DON'T SUPERSIZE ME: THE RELATIONSHIP OF CONSTRUCTION COST TO SCHOOL ENROLLMENT IN THE U.S. [2]

Craig B. Howley

ABSTRACT

Conventional wisdom holds that economies of scale necessitate the construction of larger schools: anything done bigger is presumed to be done cheaper. The study reported here doubted that claim with respect to school construction. It posed two questions: (1) are larger high schools less costly to build than smaller schools and (2) what contextual variables predict cost? Just one scholarly peer-reviewed article has examined the relationship of construction cost to size, and conventional wisdom continues to prevail. Lack of scholarly interest in these questions is surprising, perhaps scandalous, in view of the large sums spent and the political battles often waged when new schools are built. The findings show that the smaller half of these 9-12 schools (planned to enroll from 138 to 600 students) were, on average, no more expensive per student to build than the larger half (planned to enroll 601-999 students) and were less costly per square foot ($96 vs. $110, significant at $p < .01$). Interestingly, subsequent enrollments for smaller planned schools were shown to have been underestimated, whereas subsequent enrollments for schools planned as "larger" were shown to have been overestimated. These tendencies, in fact, would tend to render planned smaller schools less expensive and planned larger schools more expensive per student, a key cost metric. The findings reported here probably represent conservative estimates. Total cost was well predicted (explaining 76% of variance) by five variables, with total square feet accounting for by far the most variance. Rural location tended to reduce contracted cost. Cost per square foot was less well predicted (25% of variance) by four variables. Cost per student was more fully predicted (40% of variance) by two variables. For all equations, local wealth revenue was associated with higher cost. The report concludes with nine recommendations for school construction planners and five recommendations for researchers.

INTRODUCTION

What do smaller high schools cost to build? Can the nation afford them? Oddly enough, as often happens in education policy, no one really knows because no one has really asked. This situation renders the comparison of costs and benefits quite difficult, to say the least. (Readers are asked to suspend their disbelief momentarily).

Much more, in fact, is now known about benefits than about costs. Among the most notable benefits is an achievement benefit—larger schools and districts embed

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an achievement cost for impoverished students (e.g., Bickel & Howley, 2000; Fowler & Walberg, 1991; Friedkin & Necochea, 1988). In fact, a high school size above about 1,000 students has been shown to be detrimental to the tested achievement of all students regardless of socioeconomic status or poverty (Lee & Smith, 1997). Smaller school and district size are associated with greater equity of achievement measured as weakness of the relationship between socioeconomic status and achievement (Howley & Howley, 2004; see also Friedkin & Necochea, 1989). Smaller high schools also have been shown to be consistently associated with lower dropout rates and higher rates of participation in co-curricular activities (e.g., Fetler, 1989; Morgan & Alwin, 1980). Benefits for smaller schools also are claimed, on the basis of a somewhat weaker base of evidence, for teacher collegiality, school safety, and students' social and emotional development and well being (Cotton, 2001). Many large urban districts have concluded that the evidence is sufficiently strong to warrant policies that reduce the size of their high schools (School District of Philadelphia, 2005).

The present study sought to develop more information about the construction costs of smaller high schools, using information from two national datasets, augmented by telephone contact with study schools. The study investigated high schools partly because so many urban reform initiatives have adopted "small schools" policies (e.g., in Chicago, Los Angeles, New York, Philadelphia, and Seattle) and partly because when, in rural areas, new construction is undertaken, consolidation of two or more smaller high schools is so common.

This study addressed two research questions, as follows:

1. Are planned costs of construction equal for smaller as compared to larger high schools planned to enroll 1,000 or fewer students?
2. How do construction costs for such schools vary in light of school and context variables including planned enrollment, square footage, district revenues, locale, socioeconomic conditions, and ethnicity?

The study adopted 1,000 as the upper limit of total enrollment based in part on the finding that high schools larger than this introduce achievement costs for all students, regardless of race or socioeconomic status (Lee & Smith, 1997). This is a conservative upper limit: The National Association of Secondary School Principals (1999) suggested 600 students as the upper limit. From the perspective of this study, then, a decision to build new schools enrolling more than 1,000 students is not educationally suitable.[3]

3 Another study completed by the author (see Appendix 2 in Lawrence et al., 2005) shows that *mega-schools* (those enrolling more than 500, 750, and 1,000 at elementary, middle, and high schools, respectively) allocate less than half the square footage per student than smaller schools allocate (e.g., those described in the present study). As a result, they are less costly per student. But they have been consistently shown to be much less effective than smaller schools, on average, as noted above. If one must ask whether the nation can afford smaller schools, one must ask if the nation can afford mega-schools that are educationally wasteful of talent. Many observers appear already to agree that it cannot. It's important to understand that not being a mega-

RELEVANT LITERATURE

Several searches of relevant databases assessed the existence of pertinent research. The result of these searches should be considered shocking, given the national propensity to build larger and larger schools. The study found a single peer-reviewed research study of school construction costs in the professional education literature (Azari-Rad, Philips, & Prus, 2002). Use of a variety of ERIC descriptors and search strategies yielded consistently similar results: the relevant literature is thin and superficial. Azari-Rad and colleagues, not surprisingly, refer to *no* prior literature in their study.

