DOCUMENT RESUME

ED 459 987 RC 023 351

AUTHOR	Johnson, Jerry D.; Howley, Craig B.; Howley, Aimee A.
TITLE	Size, Excellence, and Equity: A Report on Arkansas Schools and Districts.
PUB DATE	2002-02-15
NOTE	49p.
PUB TYPE	Reports - Research (143)
EDRS PRICE	MF01/PC02 Plus Postage.
DESCRIPTORS	*Academic Achievement; Black Students; Educational Equity (Finance); Educational Policy; Elementary Secondary Education; Equal Education; Poverty; *School District Size; *School Size; *Small Schools; *Socioeconomic Influences
IDENTIFIERS	*Arkansas

ABSTRACT

Previous studies in seven states have shown that school and district size consistently mediated the relationship between socioeconomic status (SES) and student achievement, with results critically relevant to state-level policymaking. The present study examined how the relationship between size and achievement varied in Arkansas schools and districts serving students from differing socioeconomic backgrounds. Data on all schools and districts in Arkansas included school district size, school size (enrollment per grade level being analyzed), standardized test scores, SES (proportion of students receiving subsidized meals), and proportion of African American students. Unlike some other states previously studied, school and district size in Arkansas were negatively related to academic performance across the entire range of SES. The negative influence of size was quite weak in affluent settings and comparatively strong in impoverished ones. With regard to achievement equity, the negative effects of poverty on student achievement were considerably stronger in larger schools and districts than in smaller ones. A four-group comparison found inequity of achievement to be magnified within larger schools in larger districts, somewhat muted within smaller schools in larger districts, and dramatically disrupted within smaller schools in smaller districts. A separate analysis found that the negative effects of poverty, size, and the poverty-size interaction were compounded in schools and districts serving predominantly African American students. Recommendations are offered to Arkansas policymakers. Appendices present calculations of the incremental effect on achievement of size increases or decreases, and a list of 19 related reports. (SV)

Size, Excellence, and Equity:
A Report on Arkansas Schools and Districts

Jerry D. Johnson
Craig B. Howley
Aimee A. Howley

Educational Studies Department
College of Education
Ohio University
Athens, Ohio

February 15, 2002

Executive Summary

Previous reports (e.g., Bickel & Howley, 2000; Friedkin & Necochea, 1988; Howley & Bickel, 1999; Huang & Howley, 1993) have shown that school and district size consistently mediate the relationship between SES and student achievement, with results critically relevant to state-level policy making. The present study extends this work to Arkansas. Previous studies in this line of inquiry—some of which were known as "the *Matthew* Project"—examined the relationships between size, achievement, and socioeconomic status in Alaska, California, Georgia, Ohio, Montana, Texas, and West Virginia. Results in Arkansas are notably consistent with the results of the previous studies.

Excellence Effects

Regression equations were used to predict overall school and district test scores from measures of size, socioeconomic status, and the interaction of size and socioeconomic status. These equations show the extent to which variability in student achievement is regulated by the interaction of SES with school and district size. As with other studies in this series, the negative influence of school and district size on academic performance is more pronounced in impoverished communities than in affluent ones. In Arkansas, however, unlike some of the states previously studied, these negative effects persist across the entire SES range from quite affluent to very impoverished: the negative influence is quite weak in affluent settings, and comparatively strong in impoverished ones. Seldom is the influence of size positive, and in the few cases in which positive influence exists, it is comparatively weak.

Equity Effects

Correlations between SES and aggregate school achievement were computed in subsets of (1) smaller and larger schools, (2) smaller and larger districts, and (3) smaller or larger schools within smaller or larger districts—with subsets determined by dividing schools and districts at the median of the size variable (roughly 57 students per grade for schools and 745 students for districts). The results of these correlations, when squared, yield the proportion of variance in scores accounted for by SES (in other words, the shared variance between SES and achievement in these subgroups created by dividing size at the median). Comparing corresponding scores (i.e., same grade level and achievement measure—reading, mathematics, etc.), we find that the negative effects of poverty on student achievement are considerably stronger in larger schools and districts than in smaller ones (or viewed another way, that smaller schools and districts are considerably more successful in disrupting or mitigating the relationship between poverty and student achievement). In the four-group comparison (larger schools in larger districts, smaller schools in larger districts, larger schools in smaller districts, and smaller schools in smaller districts), we find that the inequity of achievement is magnified among larger schools in larger districts, somewhat muted among smaller schools in larger districts, and *dramatically disrupted* among smaller schools in smaller districts. This is good news about structural influences on inequity, exactly parallelling findings reported in a similar study conducted two years ago in Georgia (Bickel & Howley, 2000).

Other Analyses

We compared the mean size for subsets of schools based upon the following distinguishing criteria: highest quartile African-American students versus the other quartiles, Delta versus non-Delta, and metropolitan versus nonmetropolitan. Results indicate that African American students attend larger schools, particularly in schools with a tenth grade (i.e., high schools). Mean size comparisons for the Delta v. non-Delta and metro v. non-metro analyses did not reveal practically differences. We also computed part correlations from regression equations conducted in each quartile grouping indicated above. Results in this case were dramatic. For the quartile of schools with the highest percentage of African-American students in Arkansas the negative effects of poverty, size, and the interaction between poverty and size are compounded in schools and districts that serve predominantly African-American students.

Policy Implications

The creation of larger schools and districts in educational systems serving impoverished communities or African-American communities would be predicted to harm the equity and excellence of school and district performance in Arkansas. In view of these findings, a blanket policy of district consolidation and school closures in Arkansas would constitute a calculated strategy to undercut the excellence and equity of significant educational outcomes. It would, we believe, be a costly mistake.

Instead, we recommend that educational decision makers (1) build on the strength of smaller district size, (2) retain existing and build new smaller schools, (3) address the dilemmas posed by size in rural and African-American schools and districts, and (4) create smaller districts from larger ones.

Size, Excellence, and Equity:
A Report on Arkansas Schools and Districts

Increasing student achievement is the primary concern of decision makers at every level of government and education—local, state, federal. Historically (at least in the past few decades of school reform) efforts to improve student achievement have focused for the most part on manipulating educational inputs or processes, (e.g., curriculum materials, teaching strategies, teacher qualifications and expectations), without the active and thoughtful consideration of other potential leverage points such as structural variables.

By contrast with those sources of potential leverage, this report, and the line of inquiry to which it further contributes, is concerned with how structural aspects of schooling—in particular, school and district size—can be understood to influence school performance, and, more particularly, how structural manipulations of the educational system might be used in the service of improving achievement and equity outcomes.

The strongest and most prevalent threat to normal academic achievement for individuals is poverty. For the student who comes from a poor family, the prospect of meeting with academic success is clouded. For those impoverished children who attend school with other impoverished children, the odds of attaining normal levels of academic accomplishment grow even worse. Moreover, the effects are cyclical: impoverished students are far more likely to attend economically and pedagogically at-risk schools that operate in communities without the resources to intercede in the cycle. In other words, they face great challenges with very limited means. Students from affluent backgrounds, by contrast, confront fewer challenges with far greater resources. It is no wonder that schools serve as the primary sorting mechanism in an increasingly stratified society. We operate them that way—perhaps not on purpose, but arguably through bad choices, inattention, and occasionally outright negligence.

If some simple structural aspect of the schooling mechanism could be marshaled so as to address this disparity, to break (or at least disrupt) this cycle, and diminish the power of family socioeconomic status (SES) in predetermining the academic performance of individuals, we should embrace it. The line of inquiry that this study extends is geared toward just such a hope.

The Line of Inquiry

This study extends previous work that has found that the smaller school and district size mitigates the negative effects of poverty on achievement (in Alaska, California, Georgia, Ohio, Montana, Texas, and West Virginia). Findings from these studies suggest that the more impoverished the school community, the smaller should school and district size be in order to maximize student achievement (see, e.g., Howley & Bickel, 1999). See Appendix B for a complete listing of relevant research reports as well as interpretations for practitioner and lay audiences.

To investigate whether or not these relationships are also important to schools in Arkansas, we tested an "interaction hypothesis" of school and district size, which puts forward *the possibility that the strength and directionality of the relationship of size to achievement is linked to (or contingent on) community socioeconomic status.* In other words, we are testing the notion that the best size for schools and districts—in terms of their capacity to cultivate academic excellence (and, as it turns out, equity)—depends on the poverty level in the communities they serve.

This line of inquiry has for some time offered valuable insights that extend the research base beyond the numerous studies reporting that the measurable relationship between size and achievement is small if not insignificant. Use of the interaction term (size and SES operating in tandem) moves inquiry beyond testing how size and achievement are related in *all* schools (or districts) to testing how the relationship between size and achievement *varies* in schools (or districts) serving students from differing socioeconomic backgrounds. In informal terms, then, the line of inquiry to which this study contributes asks whether school and district size is beneficial or harmful to students and to what extent, in view of community socioeconomic status. The previous studies, noted above, have confirmed the hypothesis in other states (weakly in Montana, which maintains many small schools and districts, but strongly in Alaska, California, Ohio, Georgia, Texas, and West Virginia; see Bickel & Howley, 2000, and Howley & Bickel, 1999; Huang & Howley, 1993).

