (interaction) effects, a combination of effects that not only debase student achievement in communities where socioeconomic status is low, but now appear to enhance student achievement in communities where socioeconomic status is high. The data suggest a pattern of increasingly strong size effects that systematically benefit advantaged students and systematically handicap disadvantaged students.

An important caveat applies to the school-level analyses. The comparative weakness of the socioeconomic status variable (free and reduced-price lunch rates) may obscure somewhat the relationships that actually exist among the variables. Free and reduced-price lunch rates account for a comparatively small proportion of variance in the dependent variable, and hence, the amount of variance explained by the school level equations is a good deal less than might reasonably be expected from a strong SES variable. In the present analysis, the proportion of variance in the dependent variable explained by the independent variables in the regression equations varies from 9 percent (at grade 11) to 17 percent (at grade 6). In the Friedkin and Necochea study, by contrast, the proportion of variance explained by the school-level equations varied from 32 to 45 percent (Friedkin & Necochea, 1988, p. 245), with the greater amounts of variance explained at the higher, rather than lower, grade levels. Their zero-order correlations (between size and achievement at the school level) varied from r = .55 to r =3D .67 (Friedkin & Necochea, 1988, p. 243). In this study, the zero-order correlations were about half that magnitude and the correlations, moreover, were stronger at lower, rather than higher, grade levels (i.e., the reverse of the pattern observed in the Friedkin and Necochea data).

Despite these difficulties with the school-level analysis, the data are sufficient to permit rejection of the null hypothesis as given in hypothesis 3. It appears at the school level that socioeconomic status regulates the influence of school size on the achievement of regular education students enrolled in 1990 in West Virginia schools at grades 6, 9, and 11.

The data also suggest that size effects related to socioeconomic status may be cumulative, a finding that is consistent with other research that documents a widening achievement gap between disadvantaged and advantaged students over the course of 13 years of schooling. If this is the case, then one would expect that the association of achievement and socioeconomic status at grade 11 would be comparatively weak in small schools and comparatively strong in large schools (cf. Huang and Howley, 1993).

One way to assess such a hypothesis is to measure the strength of that association in senior high schools as compared with all other schools serving students in grade 11. In the 1990 data set 42 schools had low grades greater than 9 (i.e., they housed only grades 10-12), and 106 schools had low grades less than or equal to 9 (i.e., they housed grades K-12, 5-12, 7-12, and so forth). Table 5 presents the results of a subsidiary bivariate analysis to assess the comparative strength of the association between socioeconomic status and achievement among eleventh grade students attending these two different groups of schools.

Table 5

Eleventh Grade Achievement, Socioeconomic Status, and School Size in Two Groups of West Virginia Schools Serving 11th Grade Students

	means and correlations			
Grade Span	achievement mean[a]	free/reduced lunch mean[a]	grade 11 enrollment[a]	$r_{y,z}$
10-12[b]	754.1 (728.8-772.4)	.19 (.01-.75)	253.1 (75-599)	-.51**
other[c]	753.2 (720.8-774.3)	.40 (.00-.96)	114.6 (1-327)	-.11(ns)

Note. $r_{y,z}$ is the correlation of grade 11 achievement with free and reduced-price lunch rate; ** = $p < .01$; ns = not significant (one-tailed tests of significance, as a negative relationship is expected).
a Ranges for values of the variables given in parentheses.
b n = 42 (listwise)
c n = 106 (listwise)

A principal threat to analyses such as that presented in Table 5 is the possible effect of restricted range in one of the correlated variables. Both variables exhibit similar ranges, and, in fact, the "other" cohort--where restricted range would threaten the results most seriously (given the hypothesis of an attenuated relationship between achievement and socioeconomic status)--exhibits a range that is somewhat greater than the range for senior high schools (grade 10-12 schools).