The study by Azari-Rad and colleagues (2002) was based on a national data set of accepted bid prices for schools built between 1991 and 1999.[4] The data set used in the study contained information similar to that supplied for the current study (that is, few variables and many cases). Analyses examined all schools together and high schools separately. Size of school in this study was measured by total square feet rather than by planned enrollment, and on this basis the researchers concluded that doubling the square footage of a project increased costs by 91%. They also concluded that a two-school as compared to a one-school option would increase construction costs by an average of 4.7%. Azari-Rad and colleagues, however, reported that this modest advantage is fully offset when "very large schools" are planned because these projects generate demand for local construction talent that is likely to increase costs from 8% to 12%. Their best advice for saving on construction costs had nothing to do with project size (defined as total square feet); they advised simply that school construction be planned for economic downturns, when costs will be lower due to weak demand for construction.

Lack of scholarly research[5] about school construction costs, however, does not indicate lack of interest. The construction industry magazines actively report on school construction, and business magazines and newspapers also report on the trends and issues that emerge in school construction. School construction is very big business indeed. For instance, a reporter for *Building Design and Construction* observed in 2002,

Builders completed more than $62 billion worth of U.S. educational facilities during 2001, an increase of 13 percent over the total for 2000. This growth was iden-

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school does not make a school small. Enrollment of 1,000 in a high school is a large size. A high school enrolling 100 students is a quite small high school. The data set used in this study has a comparable range of high school sizes.

4 The data were collected by a subsidiary of McGraw Hill (F.W. Dodge).

5 The literature search (between 1966 and 2003) also yielded four assessments conducted by Paul Abramson, and just three other relevant publications in *practitioner magazines*. In his latest annual school construction report in an industry magazine, Abramson (2004) observes that smaller high schools (smallest quartile, with a median planned enrollment of 375) appear (a) to be *less costly per square foot* and more spacious than larger high schools and (b) *no more costly per student* than the largest quartile of schools (with a median planned enrollment of 2,100 students).

tical to the growth rate recorded between 1999 and 2000, so there's no disputing the "star" status of the educational sector [of the construction industry]. (Delano, 2002, p. 19)

School construction has an important effect on the availability of decently-paid local or regional jobs, and—obviously—on the profitability of construction companies. From the vantage of the industry, moreover, larger projects entail larger management and design fees, often calculated as a percentage of the cost of the amounts budgeted for materials and labor (Lawrence, Bingler, Diamond, Hill, Hoffman, Howley et al., 2003). The construction industry, therefore, would arguably be the last entity to object to the construction of mega-schools enrolling 2,000 to 5,000 students.

School construction also figures in political agendas in educationally irrelevant ways. A 1998 article in *Crain's Cleveland Business* reported on the "prevailing wage" controversy in Ohio. In 1997, according to the article (Ford, 1998), the state legislature ended "the decades-old practice of requiring the payment of prevailing wages on school projects. . .at the urging of business lobbyists who argued the change would save school districts money." The Ohio School Facilities Commission, which funds school construction in Ohio, affirmed that it did not have the data to support the claimed savings (Ford, 1998). The single academic study in this literature (i.e., Azari-Rad et al., 2002), published three years later, found that such savings are indeed unlikely (based on national, not Ohio, data).

METHODS

This study addressed its research questions by constructing and analyzing a data set that combined information from (a) a large national data set of school construction projects alleged to include only cases (n=3,471) representing new construction with information from (b) the Common Core of Data (CCD), the annual census of all schools in the U.S. conducted by the National Center for Education Statistics. Analysis compared means of construction costs (t-tests) and made predictions about construction costs (ordinary least-squares regression) from salient contextual variables.

Data sets

The study acquired from Paul Abramson, author of School Planning and Management's "Annual Construction Report," a dataset of 3,471 cases of school construction projects (new buildings according to survey respondents) begun in the years 1989 to 2003 for planned completion in the years 1996 to 2009. This data set contained just eight unique variables: state, zip code, educational level (elementary, middle, and high school), total planned (contracted) cost, planned enrollment, planned square feet, planned start year, and planned end year. The substantive variables of interest, of course, were planned cost and size (in planned square feet and planned enrollment).

From the perspective of the research questions, the number of variables in the source data was inadequate. The grade level variable, for instance, did not indicate exact grades; high and low grades were not part of the data set. This lack makes it difficult to compare schools with differing (or even the same) gradespan configurations. Worse still, the data set included none of the contextual variables of interest: information about poverty, race, and locale was all missing. For every school in the nation, however, the CCD does contain such missing information, and the study sought to match cases from the source data set with those in the CCD.

Creating the matched data set. In view of the challenge of accurately matching cases in the two data sets, the study tested an initial matching procedure, and improved the procedure based on the test. Appendix A describes the study's conduct of the test as well as the revised procedure. In brief, purposively selecting for high schools enrolling 1,000 or fewer students, the study matched 211 cases of high schools from the source data set with schools in the CCD. The probability of success was increased by telephone contact with the schools (see Appendix A for details).