Arkansas Policy Context

On May 25, 2001, the system by which the state of Arkansas distributes funds to schools was declared to be unconstitutional for the third time in less than 20 years (Lake View School District v. Mike Huckabee, 2001), and the legislature was directed to fix the problem. The Lake View district had originally filed a class action suit in 1992, claiming that the state's funding system was unconstitutional because it provided levels of funding insufficient for schools to meet state standards. The resulting funding scheme, however, was again challenged by Lake View in the fall of 2000, leading to the 2001 ruling that affirms the claim that the state continues to fall short in providing adequate funding.

The new ruling includes an additional, but related, finding. In his May 25 ruling Chancellor Collins Kilgore went beyond affirming claims about inadequacy of funding to rule that the existing system was inequitable as well (Fine, 2001). That is, not only did the court determine that the level of funding provided to schools in Arkansas is inadequate, it also found that the system by which that funding is distributed unfairly favors some districts.

Methodology

Data comprising information reported by the state of Arkansas, merged with data the NCES Common Core of Data, were used to prepare two distinct datasets: district level and school level. As in the previous replications in this line of inquiry (e.g., Bickel & Howley, 2000; Friedkin & Necochea, 1988; Howley, 1996), we included data from all schools and districts in the state (i.e., our "sample" was the total population). In the case of such studies, the calculation of significance levels is not considered necessary, because the observed measurements are not generalized from a subgroup to the entire group; they are, instead, measurements that directly and accurately characterize actual relationships prevailing in a population.

Variables. Our dependent variables represented school- and district-level achievement. All Arkansas students are tested at grades 5, 7, and 10 (Stanford Achievement Test 9, "SAT" hereafter); and grades 4 and 8 (Benchmark Test, with separate tests for literacy and math; "Benchmark" hereafter). SAT scores, which represented total performance on all achievement subtests, were reported as mean percentile ranks. Benchmark scores used in this study represented the proportion of students scoring at the "proficient" level or higher. Scores in the data set had been aggregated to the school and district level before we received them.[1]

All achievement test scores were available for (1) "combined students" and (2) "general students." The general student scores exclude the scores of IEP (special education) and LEP (limited English Proficiency) students, who take the tests under varying conditions and with varying modifications and accommodations. We examined relationships with regard to each set of scores—i.e., general and combined—but we report results only for the "general" scores—which we regard as more reliable because of the widely divergent conditions under which IEP and LEP students are assessed. Results were not markedly different, however.

For the school-level analyses, in each data set and for each assessment (i.e., SAT and Benchmark), we were provided with multiple years of scores—three years (1998, 1999, 2000) for the SAT scores; two years (1999 and 2000) for the Benchmark scores. For the purposes of these analyses, we computed our dependent variable by averaging the multiple years of scores, when available, for each individual achievement measure (e.g., 98-00 SAT grade 5 general, 99-00 Benchmark Literacy grade 4 general). These three-year (SAT, grades 5, 7, and 10), two-year (Benchmark, grade 4), and one-year (Benchmark, grade 8) scores served as the dependent variables in our equations. For the

[1] Typically, aggregated scores given as percentile ranks would be based on standard scores or raw scores of individual students aggregated to the appropriate level (school or district). We do not know if this was the procedure followed to derive the SAT percentile ranks for schools and districts in this data set. Averaging percentile ranks would be the alternative procedure, an alternative that would tend to weaken observed results, in which case the reported results could be viewed as conservative representations of extant relationships in the underlying constructs.

district-level analyses, however, test scores were not available from multiple years; scores from the 1999-2000 academic year were used for district-level analyses.

Our independent variables operationalized constructs of "size" and "SES." Following procedures used in the previous replication studies, we chose as our measure of school size *the ratio of total school enrollment to number of grade levels* (enrollment per grade span). This measure allowed us to control for the possible confounding effects on size of school grade span configuration (i.e., a K-8 school with an enrollment of 300 is considered in this study to be about half the size of a K-4 school with an enrollment of 300).

Testing for skewness in size measures, we found that the distribution included many smaller schools and districts and many fewer larger schools and districts (positive skew, about 2.3 for schools and above 5.0 for districts). In order to provide the (unskewed) normal distributions that are required by regression analysis, we transformed our size variables by taking the natural logarithm of each value. This transformation reduced skewness to nearly zero (skewness ~ -.10).

As a proxy for socioeconomic status, we used the proportion of school and district enrollment receiving subsidized meals. There are limitations associated with the use of this proxy, and these are considered later in this report (in the "Limitations" section). The variable used in the analyses was constructed, like the achievement measures, by averaging the multi-year (1998, 1999, 2000) subsidized meal rates. Such averaging may help to mitigate some of the shortcomings of our SES proxy.

In each of the equations, the size and SES variables were centered in accordance with the method developed by Cronbach (1987), in order to reduce the collinearity of related independent variables—an especially important procedure, given the nature of our interaction term.[2] Because the two variables from which it was derived are themselves centered, it was not necessary to center this variable (Cronbach, 1987). That term is simply the product of our logged and centered size variable and our centered SES variable.

Data analysis. Following methods employed in the previous studies, we used regression equations to predict aggregate student achievement for schools and districts (dependent variable) from the following independent variables: (1) school and district size, (2) school and district socioeconomic status, and (3) the interaction of size and socioeconomic status at both school and district level. This third independent variable, the interaction term, is of greatest concern in these replications because its strength governs the hypothesized relationship between size and achievement. The regression equations are all of the following form:

$$\beta_1(\text{size}) + \beta_2(\text{SES}) + \beta_3(\text{size} * \text{SES}) = \text{achievement},$$

where "ß" indicates the regression coefficients of the specified independent variables.

Because in 13 of 14 regression equations, the regression coefficient of the interaction term (β_3) proved to be statistically significant, we calculated the magnitude of that net influence of size (as an "effect size") using a method pioneered by Friedkin and Necochea (1988) and applied in the ensuing studies by Bickel and Howley (e.g., Bickel & Howley, 2000; Howley, 1996; Howley & Bickel, 1999).[3]

[2] Collinearity results from strong correlations among independent variables. Since the interaction term is the product of the other two terms, collinearity is a likely event (i.e., the variables would be likely to correlate highly with the product of both of them). The problem is that collinearity would inflate the error of our measures of the strength of influence (i.e., error associated with the regression coefficients). Centering drastically reduces collinearity, and in these analyses it has eliminated the threat.

[3] The Friedkin and Necochea method of deriving such effect sizes from regression equations is described in detail by Howley (1996; see the Appendix to that article).

Additional analyses were performed as a means of bringing to light some practical implications of the findings. These included an analysis of the possible "equity effects" of small size of schools and districts. As in other studies, we hypothesized that smaller schools and districts would mitigate the damaging influence of poverty on achievement. Confirmation of this hypothesis raises the possibility that the pattern of "excellence" in smaller schools and districts serving impoverished communities is a by-product of greater equity. Not only might excellence and equity *not* be mutually exclusive, but under certain circumstances they might prove to be mutually reinforcing.[4] In high poverty schools and districts, academic performance ("excellence") would theoretically improve if the bond between SES and achievement—which is quite strong—were weakened. The issue, then, is whether or not this phenomenon actually pertains to Arkansas schools and districts across the board—*regardless of community SES.* Our question therefore is this: "Is the relationship between SES and achievement weaker in smaller schools and districts?"

To test this possibility, we divided districts and schools at the median of size (into the larger half and smaller half) and computed the correlation between SES and achievement for each half. Squaring the correlation coefficient yields the proportion of variance shared by SES and achievement. Low shared variance, from this perspective, indicates greater equity, and higher shared variance greater *in*equity. Computation of variances allows for comparisons across size categories, indicating the different levels of

[4] This hypothesis is not so far-fetched as it might sound. Mark Fetler (1989), for instance, discovered that higher achievement was consistently associated with *lower* dropout rates, once the influence of SES and school size had been statistically controlled. Fetler's was an unexpected finding, since students who leave high school before graduation frequently have low test scores and their absence—all else equal—would have been expected to produce a *positive* influence on school performance. This proved not to be the case, contrary to expectations.

influence SES exerts over achievement in smaller versus larger schools and districts. Variance *not* shared, of course, might be influenced by any number of conditions other than SES (e.g., student effort and interest, a school's organizational culture, a district's curriculum, national or state standards, and so forth). For all seven test scores, we made comparisons of smaller and larger schools, of smaller and larger districts, and of smaller and larger schools *within* smaller and larger districts, according to the subgroups formed by median splits of the data.

To investigate whether larger and smaller size was itself equitably distributed, we compared the mean size of schools (cohort size at testing grade levels—i.e., 4, 5, 7, 8, 10) and districts among various subsets—percentage African-American enrollment quartiles, metropolitan versus nonmetropolitan areas, and Delta versus non-Delta region.

Additional analyses were conducted to determine whether the effect of the independent variables on student achievement differed (in terms of strength and directionality of the effect) among subsets determined by the racial composition of students served by the school or district. For these analyses, we divided schools and districts into quartiles based on proportion of African-American enrollment, and the same regression equations as for the main analysis were run again in each quartile (i.e., highest percentage of enrollment, mid-high, mid-low, and lowest). Part correlation coefficients (also called "semipartial correlation coefficients") were calculated on the basis of these regressions, then squared to determine the unique shared variance with school and district performance. Comparing the results for the different subsets (i.e., percentage African-American quartiles) allows us to see the extent of the differences in strength of those independent variables as predictors of aggregate student achievement.