The data in Table 5 suggest that in these data the association between socioeconomic status and the achievement of eleventh grade students is greater in senior high schools than it is in those schools serving eleventh grade students that have other sorts of grade-span configurations. Further, the data suggest that the poverty rate prevalent among the "other" schools is about twice that prevalent among the senior high schools. The same caveat applies here, however, that applied in the case of the observed difference in range for the free and reduced-price lunch variable: The free and reduced-price lunch rates for the senior high schools may represent, to an unknown degree, underestimates of the percentage of students actually eligible to receive free or reduced-price lunches at the senior high level.

In any case, Table 5 shows that the average enrollment of grade 11 students in the "other" schools is about half that in the senior high schools. Moreover, average eleventh grade achievement in the two schools is about the same (even in view of likely differences in socioeconomic status). These results are consistent with previous research (e.g., Fowler & Walberg, 1991; Friedkin & Necochea, 1988; Huang & Howley, 1993).

In order to eliminate the difficulties posed by the possibility that eligibility for free and reduced-price lunches is underestimated among students attending senior high schools, the analysis reported in Table 5 was repeated for students in grade 6. Two groups were selected for comparison on the basis of their relationship to the grade 6 enrollment mean. The group of larger schools comprised all those schools with enrollment greater than 1/2 standard deviation above the mean, whereas the smaller schools group comprised all those schools with enrollment less than 1/2 standard deviation below the mean. The mean was 46.5 student and the standard deviation 40.7. The larger schools group, then, had grade 6 enrollments greater than 67, whereas the

lower schools group had grade 6 enrollments less than 26. Table 6 reports the results of this analysis.

Table 6

Sixth Grade Achievement, Socioeconomic Status, and School Size in Two Groups of West Virginia Schools Serving 6th Grade Students

Size Group	achievement mean[a]	free/reduced lunch mean[a]	grade 6 enrollment[a]	ry,z
	means and correlations			
larger[b] schools	718.9 (696.5-738.9	.33 (.09-.73)	111.3 (68-383)	-.49**
smaller[c] schools	716.1 (681.7-755.6)	.48 (.10-.95)	17.3 (2-25)	-.22*

Note. ry,z is the correlation of grade 6 achievement with free and reduced-price lunch rate; ** = > $p < .01$; * => $p < .05$ (one-tailed tests of significance, as a negative correlation is expected).
a Ranges for values of the variables given in parentheses.
b n = 91 (listwise)
c n = 165 (listwise)

The results given in Table 6 are very similar to those given in Table 5, though with the grade 6 analysis, the free and reduced-price lunch rate in the smaller schools group is 50 percent greater than the rate in the larger schools group (rather than 100 percent greater, as in Table 5). In Table 6, as in Table 5, achievement is approximately the same (the standard deviation of achievement among the entire group is 12.0), and the relationship between the socioeconomic variable and the achievement variable is much weaker in the smaller schools group as compared to the larger schools group (accounting for 4 percent of the variance in the smaller schools group, as opposed to 25 percent of the variance among the larger schools group).

A final question to ask relevant to the school-level regression analyses concerns the size of schools serving students of varying socioeconomic status. The practically and statistically significant interaction terms do not specify for us the source of the relationship. Rather, the interaction is the result of an overall pattern inherent in the data. A similar result could be obtained as the result of impoverished students being served preponderantly in large schools, or in small schools, or, more likely, in some combination of small and large schools.

Given the evident similarity of the school-level analyses with those reported by Friedkin and Necochea in 1988 in California (where large urban schools serve a large proportion of impoverished communities), it is important to develop evidence that might suggest if the same, or a different, pattern prevails in West Virginia. West Virginia operates many small schools (precisely why consolidation has been promoted with such vigor), so that one would hypothesize that the source of the pattern observed has something to do with these many small schools. The practical question is simple: Do small schools in West Virginia enhance or detract from the achievement of impoverished students?

