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ABSTRACT

This report examines the relations between school design and student productivity and informs policy decisions. It contains three analytic sections: an analysis of school facilities characteristics and student productivity, a review of other research examining school facilities and student productivity, and an analysis of the need for school construction and renovation within the context of Arizona and Students FIRST (Fair and Immediate Resources for Students Today) legislation. Data collected from 394 schools representing 34,658 students show that school enrollment size is significantly more important to student achievement for Title I students than for non-Title I students. No relationships were found for academic achievement and other school design factors. Relationships between school size and student productivity measures of attendance and promotion (non-academic measures of student productivity) data show statistically small but significant correlations, with larger physical size, higher enrollments, and higher density associated with higher attendance and promotion rates. It is suggested that school administrators and school boards are pressed by the Students FIRST legislation and by the Department of Education's Management and Operations funding to build elementary and middle/junior high schools that are larger than those which support procedures the most achievement by the State's students. Appendices provide acknowlegements and information about Interactive, Inc. (Contains 17 references, 16 tables, and 5 figures.) (GR)

SCHOOL FACILITIES IN ARIZONA:
AN EXAMINATION OF THE RELATIONSHIPS BETWEEN AND AMONG SCHOOL FACILITIES CHARACTERISTICS AND EDUCATIONAL OUTCOMES

by

Interactive, Inc.

Wednesday, June 7, 2000

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1.0 EXECUTIVE SUMMARY

Purpose: This report is in satisfaction of the mandate to examine the relations between school design and student productivity as well as to inform policy decisions. The report contains three analytic sections: An analysis of school facilities characteristics and student productivity, a review of other research examining school facilities and student productivity, and an analysis of the need for school construction and renovation within the context of Arizona and *Students FIRST.*

Procedures: This first analysis examined the notion that - - in addition to what is added by teachers, schools, parents, heredity, personal characteristics (none of which we studied) -- any given educational outcome may also be a function of the school's structural and design characteristics contained within the facility. Using data collected by The Arizona Department of Education (ADE), the Arizona School Facilities Board (SFB), and an Interactive, Inc. telephone survey of facilities, we have examined the relationship between student productivity (dependent variables) and school design and size features (independent variables). This is a post hoc study of 394 schools representing 34,658 students using existing Arizona Department of Education student data and additional facilities descriptors.

School Size and Student Achievement: The relationships between and among size variables, grade configuration within schools, and student achievement are complex and are probably not able to be adequately explored with the data available. In general, size – whether enrollment or square footage – isn't highly related to achievement. For 5th and 8th grade students, the relationships are statistically significant, but not meaningful, with size accounting for less than 5% of the variance in Stanford 9 achievement. For 11th grade students, size accounts for about a quarter of the variance, a strong finding.

Size of school enrollment is significantly more important to student achievement for

Title I students than for non-Title I students.

I In examining the relationships between academic achievement and other school design factors, we found no relationships. For this analysis, we looked at the relationships between school achievement and the following design variables: Thermal factors, classroom lighting, maintenance schedule, school structure, traffic / crowdedness, parking, furniture, privacy, noise level, aesthetics, technology, available facilities, material, color, interior decoration, flooring.

Relationships between school size and student productivity measures of attendance and promotion (non-academic measures of student productivity), we found statistically small but significant correlations, with larger physical size, higher enrollments, and higher density associated with higher attendance and promotion rates.

Although we attempted to examine the relationships between school design features and negative student outcomes such as student retention, dropouts, expulsion, tobacco and substance abuse, and violent and destructive behavior, the small distributions and equally small reports of such behaviors made such an analysis meaningless.

In the end, the meaning of these differences is up to educators and parents. For example, while psychometricians would say that the 10 scale score point difference between 695 and 705 has no practical significance, in terms of effect size, we leave it up to educators to decide whether or not ten points has meaning. It is up to educators and policy makers to decide if the achievement gains that might by realized by reducing the size of schools are worthwhile. Further, this study did not examine measures other than scores on the Stanford 9 of academic productivity. These measures might show something entirely different.

We believe that size relationships should examine both school and district size as well as the influence of SES. The examination of cross-level interactions of SES, school and district size might provide further insights. There is some evidence that scaling is important.

Review of the National Empirical Literature: The national empirical literature on school design issues was somewhat similar to the findings of this analysis. The relationship between school size -- particularly student enrollment - - and student academic productivity is considerably more complex in this study than is reported in the national literature. This finding might be explained by the detail of the analysis in this study, including a student level analysis rather than an aggregate school level analysis, as has been done in the majority of other studies.