Results

We report results in three main sections: (1) results of regression equations, (2) results of correlations between SES and achievement by size halves (the unit—school or district—divided at the median size), and (3) other analyses, including comparison of mean size among subsets along with and the unique contribution (part correlation) analyses by African-American percentage quartiles. The regression results tell us something about excellence (i.e., the circumstances that would be predicted to enhance student achievement), whereas the correlations by size halves tell us something about equity (i.e., the circumstances that would be predicted to weaken the bond between poverty and achievement). The analyses by quartiles of African-American school and district population allow us to see the extent to which these variables differ in their power over schools with varying student populations. Within each section, results are reported separately for (1) school-level analyses and (2) district-level analyses. The correlational analysis also includes a two-level analysis (schools within districts) of size influences on the equity of school performance.

Regressions (schools). We regressed each of the achievement measures (SAT grades 5, 7, and 10; Benchmark at grades 4 and 8) on the pertinent size, SES, and interaction terms (i.e., centered logged cohort size, centered subsidized meal rate, and the product of those two). Table 1 reports the school-level results for the SAT "general" test scores.

Table 1
Summary of Regression Analyses for Variables Predicting School-level Performance on the Stanford Achievement Test at Grades 5, 7, and 10

Variable	B	SE B	β
Grade 5 (N= 461)			
Size	-1.925	.621	-.124**
SES	-.457	.022	-.777***
Interaction (Size x SES)	-.07302	.029	-.108*
Grade 7 (N=309)			
Size	-.444	.453	-.047
SES	-.314	.025	-.609***
Interaction (Size x SES)	-.06200	.024	-.122*
Grade 10 (N= 321)			
Size	-2.256	.510	-.274***
SES	-.298	.023	-.721***
Interaction (Size x SES)	-.06654	.020	-.180***

Note: adjusted R^2 = .503 for grade 5; R^2 = .343 for grade 7; .373 for grade 10
*$p \leq .050$, **$p \leq .010$, ***$p \leq .001$

The results in Table 1 show that the effects of size, SES, and the interaction term on this achievement measure (SAT) all confirm the expected direction (i.e., negative), and all but one (size, grade 7) constitute statistically significant ($p \leq .05$) terms in the respective equations. Consistent with the findings of previous studies, statistical significance is strongest at grade 10, where the negative effects of each variable are highly significant ($p \leq .001$). We have previously (e.g., Howley, 1996) hypothesized that size effects are *cumulative*, although we have as yet not been able to test this hypothesis.

Table 2 reports the school-level results for the Benchmark Test (general scores).

Table 2

Summary of Regression Analyses for Variables Predicting School-level Performance on the Benchmark Test at Grades 4 and 8

Variable	B	SE B	β
Grade 4 Literacy (N=514)			
Size	-1.691	.980	-.075
SES	-.540	.0328	-.655***
Interaction (Size x SES)	-.08698	.044	-.091*
Grade 4 Math (N=508)			
Size	-1.568	.962	-.068
SES	-.614	.0328	-.697***
Interaction (Size x SES)	-.145	.044	-.143***
Grade 8 Literacy (N=318)			
Size	-1.508	.816	-.106
SES	-.245	.044	-.309***
Interaction (Size x SES)	-.107	.043	-.138**
Grade 8 Math (N=299)			
Size	-1.100	.576	-.108
SES	-.210	.031	-.369***
Interaction (Size x SES)	-.131	.030	-.242***

Note: adjusted $R^2 = .363$ for gr. 4 Lit.; $R^2 = .409$ for gr. 4 Math; $R^2 = .099$ for gr. 8 Lit.; $R^2 = .186$ for gr. 8 Math

$*p \leq .050$, $**p \leq .010$, $***p \leq .001$

As is the case with the SAT equations in Table 1, the equations in Table 2 show that the variables of size, SES, and the interaction term each exerts an influence in the expected negative direction. Not surprisingly, statistical significance is strongest for the

SES variable ($p \leq .001$ on each of the four measures). Readers should note that the proportion of variance in achievement accounted for by these independent variables (i.e., size, SES, and the interaction of the two) is similar to that reported in prior studies investigating the relationships among size, SES, and achievement. [5]

In Tables 1 and 2 the influence of the interaction terms is important because it indicates that the influence of size on achievement is not constant, but varies with changes in the SES level of the school. Although the influence of size is "more positive" in affluent than in impoverished communities (as has been the case in previous studies), in Arkansas the direct and indirect (interactive) influences of school size on achievement are negative virtually across the entire SES spectrum.

Table 3 presents calculations of the net influence of school size on achievement (i.e., effect sizes) for all the tests and grade levels presented in the preceding regression tables (i.e., the 3 levels of the SAT and the 2 levels and 2 subject areas of the Benchmark test). The numbers represent the magnitude and direction of predicted change in student achievement related to an increase in school size. The chosen statistic, "effect size," gives the change in standard deviation units expected in achievement for each standard deviation change in logged school size. A change of -.38, for instance in 10th grade SAT scores, is computed as -.38 x 7.6348: a decline of about 2.91 percentile ranks.

[5]On the SAT 50% (grade 5), 34% (grade 7), 37% (grade 10); and on the Benchmark tests 36% (grade 4 literacy), 41% (grade 4 math), 10% (grade 8 literacy), and 19% (grade 8 math).

Table 3

Net Influence of School Size in Standard Deviation Units of Achievement ("Effect Sizes")

Deciles of Poverty	Stanford Achievement Test: 5th Grade	Stanford Achievement Test: 7th Grade	Stanford Achievement Test: 10th Grade	Arkansas Benchmark Test: 4th Grade (Literacy)	Arkansas Benchmark Test: 4th Grade (Math)	Arkansas Benchmark Test: 8th Grade (Literacy)	Arkansas Benchmark Test: 8th Grade (Math)
1 (richest)	-.01	+.11	-.01	-.01	+.04	+.09	+.24
2	-.04	+.08	-.06	-.04	-.01	+.05	+.16
3	-.05	+.05	-.10	-.06	-.05	+.02	+.10
4	-.07	+.02	-.13	-.08	-.07	-.02	+.06
5	-.10	-.01	-.16	-.10	-.10	-.05	.00
6	-.11	-.03	-.19	-.11	-.13	-.08	-.05
7	-.14	-.07	-.25	-.14	-.17	-.12	-.11
8	-.16	-.10	-.30	-.17	-.22	-.15	-.17
9 (poorest)	-.21	-.16	-.38	-.20	-.27	-.23	-.23

deciles of poverty	schools with a fifth grade	schools with a seventh grade	schools with a 10th grade
1	31.50	26.10	17.02
2	40.89	32.10	24.59
3	47.06	36.43	29.22
4	52.53	40.17	33.33
5	56.00	44.86	37.34
6	61.05	49.07	41.95
7	67.24	53.85	47.73
8	73.41	57.83	54.15
9	83.35	69.55	64.64

Note. Deciles of poverty vary with school level. Statistics in the second panel represent the proportion of students (three-year average) receiving subsidized meals, in percentages.

Effect sizes are calculated for schools with higher and lower subsidized meal rates to illustrate the change in the influence of size across the SES spectrum. We represent differences in SES by dividing the distribution into deciles (10-percentile increments) on the basis of the percentage of students receiving subsidized meals in a school. In fact, using the effect-size equations,[6] effect sizes could be calculated for any value of our SES variable.

Observe that in Table 3, the values in every cell in three of seven columns are negative and that in only two columns (7th grade SAT and 8th grade math) do the effect sizes in the most affluent schools exceed +.10. Effect sizes, either positive or negative, less than the absolute value of .10 (i.e., $es \leq |+/-.10|$) have marginal practical significance. This observation means that in the most affluent 30% of schools, all else equal, school size would be predicted to yield a small positive influence (in three cases) or moderate positive influence (in one case) on school performance. Elsewhere school size is shown to have a predictable negative influence, and in the poorest communities (50th percentile of poverty and poorer) school size has a moderate negative influence that has an important practical implication. The practical implication is this: *increases in school size in these communities will likely erode school performance from existing levels.*

This implication has surfaced in analyses using data from other states, but in Arkansas, the negative influence of school size prevails nearly across the *entire* SES spectrum. Whereas in comparatively affluent Arkansas communities, somewhat larger

[6]Computed directly from the regression equations. The effect-size equations thus computed (partial derivatives of the regression equations with SES held constant) are not reported here but are available from the authors (and computable based on instructions provided in the Appendix to Howley, 1996; for an online version of that report, see the following URL: http://olam.ed.asu.edu/epaa/v3n18.html).

sizes might yield a minimal increase in test scores, in most Arkansas communities such increases would not likely be associated with improved school performance. In fact, in perhaps *half* the schools in Arkansas, such increases would be associated with probable declines in school performance, a probability of decline that increases toward the lower end of the SES spectrum.

The Appendix[7] to this report provides an explanation of how to apply the effect sizes in Tables 3 (and Table 6, the equivalent report for districts) to predict the achievement consequences of incremental changes in the size of particular schools or districts.