A meaningful way to make this assessment in the context of the school-level regression analyses is to relate the data to the free and reduced-price lunch rate intervals used to interpret school-size effects in Table 4 (i.e., 5%, 15%, and so on). This

analysis is easily accomplished by recoding the free and reduced-price lunch data into 10 groups, 0-5%, 5-15%, 15-25%, and so on, with the final group comprising rates in excess of 85% (the highest observed value is 96 percent). Table 7 gives the average enrollment (grade cohort size) for each such interval at each grade level; the note also gives the zero-order correlation of free and reduced-price lunch rates and grade cohort size (two-tailed tests of significance).

Table 7

Average Grade-Level Enrollment by Socioeconomic Status Groups (Free and Reduced-Price Lunch Rates) Among Four Grade Levels

	free and reduced-price lunch groups (upper bound)									
Grade Level a	5%	15%	25%	35%	45%	55%	65%	75%	85%	96%
3 b	43 (4)	50 (29)	48 (78)	43 (107)	38 (140)	35 (124)	30 (72)	29 (49)	25 (12)	36 (18)
6 c	44 (2)	74 (23)	70 (62)	52 (88)	47 (119)	39 (108)	31 (53)	30 (36)	26 (10)	30 (9)
9 d	114 (6)	222 (23)	137 (55)	139 (42)	99 (41)	67 (15)	50 (7)	76 (5)	-- --	54 (4)
11 e	241 (6)	261 (31)	150 (40)	127 (30)	110 (20)	66 (12)	43 (2)	73 (4)	-- --	38 (4)

Note. Mean grade-level enrollment is rounded to the neare·t integer; free/reduced lunch groups are not based on equal-interval units; two-tailed tests of significance for correlations given below.
a The N of schools in each group given in parentheses, beneath mean enrollment for each group.
b r of free/reduced lunch rate and grade 3 enrollment = -.25, $p < .0001$)
c r of free/reduced lunch rate and grade 6 enrollment = -.30,($p < .0001$)
d r of free/reduced lunch rate and grade 9 enrollment = -.46,($p < .0001$)
e r of free/reduced lunch rate and grade 11 enrollment = -.51,($p < .0001$)

The zero-order correlations of size and SES given in the note are all negative and highly significant. Moreover, this negative association of socioeconomic status and size increases in magnitude with grade level. The general tendency is revealed by the data in the columns and rows of Table 7, which also give an impression of the numbers of impoverished and affluent students served by schools of various size. In general, the smaller schools in West Virginia in 1990 tended to enroll students from impoverished backgrounds. This tendency increases with grade level; small high schools are more likely to serve impoverished students than are small elementary schools.

The overall picture that emerges from the school-level regression analyses is that in West Virginia, among regular-education students in 1990, (1) the indirect (interactive) effect of school size on achievement is a better predictor of student achievement than either school size or socioeconomic status alone (Table 3); (2) the nature of the prediction is that increases in school size imply increasingly more severe negative effects among impoverished children (Table 4); and (3)

impoverished children, as compared to more affluent children, generally attended smaller schools (Tables 5, 6, and 7). Finally, the data reported in Tables 5 and 6 strongly suggest what other studies (e.g., Huang & Howley, 1993) have found, namely that small school size tends to disrupt the negative influence of socioeconomic status on the achievement of impoverished students.

County-level results. The basic analysis here is exactly parallel to the school-level analysis, with the exception, as previously noted, that an alternative measure of socioeconomic status is available to join the analysis (percentage of population aged 20 and older with educational attainment less than grade 12). Because of the character of free and reduced lunch rates, in which it was suspected that observed rates underestimated the actual prevalence of eligibility at the secondary level, the district-level free and reduced-price lunch rates were not computed as weighted averages of the all school-level rates. Instead, the district rates were based on weighted averages of the rates for grades 3, 6, and 9 only. The results derived from the socioeconomic status variable constructed in this way and for the alternative measure (the census attainment variable) were quite similar, in any case.

As in the school-level analyses all three variables in the Friedkin and Necochea model were entered first, followed by backward stepwise removal of the least significant variable. Removal was stopped when all remaining variables were significant at $p < .05$. All analyses exclude the state's largest county, which was identified in preparatory analysis as a statistical outlier.