Analysis. The augmented data set of newly constructed schools included 211 cases. Importing CCD data and developing an array of derived variables resulted in a data set with 119 relevant variables—as compared to the 17 unique and derived variables ultimately available in the source data set. The added data showed that the augmented data set contained two very distinct high school configurations: 9-12 high schools (n=168) and 6-, 7- or 8-12 high schools (n=41; referred to as 6-12 schools hereafter). The remaining 2 schools were configured quite differently; one was a 10-12 senior high school and the other a 1-12 school. These variations were expected; indeed, the matching process was necessary to identify such differences.

The study elected to concentrate effort on the 9-12 cases for two reasons. First, the 9-12 configuration is now the most common configuration for high schools in the U.S.[6] Second, the comparatively small number of cases of 6-12 schools (n=41), weakened the study's ability to answer the second research question for these schools both because fewer states were represented among the cases and because there were fewer cases. One analysis with the 6-12 schools combined with the 9-12 schools is, however, reported in the results section (where configuration itself is a variable in a prediction equation).

For the focal 9-12 schools (n=168) comparisons of means were computed for size (smaller vs. larger planned enrollment) in order to address the first research question To address the second research question, stepwise regression analyses were conducted on three dependent variables (total cost, cost per student, and cost per square foot) with, in each case, nine predictor variables. The predictor variables were (a) total planned square feet, (b) planned enrollment, (c) average district enrollment for 1997-2001, (d) average district revenue per student for 1997-2001, (e) proportion of

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6 The 9-12 configuration comprises 11,385 of 17,470 schools with grade 12 the highest grade, based on analyses by the author of 2001-02 CCD data; 3,960 such schools had lowest grade lower than grade 9. Approximately 900 schools are K-12 or 1-12 schools. Senior high (10-12) schools are now less common than in previous de-cades.

adult population 25 and older who were high school graduates in 2000, (f) percent of district families with children living above the poverty line in 2000, (g) percentage of students in the school who were African American (natural logarithm transform), (h) planned completion date, and (i) rurality (rural=1). The proportion of the study cases by locale is close to those given in the CCD for extant high schools of the sort studied (i.e., 49.4% vs. 50.8%). Total cost was used as a predictor variable in the regression for square feet per student, where the values of the variable were divided by 1,000,000 to render the regression coefficient interpretable. Predictor variables that were used to calculate the dependent variable (e.g., planned enrollment in the case of cost per student) were of course eliminated from the predictor variable set for the relevant equation.[7] The data were the most recent that could be obtained at the time of the study—varying from 1997 to 2001, depending on the variable.

LIMITATIONS

The match procedure probably does not provide perfect matches; but the initial error rate was quantified, steps were taken to reduce it, and confirmation was sought from schools that appeared to be likely matches (see Appendix A). A more comprehensive and carefully prepared data set would enhance future research efforts substantially (see recommendations).

Generalization from the data set to the nation as a whole seems reasonable for two reasons. The cases are not a random sample but instead constitute the *majority of the universe* of newly and recently constructed schools of this sort. Second, 30 states are represented among the cases. The nature of reality (non-random nature of construction efforts) nonetheless suggests the need for caution.

Generalizations to rural and suburban locales also seem warranted, on a similar basis and with similar caution. Generalizations to cities, however--particularly large cities--are by no means warranted (see Table 2, below). The data set contains just one case from a large city (9 would be expected by chance), and, within a data set of this size, 6 cases rather than 3 would be expected from the mid-size city locale.

RESULTS

Table 1 presents descriptive statistics (mean, standard deviation, and skewness) for 16 selected variables of interest. First, in Table 1 the mean planned and actual enrollments of these high schools are identical, though actual enrollments are predictably more variable than planned enrollments. Second, costs per square foot in this 8-year data set

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7 Variables in the predictor set that were used to compute any of the dependent variables were excluded from use as predictor variables in that analysis, as follows: (a) Total feet square per student was excluded as predictor variable in the regression that used cost per square foot as the dependent variable; (b) total planned enrollment was excluded as a predictor from the regression for cost per student; and (c) both square feet and planned enrollment were excluded as predictors from the regression for square feet per student.

are consistent with those reported by Abramson for 2003 only, with $108 cited there as the national median cost per square foot for new high schools planned to enroll fewer than 850 students (cf. Abramson, 2004). Third, and relatedly, the restrictive selection rules used to create this data set (unique zip code, high school unique in district) did *not* produce sharply different means on cost as compared to information reported by Abramson. Fourth, rural schools (CCD locale codes 7 and 8) comprise about half the sample (compared to the national prevalence of about 30%). Our selection rules are doubtless responsible for this difference because on average rural schools fit this profile (enrollment under 1,000) better than other schools. Fifth, the fact that the cost per square foot means reported by Abramson (2004) and by the present study are so close might arguably be interpreted as further warrant for generalizability to the nation as a whole.