These findings have implications for school facility policies, particularly as related to possible incentives for building size.

Implementing *Students FIRST:* As with any new legislation, *Student FIRST* raises questions of implementation. In general, administrators try to build the biggest schools for the least cost in order to apply the savings to other space, other purposes for which there is not state aid. Administrators also believe that bigger schools are less expensive to operate and that they offer more programs. Those beliefs have consequences for teaching programs, student achievement and other school purposes. They also differentially effect school districts by different sizes.

Finally, the process through which M&O eligibility is determined creates difficulties for districts as does the cumulating problem of building maintenance.

Summary: School administrators and school boards are pressed by the operation of the *Students FIRST* legislation and by the Department of Education's M&O funding procedures to build elementary and middle/junior high schools that are larger than the schools which support the most achievement by the State's students.

2.0 THE EMPIRICAL ANALYSIS: School Facilities Characteristics and Educational Outcomes

2.1 PURPOSE AND FRAMEWORK FOR THE EMPIRICAL ANALYSIS

> The board shall review the design differences between the schools with the highest academic productivity scores and the schools with the lowest academic productivity scores...The board shall consider the design elements of the schools with the highest academic productivity scores and parent quality ratings in the development of elementary and high school designs. (*Students FIRST,* Chapter 16, §15-2002 A.6.)

Arizona school officials are making decisions about the construction and renovation of school facilities throughout the state. As one of only 5 states for which large growth (more than 20%) of student enrollments and high school graduates are projected within the next decade[1], Arizona will be faced with decisions about what school facilities to build and where. As Hodgkinson reports, "the greatest demand for school construction will be in communities that have not even been named yet!"

This report seeks to satisfy the legal mandate to examine design differences between low productivity schools and high productivity schools as well as to inform the pending decisions by examining the possible relationships between and among the types of school facilities available to students and student productivity.

2.2 SUMMARY OF METHODS

2.2.1 Methods. This analysis examined the notion that - - in addition to what is added by teachers, schools, parents, heredity, personal characteristics (none of which we studied) -- any given educational outcome may also be a function of the school's structural and design characteristics contained within the facility. Using data collected by The Arizona Department of Education (ADE), the Arizona School Facilities Board (SFB), and an Interactive, Inc. telephone survey of facilities, we have examined the relationship between student productivity (dependent variables) and school design and size features (independent variables). This is a post hoc study of 394 schools representing 34,658 students using existing Arizona Department of Education student data, Arizona School Facilities Board data and newly collected facilities descriptors.

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[1]Harold Hodgkinson, Secondary Schools in a New Millennium: Demographic Certainties, Social Realities. NASSP: 2000.

2.2.2 Sample. Because this is a study that incorporates both individual level data and school level data, we began by drawing a random sample of schools in Arizona.

From a list of all 1,279 schools in the State of Arizona, a random sample of 394 schools was generated.[2] Although in order to be able to generalize to all 1,279 schools with 95% confidence level, we need only a sample 295 schools, we intentionally over-sampled to control for potential data loss from matching files, incomplete data and other reasons. For most findings, we can report a 99% confidence level.

From our larger sample of 394 schools, we drew a sub-sample of schools for a more in-depth analysis of design and building variables related to student achievement. For this analysis, we randomly selected 55 schools (15 HS, 15 MS, 15 ES, 10 charter schools)[3] for more fine-grained data collection via phone survey. We were able to get telephone survey data from 46 of these 55 schools, an 84% response rate.

In addition to being able to generalize to schools, we also needed a representative and sufficient sample size to generalize to students in Arizona. To isolate some of the building types and to make comparisons more meaningful, we selected the 5th, 8th, and 11th grades for analysis, since each of these grades tends to be at the end of a grade grouping within a building (elementary, middle school/junior high school, high school). We studied all students in the 394 schools who had been in the same school for 1998 and 1999 and for whom we had Stanford 9 scores for both years. Our resulting student sample was 34,658.

2.2.3 Data Collection. Data for this study were obtained from the Arizona Department of Education[4] and through telephone surveys to individual schools. Table 1 lists the school design/size, student productivity, and student demographic variables that were examined.

School *Size and Design Measures.* For each of the schools in our study, we

[2]The complete list of schools provided by the state included entities for which the School Facilities board either had no data or data that were likely to skew the results. For example, certain "alternative" schools have very low enrollments and are located in relatively sizable spaces. We eliminated those schools for the purpose of our analyses.

[3]Ultimately, 9 schools did not cooperate, resulting in a sub-sample of 46 schools.