Tables 8 and 9 report the results of the regression analyses with (1) free and reduced-price lunch rates and with (2) the alternative measure of socioeconomic status. Since there are four grade levels and two equations for each, Tables 8 and 9 provide data relevant to eight equations. Table 8 gives statistics about the final regression equations and Table 9 reports the related effect sizes on achievement.

Table 8

Summary of Hierarchical Regression Analyses for the Friedkin and Necochea Model: 54 West Virginia School Districts With Two Measures of Socioeconomic Status (Eight Equations)

Grade Level	Variables in the Equation	B	SE B	
3a,1	grade 3 enrollment	+.018044	.008636	+ .65
	interaction term	-.000519	.000254	- .64
3b,2	grade 3 enrollment	+.023862	.008743	+ .86
	interaction term	-.000745	.000273	- .86
6a,3	grade 6 enrollment	+.017703	.006257	+ .90
	interaction term	-.000532	.000177	- .96
6b,4	grade 6 enrollment	+.020666	.006135	+1.05
	interaction term	-.000653	.000182	-1.12
9a,5	grade 9 enrollment	+.031034	.007436	+1.16
	interaction term	-.001079	.000209	-1.44
9b,6	grade 9 enrollment	+.032255	.007445	+1.21
	interaction term	-.001155	.000217	-1.49
11a,7	grade 11 enrollment	+.029209	.007644	+1.10
	interaction term	-.000960	.000221	-1.24

11b,8	grade 11 enrollment	+.038620	.006825	+1.45
	interaction term	-.001327	.000210	-1.62

Note. All regression coefficients significant at $p < .05$. Residuals normally distributed for all equations (N= 54).
a Free and reduced-price lunch as SES variable.
b Educational attainment < grade 12 as SES variable.
1 F nonsignifi. ($p = .1160$); $R2=.08$; Durbin-Watson = 1.7
2 F significant ($p = .0266$); $R2=.13$; Durbin-Watson = 1.8
3 F significant ($p = .0154$); $R2=.15$; Durbin-Watson = 2.2
4 F significant ($p = .0032$); $R2=.20$; Durbin-Watson = 2.1
5 F significant ($p = .0000$); $R2=.36$; Durbin-Watson = 2.0
6 F significant ($p = .0000$); $R2=.37$; Durbin-Watson = 2.0
7 F significant ($p = .0003$); $R2=.27$; Durbin-Watson = 1.9
8 F significant ($p = .0000$); $R2=.44$; Durbin-Watson = 2.0

Table 9

Effect Sizes of District Enrollment on CTBS Composite Basic Skills Achievement Test Scores for Varying Levels of Socioeconomic Status (Two Measures of Socioeconomic Status)

	rate of socioeconomic status variable a,b									
Grade	5%	15%	25%	35%	45%	55%	65%	75%	85%	95%
3a,1	+.56	+.37	+.18	.00	-.19	- .38	- .57	-.76	-.94	-1.13
3b,2	+.73	+.46	+.20	-.08	-.35	- .62	- .89	-1.16	-1.43	-1.70
6a,3	+.77	+.50	+.22	-.05	-.32	- .59	- .86	-1.13	-1.40	-1.67
6b,4	+.89	+.55	+.22	-.11	-.44	- .78	-1.11	-1.44	-1.78	-2.11
9a,5	+.96	+.56	+.15	-.25	-.66	-1.07	-1.47	-1.88	-2.28	-2.69
9b,6	+1.0	+.56	+.13	-.31	-.74	-1.18	-1.61	-2.05	-2.48	-2.92
11a,7	+.92	+.56	+.20	-.17	-.52	- .89	-1.25	-1.61	-1.97	-2.33
11b,8	+1.20	+.70	+.20	-.29	-.79	-1.29	-1.79	-2.29	-2.79	-3.29