Table 1, Descriptive Statistics for Selected Variables, 9-12 Schools

variable	**mean**	**SD**	**skewness**
planned enrollment	590	203	- 0.12
actual enrollment 01-02	589	364	+ 0.19
planned cost	$12,795,140	$8,290,367	+ 1.79
planned ft^2	122,722	57,138	+ 1.02
planned cost per ft^2	$102.43	$40.74	+ 1.82
planned cost per student	$21,508.58	$10,792.78	+ 1.41
planned ft^2 per student	215.49	85.70	+ 0.94
school subsidized meal rate	25.93%	17.88%	+ 1.17
school percent minority	14.98%	21.08%	+ 2.11
school percent African American	6.28%	14.46%	+ 3.71
district adults w/at least HS grad	35.02%	7.37%	- 0.22
instructional expend per student	$4,065.31	$668.38	+ 0.85
district revenue per student	$7586.95	$1,601.68	+ 1.48
district membership	2,791	4,710	+ 6.65
district families above poverty line	89.59%	8.36%	- 1.57
rurality (1= rural)	.49	.50	+ 0.24

note 1. n =168 schools from 30 states (AL, 4; CA, 1; CO, 5; CT, 2; DE, 1; GA 9; IA, 2; ID, 5; IN, 1; KS, 2; KY, 5; MA, 3; ME 1, MI, 24; MS, 7; NC, 1; NE, 3; NH, 2; NY, 1; OH, 27; OK, 3; OR, 2; PA, 4; SC, 1; TN, 11; TX, 33; UT, 2; VA, 1; WA, 2; WV, 3)
note 2. The minimum planned enrollment was 138 and the maximum 962.

Table 2 reports the CCD locales for all 9-12 schools in the data set. The CCD data in Table 2 represent the prevalence of schools of the sort planned for construction in this data set. For 2001-2002, there were 6,795 regular 9-12 high schools in the U.S. enrolling fewer than 1,000 students. The universe of such schools cannot be interpreted as a guide for the representativeness of the study data set simply because some states have active programs, whereas others are relatively inactive. Nonetheless, the two data sets show surprisingly similar distributions, with the exception of cities. Generalizability to the nation as a whole seems at least arguable.

First research question

Are planned costs of construction equal for smaller as compared to larger high schools planned to enroll 1,000 or fewer students? Table 3 reports cost comparisons, with schools divided into two groups—smaller and larger—at the median of planned enrollment. For each group, means and standard deviations are reported for a number of variables of interest, in addition to cost. Three of the four cost-related variables exhibit statistically significant differences. By comparison, not one of the six contextual variables exhibits statistically significant differences.

Table 2, Number of Schools by Locale, 9-12 High Schools

	Study Cases		CCD Universe	
Locale	**N**	Pct.	***N***	Pct.
large city	1	0.6	375	5.5
mid-size city	3	1.8	222	3.3
fringe large city	23	13.7	803	11.8
fringe mid-size city	16	9.5	521	7.7
large town	0	0	21	0.3
small-town	42	25.0	1375	20.2
rural (nonmetro)	42	25.0	2406	35.4
rural (metro)	41	24.4	1045	15.4
missing	0	0	27	0.4
Total	168	100	6,795	100

note. CCD cases represent universe of 9-12 schools enrolling fewer than 1,000 students.

Table 3, Cost Differences, Smaller as Compared with Larger 9-12 Schools, Planned Enrollment Basis

variable	smaller schools (n=87) mean	SD	larger schools (n=81) Mean	SD
planned enrollment****	426	118	767	100
actual enrollment (01)	487	359	699	338
planned cost****	$9,530,127	$5,570,334		$9,277,583
cost per ft^2**	$95.73	$35.89	$109.61	$44.48
cost per student	$22,171.65	$11,332.37	$20,796.40	$10,203.66
ft^2 per student****	238.94	98.62	190.32	60.30
state rev per student	56%	15%	54%	14%
rurality	.49	.50	.49	.50
high school grads	34%	8%	36%	7%
district mdn fam inc	$46,465.69	$12,158.86	$48,662.81	$12,370.11
percent fam nonpov	89%	8%	91%	8%
dist revenue per stud	$7,490.05	$1,612.59	$7,688.62	$1,593.79

note 1. ****p<.0005; ** p<.01; * p < .05
note 2. Schools divided on median of planned enrollment, i.e., 600 students.
note 3. Schools from 27 states represent smaller schools (36 of 87 cases from MI and TX).
note 4. Schools from 18 states represent larger schools (31 of 81 cases from MI and OH).

What do the results in Table 3 suggest? With respect to costs, smaller schools are less expensive than larger schools per square foot, but they cost the same per student as larger schools. Further, the smaller schools in this data set allocate 26% more space to each student as compared with the larger schools. Conservatively, one can conclude that smaller high schools are not, in general, more expensive to build new than larger high schools, within the enrollment limits set by the study.

Second research question

How do construction costs vary in light of contextual variables including planned enrollment, square footage, district revenues, locale, socioeconomic conditions, and ethnicity? The study approached this question via a series of regression analyses that employed a uniform set of nine predictor variables (exceptions described previously).

The analyses regressed four dependent variables on this set of predictors: (a) total cost in dollars, (b) cost in dollars per square foot, (c) cost in dollars per student, and (d) total feet square per student. In all cases, the analyses were conducted as stepwise regressions.