Regressions (districts). We regressed each of the achievement measures (SAT at grades 5, 7, and 10; Benchmark at grades 4 and 8) on the pertinent size, SES, and interaction terms (i.e., centered logged cohort size, centered subsidized meal rate, and the product of those two). Table 4 reports the district-level SAT "general" results.

---

[7] Because the size variable in this (and many other studies of school and district size) is the natural logarithm of the number of students per grade and not simply the number of students per grade, applications employing number of students per grade must take into account the effect of the logarithmic transformation. The Appendix explains such applications in detail and provides two illustrations for readers interested in making such applications.

Table 4

Summary of Regression Analyses for Variables Predicting District-level Performance on the Stanford Achievement Test at Grades 5, 7, and 10

Variable	B	SE B	β
Grade 5 (N= 305)			
Size	-1.667	.579	-.152**
SES	-.343	.034	-.544***
Interaction (Size x SES)	-.09966	.032	-.154**
Grade 7 (N=306)			
Size	-.676	.575	-.062
SES	-.328	.032	-.546***
Interaction (Size x SES)	-.08826	.030	-.144**
Grade 10 (N= 306)			
Size	-.248	.485	-.026
SES	-.309	.027	-.586***
Interaction (Size x SES)	-.07811	.025	-.145**

Note: adjusted R^2 = .257 for grade 5; R^2 = .271 for grade 7; .406 for grade 10
*$p \leq .050$, **$p \leq .010$, ***$p \leq .001$

The results in Table 4 show that the effects of size, SES, and the interaction term on this achievement measure (SAT) are all in the hypothesized direction (i.e., negative), and all but two (size at 7th grade and 10th grade) are statistically significant ($p \leq .01$).

Table 5 reports the district-level results for the Benchmark Test (again, for general—i.e., non-IEP, -LEP—assessments).

Table 5

Summary of Regression Analyses for Variables Predicting District-level Performance on the Arkansas Benchmark Test at Grades 4 and 8

Variable	B	SE B	B
Grade 4 Literacy (N=303)			
Size	-2.128	.956	-.124*
SES	-.458	.053	-.481***
Interaction (Size x SES)	-.111	.050	-.114*
Grade 4 Math (N=299)			
Size	-1.951	.971	-.111*
SES	-.470	.055	-.473***
Interaction (Size x SES)	-.176	.052	-.175***
Grade 8 Literacy (N=295)			
Size	-.725	.840	-.052
SES	-.217	.048	-.270***
Interaction (Size x SES)	-.07865	.046	-.096
Grade 8 Math (N=276)			
Size	-.652	.570	-.066
SES	-.223	.034	-.377***
Interaction (Size x SES)	-.142	.032	-.245***

Note: adjusted $R^2 = .196$ for gr. 4 Lit.; $R^2 = .211$ for gr. 4 Math; $R^2 = .065$ for gr. 8 Lit.; $R^2 = .195$ for gr. 8 Math
*$p \leq .050$, **$p \leq .010$, ***$p \leq .001$

Table 5 shows that the influence of size, SES, and the interaction term on this achievement measure (SAT) are all in the hypothesized direction (i.e., negative). At grade 4, for both math and literacy, all three independent variables exert strong influences. At grade 8, SES and the interaction term exert comparatively strong influence on math achievement. For grade 8 literacy, only SES exerts a strong influence. The explained variance for this test at this grade level, however, is extremely low at the district level (6.5%), a condition that makes confirmation of a significant finding more difficult.

Effect sizes to estimate the net effect of district size on district-level achievement are provided in Table 6. The trends are the same as found in the school-level analyses (see Table 3): the influence of district size is generally negative, although in a minority of districts (the most affluent 20%), size exerts a comparatively weaker positive influence. In the poorest 50% of Arkansas districts, however, the predicted influence of district size is negative, with obvious adverse consequences for district performance.

Table 6

Net Influence of District Size in Standard Deviation Units of Achievement ("Effect Sizes")

	Stanford Achievement Test			Arkansas Benchmark Test			
Deciles of Poverty	5th Grade	7th Grade	10th Grade	4th Grade (Literacy)	4th Grade (Math)	8th Grade (Literacy)	8th Grade (Math)
1 (31.60%)	+.02	+.10	+.14	.00	+.09	+.06	+.24
2 (37.00%)	-.03	+.05	+.09	-.04	+.03	+.03	+.15
3 (42.10%)	-.08	+.01	+.05	-.07	-.03	.00	+.06
4 (44.80%)	-.10	-.02	+.02	-.09	-.05	-.02	+.03
5 (48.30%)	-.13	-.05	-.01	-.11	-.19	-.04	-.02
6 (52.30%)	-.17	-.08	-.04	-.14	-.13	-.06	-.07
7 (57.00%)	-.21	-.12	-.08	-.17	-.18	-.09	-.14
8 (62.90%)	-.26	-.17	-.13	-.21	-.24	-.12	-.22
9 (72.90%)	-.36	-.26	-.22	-.28	-.33	-.13	-.33

Note. Proportion of students receiving subsidized meals (1999-2000 school year) diven in parentheses in column 1.

As with the corresponding table for school-level regressions, we provide the previously mentioned Appendix to guide application of these results for existing districts of particular sizes and SES levels. Application to the situation of particular districts *requires* that Table 6 be interpreted with the information provided in the Appendix. An example of a district-level application is provided there.

Critical correlations (schools). The regression results reported in the preceding sections provide information on the relationships of school size to *levels* of achievement.

Another way to approach these relationships is through the lens of *equity of achievement*. Equity of achievement can be accomplished through breaking—or at least substantially mitigating—the prevailing bond between SES and achievement.

The existence of an interaction effect in Arkansas suggests the possibility of an equity effect associated with size. To test this hypothesis, we divided Arkansas's schools into two groups—schools below the median size and schools above it—then calculated correlations (Pearson's r) between SES and aggregate school achievement in each of the subsets. The square of the correlation (r^2) gives the proportion of variance in achievement that can be accounted for by SES. Comparing the values of r^2 in the smaller versus larger groups of schools provides a gauge of the degree of mitigation, if any, exhibited by the smaller schools. Table 7 reports information about these relationships in smaller versus larger schools in Arkansas.

Table 7

Summary of Critical Correlations for Arkansas Schools (N= 538 for larger schools; N = 547 for smaller schools)

Test	ss r	lgs r	ss r^2	lgs r^2
SAT 5	-.60	-.74	**.35**	**.55**
SAT 7	-.53	-.61	**.28**	**.37**
SAT 10	-.51	-.64	**.26**	**.40**
Benchmark 4 Lit	-.49	-.70	**.24**	**.49**
Benchmark 4 Math	-.51	-.73	**.26**	**.53**
Benchmark 8 Lit	-.22	-.42	**.05**	**.18**
Benchmark 8 Math	-.20	-.56	**.04**	**.31**

Notes. All test scores for general (non-IEP, -LEP) student scores.
ss r = correlation of achievement and SES among smaller schools.
lgs r = correlation of achievement and SES among larger schools.
ss r^2 = shared variance of achievement and SES among smaller schools.
lgs r^2 = shared variance of achievement and SES among larger schools.

Table 7 suggests that an equity effect of size exists in Arkansas for all grades (i.e., shared variance, or the ability of SES to "explain" variances in student achievement, is considerably lower in smaller schools than in larger ones). Put another way, poverty has a negative impact on student achievement, but *smaller schools are able to mitigate or even minimize* that negative impact.

Critical correlations (districts). We repeated the correlations by size halves for districts. Table 8 reports information about these relationships in smaller versus larger districts in Arkansas.

Table 8

Summary of Critical Correlations for Arkansas Districts (N= 154 for larger districts; N = 155 for smaller districts)

Test	sd r	lgd r	sd r^2	lgd r^2
SAT 5	-.37	-.67	**.14**	**.45**
SAT 7	-.41	-.64	**.17**	**.41**
SAT 10	-.44	-.69	**.19**	**.48**
Benchmark 4 Lit	-.33	-.58	**.11**	**.34**
Benchmark 4 Math	-.29	-.59	**.08**	**.35**
Benchmark 8 Lit	-.22	-.33	**.05**	**.11**
Benchmark 8 Math	-.23	-.58	**.05**	**.34**

Notes. All test scores for general (non-IEP, -LEP) student scores.
sd r = correlation of achievement and meal rate among smaller districts.
lgd r = correlation of achievement and meal rate among larger districts.
sd r^2 = shared variance of achievement and meal rate among smaller districts.
lgd r^2 = shared variance of achievement and meal rate among larger districts.

As was the case with school level measures (see Table 7), the results reported in Table 8 suggest that an equity effect exists at the district level in Arkansas. That equity effect is strongest at the higher grade levels—grade 8 and grade 10—with differences in shared variance of .29 (.05 versus .34 for smaller versus larger) for grade 8 Benchmark Math, and .29 (.19 versus .48 for smaller versus larger) for SAT grade 10.

Critical correlations (schools cross districts). Table 9 provides a look at the *combined influence of school and district size* on the equity of school performance.