Note. Values calculated from the partial differential of the applicable regression equations The first grade 3 equation, as noted in text, is nonsignificant. Effect size equations, which follow in footnotes 1-8, are based on equation 3, as given in Appendix A; that is, effect size $=(a + cy)(s(x)/s(z))$, where x denotes the size variable and z denotes the achievement variable.
a Free and reduced-price lunch rates as SES variable.
b Educational attainment < grade 12 as SES variable.
1 $es = (.01804 - .000519y)(264.29/7.30)$
2 $es = (.02386 - .000745y)(264.29/7.30)$
3 $es = (.01770 - .000532y)(264.39/5.19)$
4 $es = (.02066 - .000653y)(264.39/5.19)$
5 $es = (.03103 - .001079y)(263.46/7.00)$
6 $es = (.03225 - .001155y)(263.46/7.00)$
7 $es = (.02921 - .000960y)(234.27/6.23)$
8 $es = (.03862 - .001327y)(234.27/6.23)$

All variables in the equations reported in Table 8 are significant at $p < .05$ and each equation (except for the first, where free lunch rate serves as the measure of socioeconomic status) is significant at $p < .05$. The data presented in Table 8 indicate a consistent pattern in both sets of equations (i.e., those for both measures of socioeconomic status) and at all four grade levels (3, 6, 9, and 11). Each equation shows a direct positive effect of size and an indirect (interactive) effect of size and socioeconomic status. These effects, moreover,

generally increase with grade level, as does the amount of variance explained. The pattern is clearest with equations using the alternative measure of socioeconomic status (see footnotes 2, 4, 6, and 8 in Tables 8 and 9). The null hypothesis given in hypothesis 4, therefore, is rejected.

R2 values in these analyses are comparable to those reported by Friedkin and Necochea (1988, p. 246). The R2 values in their district-level analyses vary from .27 to .46. The district-level R2 values in this study vary between .13 and .44. In general, Friedkin and Necochea employed a more comprehensive measure of socioeconomic status, which was readily available to them. This difference not only accounts for higher R2 values but also for the fact that in the present analysis socioeconomic status does not remain significant in the final equations.

One can also observe in Table 8 that the values at each grade level for the main and for the interactive effects of size are nearly equal; the positive direct effects are canceled by the nearly equal negative indirect effect. For the entire population, and across all grade levels, this result means that the overall effect of size is nearly zero. Only when the effects are assessed at differing levels of socioeconomic status do the strong disparities in the effects of size manifest themselves. Table 9 demonstrates this fact.

The increasing magnitude of the direct effect of the size term (increasing from a low of +.65 in the grade 3 equations to a high of +1.45 in the grade 11 equations) and of the indirect effect of size via the interaction term (increasing from a low of -.64 in the grade 3 equations to a high of -1.62 in the grade 11 equations) accounts for the pattern of effect sizes given in Table 9. The combined effects of these two independent variables produced the increasing severity of differential effects of size calculated for differing levels of socioeconomic status.

As shown in Table 9, at grade 3 there are moderate positive effects of size (+.56 and +.73) on district-wide achievement in districts in the highest category of average socioeconomic status, whereas in the lowest category of socioeconomic status the negative effects are at least twice as strong (-1.13 and -1.70). This pattern--substantial negative effect sizes in the districts with lowest socioeconomic status and moderate positive effect sizes in the districts with the lowest socioeconomic status (i.e., high rates of free and reduced-price lunch qualifiers)--is consistent across all equations. It is moreover, consistent with the pattern of results reported by Friedkin and Necochea (1988). The effects in this study also become more extreme as grade level increases. At the 11th grade level the largest positive effect sizes are +.92 and +1.20 versus the largest negative effect sizes of -2.33 and -3.29. In general the negative extremes are about two or three times the magnitude of the positive effects.