Table 4 reports the results for the regression analyses. Panel 1 reports results for total cost, panel 2 for cost per square foot, panel 3 cost per student, and panel 4 square feet per student. Information about only the final step of the regressions is reported in Table 4. For all regressions, however, every applicable predictor was specified for possible entry (except as noted previously).

Only for the total cost equation does a regression model account for most of the variance in the dependent variable (76% in the total cost equation given in panel 1, with total square feet accounting for most of the explained variance). For the other three cost-related equations, the combined influence of all independent variables accounts for less than half the variance (40% for cost per student; 25% for cost per square foot, and 23% for square feet per student). No equation, however, accounts for a trivial amount of variance, always a possibility in an unexplored field of education research.

For the total-cost equation (panel 1), which includes five of the nine predictor variables as statistically significant, the most of any of the four equations, square feet alone accounted for 68% of the variance in cost (β = .80). Every thousand square feet increased mean total cost by about $115,000 ($115 per foot times 1000), with other (much more minor) influences controlled. Except for end date (interpretable as inflation), the other variables reflect community wealth, which tended to increase cost (rural areas are poorer on average than non-rural areas). Notably, planned enrollment exerted no influence residual of those appearing in panel 1.

Table 4, Regression for Variables Predicting Costs for 9-12 Schools

Panel 1: Total Cost in Dollars

variable	**B**	**s.e. B**	**β**	**t**	**p**
square feet	115.122	5.08	.800	22.662	.000
end date	758,036.90	139217.05	.191	5.445	.000
revenue per student	704.89	170.29	.146	4.139	.000
Rural	-1,498,198.82	575,478.73	-.091	-2.603	.010
families above poverty line	82,402.92	35,708.28	.081	2.308	.022

note. First step adjusted R^2 = .68; ΔR^2 from first to fifth step = .08; fifth step adjusted R^2 = .76

Panel 2: Cost in Dollars per Square Foot

Variable	**B**	**s.e. B**	**β**	**t**	**p**
end date	5.380	1.237	.273	4.348	.000
revenue per student	.006	.001	.271	4.366	.000
planned enrollment	.027	.012	.138	2.197	.029
families above poverty line	.674	.314	.133	2.143	.033

note. First step adjusted R^2 = .12; ΔR^2 from first to fourth step = .13; fourth step adjusted R^2 = .25

Panel 3: Cost in Dollars per Student

Variable	B	s.e. B	β	t	p
square feet	.102	.010	.541	9.938	.000
revenue per student	1.703	.344	.269	4.948	.000

note. First step adjusted $R^2 = .33$; ΔR^2 from first to second step = .07; second step adjusted $R^2 = .40$

Panel 4: Square Feet per Student

Variables	B	s.e. B	β		
million dollars of planned cost	4.304	.646	.412	6.666	.000
end date	-14.112	2.565	-.340	-5.502	.000

note. First step adjusted $R^2 = .12$; ΔR^2 from first to second step = .11; second step adjusted $R^2 = .23$

Cost per square foot (panel 2) was predicted by four variables, most strongly (β = .27) by end date (inflation factor) and revenue per student (β = .27) combined. Every additional year for completion date was associated with a $5.38 increase in mean cost per square foot (an inflation factor of about 5%), and every $1000 of additional revenue per student increased cost per square foot by about $6.00. Weaker influences were planned enrollment (β = .14) and percentage of district families with incomes above the poverty line (β = .13). Every increment of 100 students of planned enrollment increased mean cost by $2.70 per square foot and every 10% change in the proportion of families above the poverty line increased cost per square foot by an estimated $6.70. The fact that planned enrollment increased cost per square foot, all else equal, is contrary to the conventional wisdom that larger enrollments produce economies of scale.

Cost per student (panel 3) was predicted by square feet and by revenue per student. Building footprint, again, exerted much the stronger influence (β = .54), but with that influence controlled, district funding affluence separately influenced cost per student (β = .27). Again, size (in this case measured by square feet) increased cost per student, all else equal: Every 100 additional square feet increased mean cost per student by about $1.00. With respect to the influence of revenue per student, one might hypothesize that, whatever the building footprint, decision makers in more affluent communities purchase more costly amenities (quality of flooring, facade treatment, HVAC options and so forth). Every $1000 dollars of additional revenue per student increased mean cost per student by $1.70.

Square feet per student (panel 4) was predicted by two variables of approximately equal influence, million dollars of planned cost (β = .41) and end date (β = -.34). Each million dollars of planned total cost was associated with an additional 4.3 square feet per student (i.e., a larger footprint is, not surprisingly, more expensive than a smaller footprint). In this equation, end date was uniquely, and perhaps surprisingly, associated with a reduction in square feet per student of approximately 14 square feet per student. All else equal, this finding could indicate that one way planners have countered rising total costs is to reduce the footprint of schools, and this reduction over time would logically translate into a reduced space allocation per student.

One additional regression analysis relevant to the second research question was possible, using high school grade-configuration type (9-12 or not 9-12) as a predictor variable. This analysis used cost per student as the dependent measure, in view of the importance of that variable to planners. Cost per square foot (results not reported) was not significantly influenced by high school type, but cost per student was. Table 5 reports the results.