Table 9 presents similar information to that in the preceding two tables, this time for four groups of schools: (1) larger schools in larger districts, (2) smaller schools in larger districts; (3) larger schools in smaller districts; and (3) smaller schools in smaller districts. Because Arkansas maintains only 10 schools that can be classified as "larger schools in smaller districts," correlations (and associated variances) were not calculated (Ten constitutes too small a group from which to calculate the statistics—and some tests had as few as three schools with relevant scores.)

Table 9 provides information about the interaction of school and district size on the equity of school performance. For every test, the observed statistics show a distinct pattern: inequity is greatest among larger schools in larger districts, somewhat less among smaller schools in larger districts, but *inequity is weakest (by far) among smaller schools in smaller districts.*

The patterns in Table 9 bear closer scrutiny, however. Note especially the interactive effect of school and district size on the relationship between SES and achievement. This interaction is evident in the comparatively modest reductions in inequity among *smaller schools in larger districts* versus *larger schools in larger districts* as compared to the more substantial reducations in inequity among *smaller schools in smaller districts* as compared to *smaller schools in larger districts*. One possible way to gauge the comparative extent of reduction is to average the variances in each cell of Table 9 and to calculate and compare the proportional differences from one cell to the next. This is a rough guide since tests are not comparable, but since the pattern observed in Arkansas closely mirrors results previously reported (Bickel & Howley, 2000), it seems a reasonable way to illustrate the interaction effect of district size on school-level achievement equity.

On average across the seven tests, SES accounts for 41% of the variance in school performance among larger schools in larger districts. Among smaller schools in larger districts, 32% of the variance in school performance is accounted for by SES. The difference is roughly equivalent to a one-fifth reduction in the influence of poverty on achievement. That is a healthy reduction, but among smaller schools in smaller districts, by contrast, SES accounts for just 15% of the variance in school performance—a reduction of *two-thirds* in comparison to larger schools in larger districts, and a *one-half* reduction in comparison to smaller schools in larger districts. *Smaller district size substantially compounds the positive influence of smaller school size on the equity of achievement—and compounds it well beyond the moderate provided by changes in school size only.*

Different tests and student populations would yield (have yielded in other replications) somewhat different values, but the reductions in inequity associated with smaller school and district size are substantial, and the observed patterns are evident now in six states (that is, now including Arkansas; equity analyses were not conducted by Friedkin & Necochea, 1988, or by Huang & Howley, 1993).

Table 9

Relationship of School-Level Achievement and SES by School and District Size

	larger schools r^2	smaller schools r^2	Test
larger districts	.55	.51	SAT 5
	.38	.33	SAT 7
	.40	.39	SAT10
	.49	.36	Benchmark 4 (literacy)
	.53	.41	Benchmark 4 (math)
	.18	.08	Benchmark 8 (literacy)
	.31	.18	Benchmark 8 (math)
smaller districts		.21	SAT 5
		.27	SAT 7
		.25	SAT10
		.10	Benchmark 4 (literacy)
		.09	Benchmark 4 (math)
		.06	Benchmark 8 (literacy)
		.05	Benchmark 8 (math)

Note. Comparisons are based on school size medians *by grade level* for the seven tests. Taking all schools together (rather than by test by grade level), the school size median (students per grade level) in Arkansas is 70.375 and the district size median is 745 students. Correlations on which the variance reported in Table 9 are based may be computed by taking the square root of the reported variances; all resulting correlations are, of course, negative, since the proportion of a school's students receiving subsidized meals correlates negatively with achievement in all cases, even among smaller schools in smaller districts, where the usual strong relationship is dramatically disrupted.

Additional analyses. We performed several secondary analyses, summarized briefly in this section but not reported in detail. Having investigated the effects of size, SES, and the interaction term on achievement for the entire population of Arkansas schools and districts, we next looked to determine the extent—if any—to which these effects differed among different subsets from among that population. In particular, we looked at subsets that, based upon earlier studies in this line as well as other lines of inquiry, could be considered at-risk.

We compared the mean size for subsets of schools based upon the following distinguishing criteria: highest quartile percentage African-American students versus three other quartiles, Delta versus non-Delta[8], and metro versus non-metro[9]. Results of these comparisons indicate that African-American students attend larger schools, particularly at the grade 10 level (mean size for highest percentage African-American schools is 142.42 versus 95.47 for the other three quartiles [10th grade cohort], and 126.38 versus 96.03 [7th grade cohort]). This finding is consistent with previous studies and is partly accounted for by the concentration of African-American populations in urbanized areas. The finding that the imbalance in terms of size occurs most strongly at the 10th grade level is particularly significant for Arkansas, because it is at the 10th grade level that we have found the strongest effect sizes in the regression analyses ("excellence results"). Since poverty rates are higher for African American students than for other students, size differentials are probably tending to magnify the social inequalities confronting these students.

Mean size comparisons for Delta versus non-Delta and metro versus non-metro were inconclusive, producing varying but insignificant differences (i.e., the means were

[8] Delta schools and districts are defined as those districts whose geographical boundaries are within or correspond to the boundaries of the counties designated as *Delta Region* on the Arkansas Department of Tourism state map.
[9] As per NCES categories.

not dramatically different; the larger versus smaller distinctions differed from one grade level to the next, though without significant practical import).

We also computed part ("semipartial") correlations from the regression equations, in order to examine the unique contributions of the independent variables and to examine whether these unique contributions differed among subsets. Using the same subsets as we did in the mean comparisons, we compared the part correlations for each independent variable. This analysis allowed us to investigate the extent—if any—to which the strength of influence of the individual independent variables on the dependent variable differed for members of the different subsets.

The results were in fact dramatic. In schools with a high percentage of African-American students (highest quartile), the effects of the independent variables, particularly poverty and the interaction term, exerted as much as *three times the strength as in other schools.* The results for the part correlations clearly suggest that, in Arkansas, the negative effects of poverty, size, and the interaction of the two are compounded in schools and districts (both rural and urban) that serve predominately African-American students.

Limitations

Arkansas maintains mostly K-12 school districts, and mandates a standard system of statewide testing (SAT at grades 5, 7, and 10; Benchmark at grades 4 and 8). This standardized approach eliminates the need to account for inconsistencies in testing programs from school to school, an issue that has been faced in earlier investigations of this type in at least one preceding analysis (Howley, 1999). In rural areas of the state, many districts are made up of only one high school—and, in some instances, only a single school at each successive building level (elementary and secondary). In these cases, district-level data simply replicate school-level data.

Our SES measure, free and reduced lunch rate, exhibits reported shortcomings as a proxy for this construct. These rates are subject to conditions unrelated to SES, including (a) willingness to apply for subsidized meals (e.g., rural people, in general, are less likely than others to participate in programs), (b) the procedures that school officials use to secure applications (some schools are more assertive or insistent than others), and (c) the high tendency of secondary students to decline participation. Likely evidence of the latter point can be seen in the difference between the correlation of achievement and subsidized meal rates at the elementary and high school levels: the correlation of meal rates and achievement for schools with a 5th grade in this data set is -.687, whereas the correlation for schools with a 10th grade is weaker: -.581. A likely result of these shortcomings is reduced R^2 values (indicating explained variance) in the regression analyses, especially at the high school level. Nonetheless, the relationship of subsidized meal rates and the other variables in this study did prove sufficiently strong to replicate previous findings. Subsidized meal rates were, in fact, the most commonly used SES proxy in the previous studies). A more sensitive SES measure would probably strengthen already strong associations.

Conclusions and Recommendations

Results in Arkansas are consistent with results reported in Alaska, California Georgia, Montana, Ohio, Texas, and West Virginia. School and district size interact with socioeconomic status in ways that seem to regulate the relationship between size (of schools and districts) and achievement. Smaller size facilitates academic performance among schools and districts serving impoverished Arkansas communities, and it does so significantly whether the measure of performance is a norm-referenced or a state-designed criterion-referenced test. Moreover, in Arkansas, unlike some of the other states studied, the benefit of larger schools and districts among affluent communities is comparatively weak and more limited.

In all tests and grade levels, negative net effects of size (direct plus indirect effects) are observable across most of the SES range. These negative effects are substantial in impoverished communities. Increases in school or district size in these communities would be predicted to yield lower—sometimes dramatically lower—academic performance at both the school and district level.

As in all other states to which the equity analyses have been applied (Georgia, Ohio, Montana, Texas, and West Virginia), inequity in the Arkansas educational system seems to be magnified by larger school and district size and *significantly disrupted* by smaller school and district size. This finding is among the most consistent ever to be reported in educational research—rivaling the strong relationship between SES and achievement; Arkansas now constitutes an additional demonstration.

The news, however, in this case is, once again, good. If school reformers are serious about making systemic reforms that would be predicted to diminish the inequity of school outcomes in Arkansas as in other parts of the United States, keeping schools and districts small would seem to be a most productive policy. *Widespread consolidations of either districts orschools, by contrast, would be predicted to increase inequity and to degrade academic accomplishment in most Arkansas schools and districts.*

Given the policy context in Arkansas, education decision makers will probably be looking for ways to reallocate and, perhaps, to increase school funding—in order to improve fiscal adequacy and equity. We advise policy makers to remember that educational outcomes are the ultimate measure of the success of improvements in fiscal adequacy and equity, and there is a well known principle of policy that suggests the equal treatment of unequals may be the greatest inequality.