Conclusions

The correlational and regression analyses disclose preponderant support for all four hypotheses. The direct association of size and achievement is neither practically nor statistically significant, but, instead socioeconomic status governs the relationship. As in the California study (Friedkin & Necochea, 1988), large size benefits affluent students, but afflicts impoverished students and vice versa. And, as in the California study, the negative effects of size on the achievement of impoverished students are much stronger than the positive effects of size on affluent students. However, small schools and districts in West Virginia were shown in the analysis to disrupt the negative relationship of size and student achievement, whereas the reverse seems to have been true in California. At least in 1990, the smaller schools in West Virginia tended to serve impoverished communities, an association that was strongest at the high school level (see the note to Table 7). Since that time, however, West Virginia has facilitated the closure of many

small schools.

The findings developed in this study provide strong evidence that small school size benefits the achievement of impoverished West Virginia students. The evidence suggests, as well, that increasing school size may produce effects that are the opposite of those that policymakers claim they intend in closing smaller schools.

The Case for the Model

As noted previously, one may complain that the Friedkin & Necochea model avoids variables supposedly known (via the various school effectiveness literatures) to influence student achievement. Some species of production function, on this view, would serve educators much better than an analysis of two structural variables over which educators have little influence.

But critics like Steven Hodas (1993) charge that the notion of an abstract production function substantially misrepresents the nature of teaching and learning. In the view of such critics, teaching and learning are complex, idiosyncratic, and even chaotic. For them, "re-inventing the wheel" is not only unavoidable, it is absolutely necessary. Education production functions, on this view, oversimplify the complexity of schooling as an organic system. In short, the presumption that we can manipulate features of reality in the same way that we can manipulate features of a regression equation is unwarranted.

Far more useful would be an analysis that suggests how educators might leverage the features of existing reality to good effect. Call it the "Zen approach" if you like. The present study and its predecessor provide an example of such an approach, with useful findings. The parsimony of the model might even commend it as appropriate theorizing.

Small schools effectively disrupt a dangerous cycle in education. Small scale-schooling seems to accomplish this miracle without extensive staff development budgets, without widespread dissemination of innovative materials and methods, and without vast systemic aspirations for reform that implicate everything from teacher education to American culture itself in the name of enhanced student performance. In West Virginia in 1990, at least, small schools were going about their good work unremarked and unappreciated; indeed, they were under attack as an embarrassment.

The method employed by this study and by Friedkin and Necochea is not a production-function, nor is it a truncated form thereof. It is, instead, an analysis of the interacting effects of key structures per se. In the present study, neither the need to manipulate key process variables nor the ability to do so is assumed. The assumption of such a model, rather, is that social structures are significant, meaningful, and perhaps--if we design wise analyses--may reveal themselves as determining. These assumptions, of course, are more sociological than educational. The point is that wise policy would work with, rather than against, such structures, when possible, as it appears to be in the present case: the state of West Virginia could seek to retain rather than to eleiminate its small schools. These assumptions and insights owe more of a debt to the sociological than to the pedagogical imagination.

In fact, it is very difficult to believe (on the basis of personal experience) that small schools, serving impoverished students in rural areas of a very rural state are systematically implementing innovative practices that produce the results reported in this study. Instead, it is more likely that the school effectiveness literatures merely point to an assortment of virtues that somehow persist better in small-scale than in large-scale schooling. Most teachers in West Virginia's small rural schools are locals, not cosmopolitans, in Alvin Gouldner's sense of that term; they are generally more committed to the communities where they teach than to pursuit of a brilliant career. For the most part, they are skeptical of state and national reform efforts (Seal & Harmon, 1995), perhaps with

justification. Moreover, these teachers have been shown to cherish a range of values that would subvert any concertedly systematic (or "systemic") scheme of reform (Howley, Ferrell, Bickel, & Leary, 1994). In short, there is probably considerable resistance in West Virginia schools to the grand plans of reformers. Mostly, such plans do not sell well from the courthouse steps: "Rural residents distrust outsiders with big plans for making 'deprived' people want to be 'middle-class'" (Seal & Harmon, 1995, p. 119).