With 6-12 schools represented in the data set and with a dummy variable for high school type (9-12 school = 1), four variables predict cost per student in the combined data set. In contrast to the regression reported in panel 3 of Table 4, both rural and 9-12 schools enter the equation as significant predictors, explaining slightly more total variance (42% vs. 40%). Both variables tend to reduce cost per student, but their unique influence in this regard is comparatively weak (i.e., together they explain an additional 2% of the observed variance in cost per student, once the strong influence of square feet and revenue per student is taken into account).

Table 5, Regression of Cost per Student for 9-12 and 6-12 High Schools

Variable	B	s.e. B	β	t	p
square feet	.105	.011	.554	9.950	.000
revenue per student	1.708	.345	.269	4.952	.000
9-12 high school	-3719.051	1524.72	-.137	-2.439	.016
Rural	-2591.732	1193.45	-.120	-2.172	.031

note 1. n = 206 due to missing data

note 2. First step adjusted R^2 = .33; ΔR^2 from first to fourth step = .09; fourth step adjusted R^2 = .42

note 2. dummy variable values: rural = 1; 9-12 high school =1

note 3. 78% of the 6-12 schools (n=41) were located in rural places; mean district membership was 1,925 (SD=2,738); mean enrollment was 496 (SD=219); and mean total cost was $11,689,487.

DISCUSSION

Are planned costs of construction equal for smaller as compared to larger high schools enrolling 1,000 or fewer students? Once the decision is made *not to build very large schools*, contracted costs for larger and smaller high schools cannot be said to vary appreciably, based on findings from this study. The findings show that the smaller half of these 9-12 schools (planned to enroll from 138 to 600 students) were, on average, no more expensive *per student* to build than the larger half (planned to enroll 601-999 students) and were less costly per square foot ($96 vs. $110, significant at p < .01).

One detail from Table 3 deserves particular attention. Smaller planned schools (enrollment basis) projected an average enrollment of 426 students, but subsequently enrolled more students, 486 on average. Larger schools (enrollment basis) projected an average enrollment of 767 students, but subsequently enrolled fewer students, 699 on average. In other words, planned costs per student of the smaller schools were, on average, overestimated, whereas planned cost per student of the larger schools were, on average, underestimated.

The second research question examined the variation in planned construction costs related to context. It asked, in essence, "What *does* predict cost among these 9-12 high schools?"

Total cost was well predicted (explaining 76% of variance) by four variables, with footprint (total square footage) accounting for nearly 90% of the explained influence (i.e., 0.68/0.76). Rural location tended to reduce costs, whereas the other predictors were associated with increased costs. Contrary, perhaps, to conventional wisdom, planned enrollment exerted no separate influence.

Cost per square foot was less well predicted (25% of variance) by: (a) inflation (construction end date), (b) local revenue wealth, (c) planned enrollment, and (d) proportion of families not living in poverty. Contrary to conventional wisdom, planned enrollment (all else equal) tended to *increase* cost per square foot, all else equal, consistent with Azari-Rad and colleagues (2002).

Cost per student was more fully predicted than cost per square foot, with 40% of the observed variance accounted for by just two variables, footprint and local revenue wealth. All else equal, schools with larger footprints and wealthier clientele cost more per student. The effect of enrollment could not be separately assessed, of course, because planned enrollment was used to construct the dependent variable. The study also found that 9-12 (as opposed to 6-12) configuration and rural location exerted weak *negative* influences on cost per student.

Square foot per student. The space allocated per student was predicted by planned cost and end date. Not surprisingly, all else equal, more space costs more money. A surprising finding was that schools completed later allocated less space (14 square feet less) per student. This might indicate that one way that planners attempt to control costs is by reducing footprint size, all else equal.

RECOMMENDATIONS

Given the findings, this report makes recommendations for the practice of planning high schools of appropriate—educationally productive—size. It also poses recommendations for researchers' consideration. The recommendations for practice are more numerous because entrenched misconceptions, firmly lodged in policy, have made it difficult to plan smaller schools as new construction.

Recommendations for practice. The nine recommendations that follow address school board members, community advocates, school administrators, and legislators and their staffs. These recommendations extend the findings of this study to the issues of practice related to building and operating schools; that is, the broadly applicable research and policy context is taken into consideration in their formulation. The recommendations follow:

1. Be comparatively confident that within the range of educationally productive high school size (9-12 enrollment under about 1,000 students), larger schools are not less costly to build than smaller ones (and vice-versa).
2. Understand that the influence of existing state regulations pushes local planning efforts towards the construction of larger schools (Lawrence, 2001).
3. Join with one another to modify the application of state regulations governing school size, to win variances from such regulations, and, finally, to get them changed.
4. Create long-term plans at state and local levels that permit construction to occur during economic downturns (Azari-Rad et al., 2002) as the most effective way to minimize construction cost.
5. Do not expect operating-cost savings from consolidation. Existing studies of operating costs show no significant difference before and after consolidations (e.g., Schwinden & Brannon, 1993; e.g., Streifel *et al.*, 1991). Making this argument to win the support of taxpayers is not simply to mislead the public, but to manipulate it.
6. For further counsel on operating costs of smaller schools, see the work of Lawrence and colleagues (2005, 2003).
7. Build schools of an appropriate size for the community. No one size is best. The appropriate size depends on circumstance (see #8).
8. Peg school size to community poverty level, building smaller schools in more impoverished communities. Very small high schools (fewer than 200 or so students) are appropriate in some circumstances.
9. If planning a 9-12 school smaller than about 600 students, let stakeholders know that available research (this study) suggests your enrollment projections may be an underestimate, and that underestimates of student enrollment result in overestimates of cost per student.