This principle is not, however, a reason for wealthy districts to spend more for the education of their children than do impoverished districts. It would be an improvement, in fact, if all districts were required to expend exactly the same funds per student, with wealthy districts expending less than they do now, and impoverished districts expending substantially more (see Kozol, 1991). Vermont has reportedly adopted a system that comes closer than many to Kozol's ideal. In general, however, incremental improvements are more likely to succeed politically.

If making incremental improvements, we advise that education decision makers refrain from adopting policies that enforce widespread consolidations and school closures. The belief that smaller schools and districts are more expensive to operate is generally given as the reason for consolidation and closure, yet the existing literature suggests (a) money is not saved and (b) educational outcomes are likely to be harmed. Smaller schools and districts may be *somewhat* more expensive to operate than larger districts and schools, but that marginally greater expense seems, on the basis of this study and others like it, to be required to improve the adequacy and equity of educational *outcomes*—measured as student achievement on state-mandated tests. Very large districts and schools, however, are both ineffective (they exhibit poor educational outcomes) *and* inefficient (they are more costly).

If there is a better measure of adequacy and equity than that provided by achievement tests, we haven't seen it. Many people, it seems, do not agree with this reasoning. From this perspective, we nonetheless offer four recommendations. We don't offer these recommendations as a prioritized set, but rather as set of issues to be considered simultaneously.

Recommendation No. 1: Build on the Strength of Smaller District Size

> Arkansas, like many states west of the Mississippi River, retains many districts that would be considered small by national norms. Policy makers are advised to regard this circumstance as a decided strength in comparison to states like Georgia, West Virginia, and Kentucky. Widespread district consolidation is, on the terms of this study and its predecessors, likely to degrade the adequacy and equity of educational outcomes in the state. Arkansas is not extreme in the number of districts it maintains, but further district consolidations will likely (1) decrease community and parental involvement in education and (2) erode the excellence and equity of school performance. Furthermore, consolidation will not be likely, even at the expense of excellence and equity of outcomes, to save Arkansas much money.

Recommendation No. 2: Retain Existing Smaller Schools and Build New Ones

Regulations for the construction of new schools should facilitate the creation of smaller schools and the preservation of most existing smaller schools. The regulations should encourage renovation more commonly than is usually the case. Many states have adopted regulations that set high, even arbitrary, limits on minimum size. A school serving 50 students cannot be judged to be "too small" on the basis of any research known to the authors. We recommend that Arkansas not make the mistake of refusing to provide for the construction of schools this small. Not all schools need be small, in view of the findings of this study. But they need to be smallest, often, in precisely those places where they are least likely to be small (i.e., impoverished communities) given the usual exigencies of capital funding for school construction.

Recommendation No. 3: Address Rural and African-American Dilemmas

Arkansas is a comparatively rural state, but educational policies devised for a national clientele, by national experts, usually overlook the unique circumstances that prevail within states. One-size-fits-all policies—often modeled on generic professional norms and national prescriptions for reform—nearly always do more harm than good, in our view. If, as this report suggests, African-American students (many of whom live in urban areas) would prosper in smaller districts and smaller schools, then breaking up larger districts and building more schools makes sense on their behalf. Taking this step does not mean, however, that districts and schools (predominantly rural) with proportionately fewer African-American students ought to be consolidated or enlarged. Many rural students come from impoverished backgrounds; so they, too, benefit from smaller schools and districts. Only urban and suburban schools and districts serving affluent communities can derive possible benefits from increases in size. However, in the case of these schools (generally among the larger half of Arkansas schools already), the need to address other concerns (e.g., school safety) may cast doubts about the choice to increase school size in order to maximize achievement. Addressing such considerations is difficult, so we recommend that strong African-American and rural voices be welcomed at the tables where decisions are made.

Recommendation No. 4: Create Smaller Districts from Larger Districts

According to this report, benefits to the equity of school performance seem to be maximized most consistently among smaller schools in smaller districts. Unfortunately, Arkansas has 550 "larger schools in larger districts." This is nearly 50% of all schools in the state. Many of these schools serve African American urban communities. Maximum benefits to the equity of school performance would be predicted to ensue from making smaller schools *and* smaller districts in these places. Just making smaller *schools* does *not* seem to provide dramatic improvements to school-level achievement equity.

References

Bickel, R., & Howley, C. (2000). The influence of scale on student performance: A multi-level extension of the Matthew principle. *Education Policy Analysis Archives* (Online), *8*(22). Retrieved February 11, 2002 from: http://olam.ed.asu.edu/epaa/v3n18.html

Cronbach, L. (1987). Statistical tests for moderator variables: Flaws in analyses recently proposed. *Psychological Bulletin, 102*(3), 414-417.

Fetler, M. (1989). School dropout rates, academic performance, size, and poverty: Correlates of educational reform. *Educational Evaluation and Policy Analysis*, - *11*(2), 109-116.

Fine, L. (2001, June 6). Arkansas school finance system overturned. *Education Week.* Retrieved February 11, 2002 from: *http://www.edweek.org/ew/ew printstory.cfm?slug=39ark.h20*

Friedkin, N., & Necochea, J. (1988). School system size and performance: A contingency perspective. *Education Policy Analysis Archives, 10*(3), 237-249.

Howley, C. (1996). Compounding disadvantage: The effects of school and district size on student achievement in West Virginia. *Journal of Research in Rural Education, 12*(1), 25-32.

Howley, C. (1999a). *The Matthew Project: State report for Montana.* Randolph, VT: Rural Challenge Policy Program. (ERIC Document Reproduction Service No. ED 433 173)

Howley, C., & Bickel, R. (1999). *The Mathew Project: National report.* Randolph, VT: The Rural School and Community Trust. (ERIC Document Reproduction Service No. ED 433 174)

Huang, G., & Howley, C. (1993). Mitigating disadvantage: Effects of small-scale schooling on student achievement in Alaska. *Journal of Research in Rural Education*, *9*(3), 137-149.

Kozol, J. (1991). *Savage inequalities: Children in America's schools.* New York: Crown Publishing.

Lake View v.Huckabee. No. 1992-5318. Chancery Court of Pulaski County, AR, May 25, 2001. Retrieved February 12, 2002 from the World Wide Web: http://www.ardemgaz.com/week/schools.htm

Meier, D. (1995). *The power of their ideas: Lessons for American from a small school in Harlem*. Boston: Beacon Press.

Sergiovanni, T. (1994). Organizations or communities? Changing the metaphor changes the theory. *Educational Administration Quarterly, 30*(2): 214-226.

United States Department of Education. [Homepage of the National Center for Education Statistics]. Retrieved February 6, 2002 from: http://nces.ed.gov/index.html.

Appendix

Considering the public decisions confronting Arkansas today (i.e., decisions contingent on the courts' directives to address adequacy and equity), educators, policy makers, and citizens are probably attuned to the question: "What will be the probable effects on school and district performance of changes in school and district size?" As our analyses showed, these probable effects must be examined in relationship to school and district SES.

Our findings enable calculations of the incremental effect on achievement of size increases (or decreases) in particular schools and districts with varying SES levels. Thes calculations probably constitute one of the main practical applications of the findings of this study. Because of the characteristics of the size distribution, however, these calculations are not straightforward. The essence of the difficulty lies in the necessary use of a mathematical transformation of data values to study school and district size, as we explain next.

The underlying distribution of the size variable—students per grade—is very highly skewed (smaller schools are more numerous than larger ones). Skewness violates one of the assumptions on which regression analysis is based (normal distribution of variables). This is not an unusual occurrence, and to reduce or eliminate skewness in an original distribution, researchers usually employ mathematical transformations (e.g., taking the natural logarithm of the values, squaring the values, taking the square root of the values). Such transformations essentially turn a curved line into a straight line (or a skewed distribution into a more normally distributed one) so that a valid statistical analysis can be conducted. For the variable "size" in this study (as for other positively skewed variables in other studies, including studies of school and district size), the natural logarithm provides the most effective correction.

If significant findings emerge from a study (as in the present case), the logarithmic transformation introduces a difficulty of interpretation, but one that is nonetheless easily resolved. Policy discussion requires reference to *actual numbers of students* and not *the natural logarithm of numbers of students*. The former expression has common-sense meaning to most people, but the latter does not. Therefore, some procedure for translating backwards from logged to unlogged values is needed. Appendix Tables 1 and 2, included below, provide the needed resolution of this problem.

Whereas the transformed variable (the natural logarithm of number of students per grade) has a constant standard deviation, the backward translation from logged to unlogged values (computing the antilog of a particular logged size) actually entails the creation of *standard deviation units of varying numbers of students*, a variation that depends on the current size of the school (or district) for which a prediction is being made.

Appendix Tables 1 and 2 provide one scheme for representing these differing values of unlogged standard deviation units in numbers of students per grade rather than in logged numbers of students per grade. Evaluations of the unlogged values of standard deviations for a logged variable could, of course, also be provided by percentiles rather than deciles. In this case, however, deciles seemed to provide sufficiently fine-grained values for policy discussions.