[4] We are particularly grateful to David Garcia, Director of Research and Policy, Arizona Department of Education for his assistance in obtaining the data we needed for this analysis.

received average attendance, total square footage, layout, and grade level information. From these data we computed a density variable, which is an enrollment to square

Table 1. Variables in Analysis

SCHOOL FACILITIES CHARACTERISTICS (Independent Variables)	
SIZE AND STRUCTURE VARIABLES **All Schools (n = 394)**	**DESIGN VARIABLES** **Subsample of Schools (n = 46)**
• School Size	• Thermal factors
*Total ADM	• Classroom lighting
*Total Square Footage	• Maintenance schedule
*Density (Sq. Ft. / ADM)	• School structure
• School Configuration	• Traffic / Crowdedness
*Layout	• Parking
*Grade Levels	• Furniture
• Age	• Privacy
* Date first constructed	• Noise level
* Date of renovations	• Aesthetics
	• Technology
	• Available Facilities
	• Material
	• Color
	• Interior Decoration
	• Flooring
STUDENT PRODUCTIVITY (Dependent Variables) **Students (n = 35,658)**	
• Student Standardized Test Scores (Academic Productivity)	
*Spring 1999 Stanford-9 Scores (Basic Skills, Reading, Math, and Language)	
*1998 to 1999 Stanford-9 Gain Scores (Basic Skills, Reading, Math, and Language)	
• Attendance Rate	
• Expulsion Rate (School level)	
• Drop Out Rate (School level)	
• Promotion/Retention Rate (School level)	
• Post-secondary Enrollment Rate (School level)	
• Risk Behaviors (School level)	
*Substance Use	
*School Violence	
*School Injuries	
STUDENT DEMOGRAPHICS (Mediating Variables) **Students (n = 35,658)**	
• Sex	
• Race	
• SES (Title I status)	
• Primary Language	
• SPED/Gifted Status	
• LEP Status	

footage ratio.

For a subsample of schools (n=46), we collected more-finely grained information about the 46 school facilities from school principals, assistant principals, district plant officials and/or custodial staff. We specifically attempted to find out about school facilities factors that the national empirical literature[5] suggests are related to educational outcomes and about which the state could not provide us with relevant data.

Student Productivity Measures. *Students FIRST* very specifically calls for an examination of the relationship between school facilities characteristics and academic productivity. For the purposes of the analysis, the state law defines "academic productivity" as "academic year advancement per calendar year as measured with student-level data using the statewide nationally standardized norm-referenced achievement test." Although we favor gain scores over "point in time" achievement scores, it is our belief that for this study, such an analysis has its limitations.[6] Therefore, in addition to academic productivity, we have considered the relation of multiple educational outcomes with various school facilities characteristics. For each of the 34,658 students (5th, 8th, and 11th grade students) in the 394 schools in our sample, we obtained Stanford-9 Basic Skills, math, language, and reading standard scores for 1998 and 1999. We computed gain scores for each student in Basic Skills, math, language, and reading.

In addition to the academic productivity measure, we explored the relationship between student attendance, school attendance rates, expulsion, promotion/retention rates, post secondary enrollment rates, and risk behaviors (substance use, school violence, school

[5]For a brief review of the national literature, see section 3.2 below.

[6]For instance, "academic productivity" is essentially equivalent to calendar year gain scores on standardized tests. Gain scores are generally utilized as a dependent variable for analyses of new programs or other educational "treatments" implemented in schools. School facilities are not necessarily distinct "treatments" applied to students in a given year. Rather, they are subtle, unobtrusive "treatments" that only change as students change schools or as schools are changed. Thus, single-year gain scores would be a particularly relevant outcome for students moving into a new school or whose school is significantly renovated over the summer. We will, nonetheless, consider the effects of school facilities on academic productivity as per *Students FIRST*, that is gain scores as well as point in time scores.

injuries)[7].

Mediating Variables. To determine differences based upon demographic variables, we obtained the following information for each student: race, sex, SPED/Gifted status, LEP status, Title I status, student absentee rate, and student primary language. The Arizona Department of Education provided these data in an electronic data file.

2.2.4 A Context for Understanding Student and Other Outcomes As They May Be Related to School Facilities. There are many reasons for building and renovating schools: facilitating learning, ensuring a safe and wholesome environment, housing co-curricular activities, providing functional working conditions for employees, and hosting community activities are all legitimate goals.

Learning is a central purpose of schooling and facilitating learning is central to school construction and renovation. It is important to be exact in expectations about the relation between school facilities and the production of learning in children.