A key part of the challenge confronted by planners who, contrary to conventional wisdom, want to build smaller schools is how to deal with the deformations, mistaken opinions, and manipulative practices lodged in the conventional wisdom. The forgoing recommendations show the range of possibilities for action.

Recommendations for research. Newly constructed smaller schools come into being *qua* new schools because they are purposively planned that way. Unfortunately, as Lawrence's review (Lawrence, 2001) shows, conventional wisdom about size deforms the planning process in ways that lead construction planners to plan larger rather than smaller schools, at just the time when smaller schools are apparently widely (though not universally) needed. Actual research about the relationship between school size and construction costs is shockingly—irresponsibly—thin, and given the substantial financial interests involved, a few recommendations seem overdue to guide future scientific research (i.e., systematic studies defensibly careful about conceptualization, validity, and responsible with the interpretation of results). Five such recommendations follow:

1. State agencies and especially the federal government (the National Center for

Education Statistics in particular) should start now to build large databases describing the universe of new school construction projects in respectable detail. New buildings should be the initial focus.

2. Such databases should be designed with significant counsel from education researchers interested in the costs and benefits of schools of varying sizes.
3. Research about this issue is at present driven by a practical concern, not a theoretical one—namely the concern to increase the number of smaller schools. This position has defensible empirical warrant, and research into cost of new construction should acknowledge the fact.
4. Research designs and data collection should (as a result of #3) focus on the plans and the planning process, because the planning episode is when the decision to build schools of one size or another is taken (at present, usually resulting in larger rather than smaller schools, and often in schools too large to be educationally defensible). This may be the most critical research recommendation since it embeds the salient ontological necessity (i.e., planning shapes the events under scrutiny).
5. Research designs should address state planning issues and issues of local political, economic, social, and historical context. Rural and urban construction projects, for instance, face sharply different challenges (e.g., new consolidations and altering of existing megaschools, respectively).

These recommendations for research and practice indicate a bare-bones beginning of a research effort that has been needed to support wise practice. The effort is decades overdue but has remained strangely unengaged by both the government and independent researchers. This study, now one of two scholarly, peer-reviewed efforts to engage the needed work, was enabled by a very small allocation from two private foundations.

In the view of the present author, this very modest level of funding demonstrates that critically useful research can be accomplished frugally by independent researchers. The funding also enabled a group of researchers, advocates, and practitioners to assemble for discussions; the construction database accessed and augmented by this study was a result of those interactions.

Lack of resources would therefore seem an unsatisfactory explanation for the durable silence of government and independent researchers. Why has this sorely needed research effort not been engaged? As noted in the literature review, school construction is big business. And the bigger is the school, presumably the bigger is the business. Such opinion, however, may be as much an illusion as the lower cost of larger schools. Perhaps architectural and construction firms that learn to build small schools will succeed by addressing the needs of an emerging market.[8]

One hopes the tide of opinion about the need for smaller school and the feasibility of constructing them new may be changing, but opinion will always need to be examined

8 Architects of Achievement and Concordia have been involved in the design and construction of smaller schools. They can be located easily on the web. Other firms with an interest in helping communities to build smaller new schools may exist.

and doubted and challenged. There is no final word on any of these matters. Thoughtful practice is the overall aim, and a mere opinion is insufficiently thoughtful. Continued research is essential for this reason.

REFERENCES

Abramson, P. (2004, February). Ninth annual school construction report. *School Planning and Management*, 2-16.

Azari-Rad, H., Philips, P., & Prus, M. (2002). Making hay when it rains: The effect prevailing wage regulations, scale economies, seasonal, cyclical and local business patterns have on school construction costs. *Journal of Education Finance, 27,* 997-1012.

Bickel, R., & Howley, C. (2000). The influence of scale on school performance: A multilevel extension of the Matthew principle. *Education Policy Analysis Archives, 8*(22).

Cotton, K. (2001). *New small learning communities: Findings from recent literature*. Unpublished manuscript, Portland.

Delano, D. (2002). Education market still earning honor roll mention. *Building Design and Construction, 43*(4), 19.

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

Ford, T. (1998, November 16). Schools ponder prevailing wage for projects. *Crain's Cleveland Business,* 18.

Fowler, W., & Walberg, H. (1991). School size, characteristics, and outcomes. *Educational Evaluation and Policy Analysis, 13*(2), 189-202.

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

Howley, C. B., & Howley, A. A. (2004). School size and the influence of socioeconomic status on student achievement: Confronting the threat of size bias in national data sets. *Education Policy Analysis Archives, 12*(52).