Appendix Table 1

Corresponding Values for Standard Deviations of the Natural Logarithm of School Size Expressed as Number of Students

Grade Level	Deciles of size at Grade Level	Size (natural logarithm)	Sigma of size (natural logarithm)	Size plus sigma of size (natural logarithm)	Antilog of size (i.e., students per grade level)	Antilog of size plus sigma (unlogged size one standard deviation above antilog of size)	Unlogged standard deviation (difference of columns E and F)
	A	B	C	D	E	F	G
	1	3.0308	.7162	3.7470	20.71	42.39	21.68
	2	3.4012	.7162	4.1174	30.00	61.40	31.40
	3	3.6874	.7162	4.4036	39.94	81.74	41.80
	4	3.8193	.7162	4.5355	45.57	93.27	47.70
Fifth	5	4.0099	.7162	4.7261	55.14	112.85	57.71
	6	4.1481	.7162	4.8643	63.31	129.58	66.27
	7	4.3444	.7162	5.0606	77.05	157.69	80.64
	8	4.5070	.7162	5.2232	90.65	185.53	94.88
	9	4.8903	.7162	5.6065	132.99	272.19	139.20
	1	3.0681	.9334	4.0015	21.50	54.68	33.18
	2	3.3900	.9334	4.3234	29.67	75.44	45.78
	3	3.6288	.9334	4.5622	37.67	95.79	58.13
	4	3.8430	.9334	4.7764	46.67	118.68	72.01
Seventh	5	4.1054	.9334	5.0388	60.67	154.28	93.62
	6	4.3758	.9334	5.3092	79.50	202.19	122.68
	7	4.8389	.9334	5.7723	126.33	321.28	194.95
	8	5.1259	.9334	6.0593	168.33	428.08	259.75
	9	5.3930	.9334	6.3264	219.86	559.14	339.28
	1	3.0910	.9287	4.0197	22.00	55.68	33.69
	2	3.3989	.9287	4.3276	29.93	75.76	45.83
	3	3.6419	.9287	4.5706	38.16	96.60	58.44
	4	3.8614	.9287	4.7901	47.53	120.31	72.78
Tenth	5	4.0775	.9287	5.0062	59.00	149.34	90.34
	6	4.2716	.9287	5.2003	71.64	181.33	109.69
	7	4.5422	.9287	5.4709	93.90	237.67	143.78
	8	4.9767	.9287	5.9054	145.00	367.01	222.02
	9	5.5182	.9287	6.4469	249.19	630.74	381.56

Note. This table gives deciles of the school size variable for schools with grades 5, 7, and 10 (and valid data for the SAT regression analyses). The (logged) size associated with a given decile appears in column B. The standard deviation of this (logged) variable appears in column C. Column D is the sum of columns B and C (i.e., column C represents a school one standard deviation larger than the school in column B). Columns E and F give the antilogs of the values in columns B and D, respectively. Columns B and D represent numbers of students in a school at the given decile of size and a school one (unlogged) standard deviation of size larger. Column G is the difference between column F and column E—the (unlogged) standard deviation of (logged) size evaluated at the given decile of initial size. See Appendix discussion for further detail and examples.

Appendix Table 2

Corresponding Values for Standard Deviations of the Natural Logarithm of District Size Expressed as Number of Students

Deciles of district size	Size (natural logarithm)	Standard deviation of size (natural logarithm))	Size plus standard deviation of size (logged; B + C)	Unlogged size (district enrollment)	Unlogges size plus one standard deviation of size	Unlogged standard deviation of size evaluated by deciles of size
A	B	C	D	E	F	G
1	5.6095	.9647	6.5742	273.01	716.37	443.36
2	5.9296	.9647	6.8943	376.00	986.63	610.63
3	6.1862	.9647	7.1509	486.00	1275.25	789.26
4	6.3936	.9647	7.3583	598.01	1569.17	971.16
5	6.6134	.9647	7.5781	745.01	1954.91	1209.90
6	6.8134	.9647	7.7781	909.96	2387.73	1477.77
7	7.0934	.9647	8.0581	1203.99	3159.28	1955.29
8	7.4955	.9647	8.4602	1799.92	4723.00	2923.08
9	8.0333	.9647	8.9980	3081.90	8086.89	5005.00

Note. Layout and contents are the same as in Table 1. Column G gives the unlogged standard deviation of district size evaluated at decile intervals of district size using the procedures outlined in the note to Appendix Table 1. See Appendix discussion for further detail and examples.

In short, calculation of predicted achievement changes contingent on increases in school and district size for particular schools and districts depends on (a) SES level and (b) on current size of the school or district. Readers who wish to make such calculations must combine information from Tables 3 and 6 (which give effect sizes contingent on declies of SES) to information in Appendix Tables 1 and 2. We provide several examples of such calculations. (To convert standard deviation units to SAT percentile ranks or Benchmark percent passing, consult Appendix Tables 3 and 4, which provide salient descriptive statistics for our dependent variables at the school- and district-level.)

First school-level example. Consider for instance, an Arkansas high school with a student population in the poorest 20% of all Arkansas schools, and with a 10th grade enrollment equal to the median—about 60 students per grade, or about 240 students in a 9-12 high school. A school of this size is still regarded as a very small high school in most of the United States, although several astute writers on school size (e.g., Meier, 1995; Sergiovanni, 1993) argue that no high school anywhere ought to enroll more than 300 students. What, howver, if an Arkansas high school of this size were to enroll as many students as the average high school in the U.S.? What would the predicted achievement consequences be?

The effect sizes of Table 3 can be applied to the information in Appendix Table 1 to calculate the predicted change. According to the U.S. Department of Education (2002), the average high school enrollment in the U.S. is 752 students, or approximately 188 students per grade. In this school an increase of this magnitude—about 129 students per grade—*triples* the size of the school. Such a change would be associated with a predicted 1.43 standard deviation loss in achievement. This value is calculated as follows. Appendix Table 1 gives 90.34 as the applicable unlogged standard deviation of size for an Arkansas school with a 10th grade in the 5th decile of size (Appendix Table 1, panel 3 [10th grade], row 5, column g). The ratio of 129 and 90.34 yields the predicted achievement effect in standard deviation units.

An achievement loss of nearly one and a half standard deviations is quite large. Recall that two standard deviations difference in test scores is equivalent to the difference between "average" and "gifted." For such students in such a school, a change of this predicted magnitude is educationally catastrophic.

For very small and very poor extant schools, changes of this magnitude in overall size (creating a high school near the national median of size) would induce a predicted deline of nearly two standard deviations in the school performance of the children enrolled in the original school.

Second school-level example. In schools with a fifth grade, at the first decile of size (i.e., schools with about 21 students per grade; see Appendix Table 1, column E), an additional 22 students per grade (see Appendix Table 1, column G) is the approximate number of students associated with the effect sizes indicated in Table 3 in the body of the report—a one standard deviation increase in size for a school of this original size. This backward-transformation of the logged standard deviation applies, of course, to schools of this size with any SES profile given by decile of our SES variable in Table 3 (school-level effect sizes). In conjunction with Table 3, then in the *most affluent* schools, an additional 22 students (per grade level) would be predicted to produce a decline equal to 1/100 of a standard deviation in achievement—a predicted minimal negative impact. With similar logic, at the seventh grade level, in the same sort of school (very affluent, very small) an additional 33 students would likely produce a positive change in achievement equal to about 1/10 of a standard deviation: a small but possibly meaningful improvement

The situation, however, is reversed in the case of schools in the *bottom decile of size* and the *top decile of poverty*. In such schools with a fifth grade, an additional 22 students per grade (a change equivalent to the doubling in size of such a school) would be predicted to entail an achievement decline of about 1/5 of a standard deviation. In the case of the school with a seventh grade, an additional 31 students per grade would be associated with a probable achievement decline of about 1/6 of a standard deviation. Predicted declines of this magnitude are serious threats to school performance.

A simple algorithm for these calculations (schools only) follows:

[(N/L-E) / G] * (ES) = predicted achievement change in standard deviation units, where

N = total enrollment in number of students for school after size is changed,
L = number of grades planned for school after size is changed,
E = unlogged size of current school,
G = unlogged standard deviation of size (from column G) associated with current size,
ES= effect sizes for applicable test given in Table 3.

The expression, [(N/L-E)/G], gives the number of standard deviations of change in size.

Narratively, this formula means: "Take the number of students in the planned school and divide by the number of grades in the planned school. From this quotient, subtract the number of students per grade in the existing school (given in column E). Divide this difference by the unlogged standard deviation of size (given in column G). Multiply this quotient by the applicable effect size given in Table 3. The product is the predicted change in standard deviation units of school performance."

<u>District –level example</u>. In a small district at the 10^{th} percentile of size and the 90^{th} percentile of poverty, the addition of 443 students per grade level (a proportional increase of about 162%--more than doubling the size of the district, from 273 to 716 students) would have a predicted negative influence on SAT 5^{th} grade scores equivalent to more than one-third of a standard deviation. Increasing the size of such a district from 273 to 1,159 (a two-standard deviation increase in size) would have a predicted negative effect of .72 standard deviations—a substantial negative consequence, even though the resulting district would still be considered small in comparison to national norms.

One caveat remains: the foregoing calculations are completely accurate only at decile intervals. Intervening values (between deciles of size) may be interpolated with sufficient accuracy for policy discussions. If more precise estimations are required, percentile tables like those developed for deciles in this Appendix can be produced by the authors.