The educational achievement of children comes from several sources, one of which is the school. Families educate, the media educates, and the peer group educates. Parents are the child's first teachers and the home has been called America's smallest school. About 70% of the variance in students' test scores is due to those other educators (especially variations in family background including socio-economic and cultural factors): thirty percent is attributable to schooling[8].

Schools can be described by their age, size, layout, numbers of special programs accommodated, etc. The descriptive characteristics of the school facility are only one of the several variables that account for the effect of the school on the child. The quality of instruction, the preparation of the teachers, the nature of the curriculum (expectations, diagnosis, lesson presentation), the amount and kind of learning technology all impact a child's learning more directly and more powerfully than does the nature of the school building.

Thus, it is possible for students to attend a sub-standard school facility but still learn and test well if they have supportive parents, gifted teachers and a high standards

[7] Most of these data are not strong. They are self reports by schools and districts on sensitive variables for public scrutiny. Some of these data came from a CHAPPS data base.

[8] Coleman, James. S., et al. (1966). *Equality of Educational Opportunity*. Washington, DC., U.S. Department of Health, Education and Welfare.

curriculum. But who would want to require children's attendance at a sub-standard school? Conversely, if children from homes with few opportunities for extended or reinforced learning attend a brand new campus, they are not going to do well in school simply by virtue of their physical presence in newly constructed or newly renovated space.

Just as parents considering a school weigh several factors, the production of learning (and the presentation of high quality learning opportunities) is a complex set of relations only one of which is captured in the descriptive characteristics of a school. School building design, physical size, and conditions are but one of many factors which combine to provide a productive and supportive learning environment.

That being said, this analysis does not examine the other -- and more powerful – predictors of student productivity such as teachers, families, expectations. The analysis that follows examines only the relation between school facilities and two types of student outcomes—academic and non-academic. In reading the discussion of those relationships, we recommend that the reader keep in mind: (1) the power of educators other than the school in determining student achievement; (2) the subtle and attenuated path from school facilities through several adult and curriculum related phenomena to achievement; and (3) the breadth of goals that parents, educators and communities have for schools, many of which are directly related to school facilities.

Students FIRST requires a study of the physical characteristics of schools that have high achieving and low achieving students. This analysis has examined the relation between achievement and school facilities more closely than was heretofore possible including school site phone surveys commissioned for these purposes and data uniquely combined from the SFB and the ADE.

2.3 FACILITIES AND ACADEMIC PRODUCTIVITY

This section of the report examines the associations between student achievement, and the three categories of school size, and grade configuration of the school.

2.3.1 School Size. Given the need to build and renovate schools in Arizona (see section 3.3 below), of all the data made available for this analysis, perhaps the most important and relevant information has to do with the physical school structures and size. For the purposes of analyzing the relationship of school structure to student achievement, the School Facilities Board and the Arizona Department of Education provided us with data on square footage and average daily membership (ADM) in each of the schools in our sample. In addition to those two size variables, we computed a third variable, density.

The square footage information was broken down by individual campus buildings, wings, etc., but it was not possible to differentiate between classroom square footage and square footage used for non-classroom space. Therefore, all analyses utilize ***total square footage*** that includes all space available to and used by the individual schools. This is an important point because Arizona school facilities regulations specify

minimums for classroom space and non-classroom space. Also, particularly in high schools that have large gyms or auditoriums, total square footage may overstate the size of the school.

In addition to total square footage, all analyses utilize ***total ADM,*** which is the enrollment figure schools present to the state for all school finance decisions. Finally, for each school in the sample, we have computed a variable called ***density*** that is simply total square footage divided by total ADM.[9]

Thus, we have examined the relationship of student productivity with three measures of school size: total square feet, average daily enrollment, and density. Table 2 shows descriptive statistics for these key variables, providing means for schools at the 25th, 50th, and 75th percentiles.

Very generally, Table 2 and Figure 1 show that the older the child, the more likely he or she is to be in a larger school, a school with more students, and in a school with more room per child. The slight upward tilt at the end of the top line in Figure 1 suggests a slight disproportionality in density in the high schools. That is to say, high school students are in much bigger schools, but there is also a disproportionally larger amount of square footage available to the high school students than to students in other grade arrangements.[10]

Table 3 shows the correlations between the three school structure variables. Assuming that a correlation of .75 (1.0 would be a perfect correlation) is a strong correlation, the relationships between enrollment and square footage, as expected, are positively strongly correlated. These relationships are strongest in high schools and elementary

[9]***NOTE BENE:*** please note the distinction between **density** and **square footage per student**. These two concepts are the inverse of each other. That is to say, the more square footage per student, the lower the density and vice versa. Therefore, where we report "high density," we are actually referring to a school that has a small amount of square footage available to each student.