Lawrence, B., Abramson, P., Bergsagel, V., Bingler, S., Daimond, B., Greene, T., et al. (2005). *Dollars and sense ii: Lessons from good, cost-effective small schools.* Cincinnati, OH: KnowledgeWorks Foundation.

Lawrence, B., Bingler, S., Diamond, B., Hill, B., Hoffman, J., Howley, C., et al. (2003). *Dollars and sense: The cost effectiveness of small schools.*

Lawrence, B. K. (2001). *Effects of state policy structures on facilities planning and construction in rural districts* (ERIC Digest). Charleston, WV: ERIC Clearinghouse on Rural Education and Small Schools.

Lee, V., & Smith, J. (1997). High school size: Which works best, and for whom? *Educational Policy Analysis Archives, 19*(3), 205-227.

Morgan, D., & Alwin, D. (1980). When less is more: School size and social participation. *Social Psychology Quarterly, 43,* 241-252.

National Association of Secondary School Principals. (1999). *Breaking ranks:*

Changing an American institution (4th ed.). Reston, VA: Author.
School District of Philadelphia. (2005). *Fact sheet: School district of: Philadelphia small high school proposal*. Philadelphia, PA: Author.
Schwinden, T., & Brannon, L. (1993). *School reorganization in Montana: A time for decision.* Helena, MT: Montana School Boards Association.
Streifel, J., Foldsey, G., & Holman, D. (1991). The financial effects of consolidation. *Journal of Research in Rural Education., 7*(2), 13-20.

APPENDIX A

Test Match Process

The test matching was done with 40 cases selected at random from the dataset, with matches attempted on the basis of zip code, educational level (elementary, middle, and high school), and planned enrollment. When all 40 cases had been matched in this tentative way, phone calls were placed to the school identified in the CCD (using the "matched" school's phone number as listed in the CCD). Four schools could not be reached on repeated attempts because phone numbers were incorrect. We asked a series of questions to arrive at the judgment of probable match, with the key question asking if the school had experienced substantial new construction in recent years (additions, renovations, or if the school were newly constructed). We also asked about the nature of the substantial new construction.

In 28 of the 36 remaining cases (78%), the success of the matching effort seemed probable based on answers provided by interviewees. Although the construction data set had identified *all* cases as new construction, in fact our respondents reported that only 60% (n=17) were newly constructed schools. Interviewees at the other schools reported a substantial variety of projects including new roofs, new heating and air conditioning installations, portable buildings, and additions. Interviewees were never in any doubt about whether their school had been newly constructed within the past 10 years or not. Taken together, the encouraging news (arguable 78% match rate on the test) and the bad news (40% of cases not new construction) seemed to point to the need to devise an improved match strategy. Such an improvement would be likely, it seemed, if the study could restrict the number of CCD schools presented for matching.

What might accomplish this restriction efficiently in the case of high schools? Cases with zip codes that were unique among schools in the basic data set would do so; this provision would seem to reduce (but not eliminate) the probability of one school within the zip code being confounded with another.

Applying the relevant selection rules to cases in the source data set (i.e., high school level only, unique zip code in source data set, enrollment less than 1,000) 296 cases of the 803 total high school cases were drawn (note that this is a *purposive*, not a random, sample).

Post-draw, one additional selection rule was imposed to improve the accuracy of matches. Based on zip code of school and corresponding district, we excluded 12 cases where the district with the same zip code as the school operated more than two high schools. In another 12 cases, no likely match was evident. Additionally, 3 cases also were excluded because of evidently erroneous information in the basic data set (e.g., zip code mismatch with state—that is, the state in the case record did not contain the zip code given for the school). The remaining 269 cases from the source data set exhibited prospective matches with schools in the CCD—based on matching zip code and enrollment (planned enrollment in the source data set and actual current enrollment in the CCD). Attempts were made to reach all 269 schools, including multiple calls over a span of three weeks. At the end of that time (May, 2004), calling was discontinued as further effort yielded no additional contacts. The study had contacted 244 schools.

In making telephone contact, they study posed two questions to respondents: (a) Is this the only high school in the district? and (b) Was this high school newly built within the past 10 years? Of the 244 schools contacted, 79.1% (193) were the only high school in their district and 86.5% (211) were newly built schools. Table A-1 provides the relevant crosstabulation.

The cross tabulations in Table A-1 also provide confirmation of the success of the purposive sampling rules in identifying newly built schools. For districts in which the contacted high school was not the only high school, respondents at 35% (as compared to 40%) of matched schools contacted denied that they had been newly built. For high schools unique to their operating districts, however, respondents at only 8% of schools contacted (15 of 193) made this denial. With this information in hand, the study determined to perform analyses *only* on schools that were confirmed new construction regardless of whether or not the schools were the only high schools in their respective districts.

Table A-1
Answers to "Two or Fewer High Schools in District" and "Newly Built School"

only high school in district?	**newly built high school?**		
	no	**yes**	**row total**
yes	15 (6.1%)	178 (73.0%)	193
no	18 (7.4%)	33 (13.5%)	51
column total	33 (13.5%)	211 (86.5%)	244