Appendix Table 3

Descriptive Statistics for Dependent Variabls: School Level

Test	SD	Mean	Skewness	minimum	maximum	N
SAT 5	11.14	46.92	-.33	16.67	76.00	461
SAT 7	8.81	48.09	-.73	7.00	69.33	309
SAT 10	7.63	46.89	-.35	25.00	67.00	321
4 Literacy	15.73	45.03	-.09	4.00	90.00	516
4 Math	16.00	37.84	+.01	4.00	84.50	510
8 Literacy	12.79	23.69	+.91	3.00	91.00	326
8 Math	9.02	15.11	+.98	1.00	55.00	307

Note. SAT scores given in mean percentile ranks. Benchmark scores given in percent passing. SAT scores are three-year averages; Benchamrk grade 4 are two-year averages; Benchmark grade 8 scores are for 1999-2000. (SD = standard deviation; N = number of schools with valid data.)

Appendix Table 4

Descriptive Statistics for Dependent Variables: District Level

Test	SD	Mean	Skewness	minimum	maximum	N
SAT 5	10.49	48.53	-.36	14.00	72.00	308
SAT 7	9.98	49.96	-.26	18.00	77.00	309
SAT 10	8.77	48.32	-.29	20.00	72.00	309
4 Literacy	15.74	46.05	+.04	8.00	93.00	306
4 Math	16.06	40.97	+.04	5.00	83.00	302
8 Literacy	12.66	23.87	+.92	3.00	91.00	298
8 Math	8.88	15.11	+1.05	1.00	55.00	279

Note. SAT scores given in mean percentile ranks. Benchmark scores given in percent passing. All scores for the 1999-2000 academic year. (SD = standard deviation; N = number of districts with valid data.)

Appendix B

Note on Studies Pursuing This Line of Evidence

Noah Friedkin and Juan Necochea's study of California schools and districts (Friedkin & Neocochea, 1988) prompted Craig Howley's dissertation using West Virginia (see Howley, 1996). Four studies (Georgia, Montana, Ohio, and Texas) followed, and were collectively known as "The *Matthew* Project." A subsequent two-level reanalysis of Georgia data (Bickel & Howley, 2000) was published later, followed by a reanalysis of Texas data (Bickel, Howley, Williams, and Glascock, 2001) and the present study. Chapter 2 of Howley's dissertation (included in the list that follows) summarized and critiqued research conducted prior to 1988 that appeared to foreshadow Friedkin and Necochea's proposal that size and SES interacted to influence school performance.

Citations to reelated research reports works, including this one, appear below:

Bickel, R. (1999b). *School size, socioeconomic status, and achievement: A Georgia replication of inequity in education.* Randolph, VT: Rural Challenge Policy Program. (ERIC Document Reproduction Service No. ED 433 985)

Bickel, R. (1999b). *School size, socioeconomic status, and achievement: A Texas replication of inequity in education.* Randolph, VT: Rural Challenge Policy Program. (ERIC Document Reproduction Service No. ED 433 986)

Bickel, R., & Howley, C. (2000). The influence of scale on student performance: A multi-level extension of the Matthew principle. *Education Policy Analysis Archives* (Online), *8*(22). Retrieved February 11, 2002 from: http://olam.ed.asu.edu/epaa/v3n18.html

Bickel, R., Howley, C., Williams, T. and Glascock, C. (2001, October 8). High school size, achievement equity, and cost: Robust interaction effects and tentative results. *Education Policy Analysis Archives, 9*(40). Retrieved October 8, 2001 from http://epaa.asu.edu/epaa/v9n40.html.

Friedkin, N., & Necochea, J. (1988). School system size and performance: A contingency perspective. *Education Policy Analysis Archives, 10*(3), 237-249.

Howley, C. (1995). The Matthew principle: A West Virginia replication? *Education Policy Analysis Archives*, *3*(18). Retrieved February 13, 2002, from http://seamonkey.ed.asu.edu/epaa/v3n18.html.

Howley, C. (1996). Compounding disadvantage: The effects of school and district size on student achievement in West Virginia. *Journal of Research in Rural Education, 12*(1), 25-32.

Howley, C. (1996b). *Sizing up schooling: A West Virginia analysis and critique*. Dissertation Abstracts International(A), 57(3), 940. (University Microfilms No. AAT 9622575)

Howley, C. (1999a). *The Matthew Project: State report for Montana*. Randolph, VT: Rural Challenge Policy Program. (ERIC Document Reproduction Service No. ED 433 173)

Howley, C. (1999b). *The Matthew Project: State report for Ohio*. Randolph, VT: Rural Challenge Policy Program. (ERIC Document Reproduction Service No. ED 433 175)

Howley, C. (1999c). *The Matthew Project: State report for Montana*. Randolph, VT: Rural Challenge Policy Program. (ERIC Document Reproduction Service No. ED 433 173)

Howley, C., & Bickel, R. (1999). *The Mathew Project: National report*. Randolph, VT: The Rural School and Community Trust. (ERIC Document Reproduction Service No. ED 433 174)

Huang, G., & Howley, C. (1993). Mitigating disadvantage: Effects of small-scale schooling on student achievement in Alaska. *Journal of Research in Rural Education*, *9*(3), 137-149.

Johnson, J., Howley, C., & Howley, A. (2002). *Size, excellence, and equity: A report on Arkansas schools and districts*. Athens, OH: Educational Studies Department, Ohio University.

Practitioner publications that synthesize this line of evidence include the following:

Howley, C. (1996). *Ongoing dilemmas of school size: A short story* (EDO RC-96-6). Charleston, WV: ERIC Clearinghouse on Rural Education and Small Schools. (ERIC Document Reproduction Service No. ED 401 089)

Howley, C. (1997). Dumbing Down by Sizing Up. *School Administrator*, *54*(9), 24-26,28,30.

Howley, C. (2000). *School district size and school performance*. Charleston, WV: AEL, Inc. (ERIC Document Reproduction Service No. ED 448 961)

Howley, C. (2001). *Research on smaller schools: What education leaders need to know to make better decisions*. Arlington, VA: Educational Research Service.

Howley, C., Strange, M., & Bickel, R. (2000). *Research about school size and school performance in impoverished communities*. Charlteson, WV: ERIC Clearinghouse on Rural Education and Small Schools.

U.S. Department of Education
Office of Educational Research and Improvement (OERI)
National Library of Education (NLE)
Educational Resources Information Center (ERIC)

ERIC REPRODUCTION RELEASE

I. **Document Identification:**

Title: Size, excellence, and equity: A report on Arkansas schools and districts

Author: Jerry D. Johnson, Craig B. Howley, Aimee A. Howley

Corporate Source: Ohio University, Dept. of Educational Studies

Publication Date: February 15, 2002

II. Reproduction Release:

In order to disseminate as widely as possible timely and significant materials of interest to the educational community, documents announced in the monthly abstract journal of the ERIC system, Resources in Education (RIE), are usually made available to users in microfiche, reproduced paper copy, and electronic media, and sold through the ERIC Document Reproduction Service (EDRS). Credit is given to the source of each document, and, if reproduction release is granted, one of the following notices is affixed to the document.

If permission is granted to reproduce and disseminate the identified document, please check one of the following three options and sign the release form.

✓ Level 1 - **Permitting reproduction and dissemination in microfiche or other ERIC archival media (e.g. electronic) and paper copy.**

Level 2A - Permitting reproduction and dissemination in microfiche and in electronic media for ERIC archival collection subscribers only.

Level 2B - Permitting reproduction and dissemination in microfiche only.

Documents will be processed as indicated provided reproduction quality permits. If permission to reproduce is granted, but no box is checked, documents will be processed at Level 1.

Sign Here: "I hereby grant to the Educational Resources Information Center (ERIC) nonexclusive permission to reproduce and disseminate this document as indicated above. Reproduction from the ERIC microfiche or electronic media by persons other than ERIC employees and its system contractors requires permission from the copyright holder. Exception is made for non-profit reproduction by libraries and other service agencies to satisfy information needs of educators in response to discrete inquiries."

Signature: Jerry D. Johnson — Position: co-researcher

Printed Name: Jerry D. Johnson — Organization: Ohio University

Address: 2638 Virginia Avenue, Ashland, KY 41102 — Telephone No: (606) 326-0018

Date: 2/14/02

III. Document Availability Information (from Non-ERIC Source):

If permission to reproduce is not granted to ERIC, or, if you wish ERIC to cite the availability of the document from another source, please provide the following information regarding the availability of the document. (ERIC will not announce a document unless it is publicly available, and a dependable source can be specified. Contributors should also be aware that ERIC selection criteria are significantly more stringent for documents that cannot be made available through EDRS.)

Publisher/Distributor:

Address:

Price per copy: Quantity price:

IV. Referral of ERIC to Copyright/Reproduction Rights Holder:

If the right to grant this reproduction release is held by someone other than the addressee, please complete the following:

Name:

Address:

V. Attach this form to the document being submitted and send both to:

Velma Mitchell, Acquisitions Coordinator
ERIC Clearinghouse on Rural Education and Small Schools
P.O. Box 1348
1031 Quarrier Street
Charleston, WV 25325-1348

Phone and electronic mail numbers:

800-624-9120 (Clearinghouse toll-free number)
304-347-0467 (Clearinghouse FAX number)
mitchelv@ael.org