There is one additional, important observation that should be made. It is clear that without a structural model such as that used in this study, the contradictory role that socioeconomic status plays in determining the effects of size will continue to be overlooked, especially given the prevalent commitment to equilibrium theories versus conflict theories. It is, for instance, a bit strange that the original 1988 study, though so often cited in the literatures on school size and rural education, has not been replicated until now.

Whatever the motive, a likely result of such an oversight is that a bogus conventional wisdom (the nostrum that bigger is better) will be replaced with another, but equally suspect, conventional wisdom (e.g., small is always best). Clearly, small is not always best. In West Virginia schools in 1990 seemed well sized to the needs of the population. Sadly, the situation may be changing in that state.

In other states, however, the danger, of the view that small-is-always-best is that it enacts a Malthusian compromise, the greatest good for the greatest number. This utilitarian choice, however, is still preferable to a compromise that imposes sanctions on a great number for the benefit of a privileged minority.

Appendix A

In calculus, the derivative (often written as "dy/dx") gives the value of the change in a dependent variable, y, associated with change in a single independent variable, x. The derivative is a ratio, often construed as a generalized form of slope (familiar in algebra as the ratio of rise over run, or [y2 - y1]/[x2 - x1]). The regression coefficient, of course, provides an estimate of slope in regression analysis, with regression coefficients appearing as constants in regression equations. It is important to note well this fact, since during the process of taking a derivative one distinguishes which values are constant ("constants") from those that which vary ("variables").

Unlike the derivative, the partial derivative (like the partial regression coefficient) is particularly useful in working with equations with two or more independent variables (e.g., as in regression equations). The partial derivative merely gives the rate of change in the function (i.e., the value of the dependent variable) with respect to one independent variable as another is held constant. This resembles the way in which partial regression coefficients give the influence of one variable on another when the influence of a third variable is eliminated.

To calculate the partial derivative, one variable (either x or y) is held constant while differentiation proceeds with respect to the other; the variable "held constant" is treated during differentiation as if it were a constant. Afterwards, in the resulting differentiated equation, values of the variable held constant (socioeconomic status, in this case) can be substituted in order to calculate actual values of the partial derivative function (i.e., to determine the influence of the variable not held constant on the dependent variable with respect to differing values of the variable that was held constant during partial differentiation). In this proposed study, the effects of size on achievement are hypothesized to vary by socioeconomic status, and the partial derivative hypothetically provides a

mechanism to evaluate the differences.

For this study, the applicable partial derivative will give the effect of change in size (defined as cohort-level enrollment) on achievement (CTBS composite scores) as socioeconomic status (free and reduced-price lunch rates and, alternatively, in county-level analyses, percent of the general population with less than a twelfth-grade education) is held constant. The general form of the mathematical model proposed is given by the following equation:

$$f(z) = ax + by + cxy \qquad \text{(equation 1)}$$

where

a, b, and c are the unstandardized regression coefficients (of size, socioeconomic status, and the interaction term, respectively);

z represents values of achievement (the dependent variable);

x represents values of size (one independent variable); and

y represents the values of the socioeconomic status variable (the second independent variable).

Holding y constant, and differentiating z with respect to x, the relevant partial derivative is given by the equation:

$$fx(z) = a + cy \qquad \text{(equation 2)}$$

This equation can be used to calculate the effect on the dependent variable (z, achievement) for differing values of the variable held during partial differentiation (y, socioeconomic status).

Standardizing the partial derivative renders it as an "effect size," which is more easily interpretable than the unstandardized form. The total, standardized effect of school size on achievement (in standard deviation units) is given by the following formula:

$$\text{effect size} = (a + cy)(s(x)/s(z)) \qquad \text{(equation 3)}$$

This is the final form of the regression equations, and it represents the change in achievement (in standard deviation units) expected with change in size (also in standard deviation units) among cases with a particular SES.

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