[10]This finding may be an artifact of using **TOTAL square footage** as our size variable.

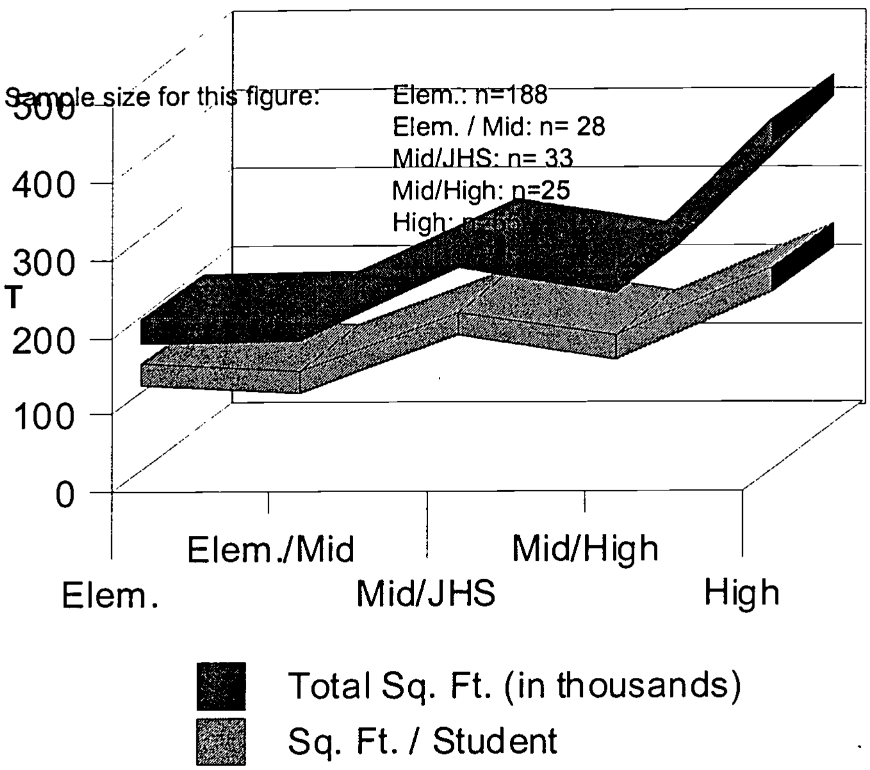
schools. That simply states the obvious: large-enrollment schools are physically bigger schools. It is perhaps more interesting to note that physical size is not strongly related to density. The strongest relationship is in high schools, where the correlation is -.191. For all schools, the correlations, while statistically significant, aren't meaningful. However, total ADM is moderately negatively associated with density in elementary schools (-.504), middle schools (-.526), and high schools (-.602). This means that the more students that are in each of the schools, the less space each student has available. Schools with large enrollments tend to be more densely populated. This

Table 2. Size: Square Footage, Average Daily Attendance, Density

TYPE OF SCHOOL	N		MEAN	25th percentile	50th percentile	75th Percentile
Elementary School	188	Total sq. ft.	55,779	41,319	57,208	69,484
		Total ADM	518.2	337.6	514.3	696.9
		Sq. ft./student	122.1	86.9	102.9	134.3
Elementary/Middle School	28	Total sq. ft.	67,469	53,597	67,839	81,639
		Total ADM	592.5	462.7	608.4	837.9
		Sq. ft./student	111.9	87.5	103.9	126.5
Middle/Junior High School	34	Total sq. ft.	85,789	55,812	91,786	106,645
		Total ADM	625.7	399.9	643.2	941.2
		Sq. ft./student	186.9	114.4	127.5	160.3
Middle/High School	25	Total sq. ft.	84,528	51,330	76,006	120,339
		Total ADM	541.8	97.7	433.9	963.7
		Sq. ft./student	155.7	114.6	131.3	166.5
High School	56	Total sq. ft.	190,562	92,772	201,838	304,197
		Total ADM	988.4	191.6	811.9	1772.5
		Sq. ft./student	241.9	140.9	192.8	265.1

*NOTE: One school in the sample provides for students in grades K-12. For these analyses, we have not included that school.

Figure 1. School Size: Square Footage and Density



Sample size for Figure 1:	Elem.: n=188 Elem. / Mid: n= 28 Mid/JHS: n= 33 Mid/High: n=25 High: n=55

TABLE 3. School Size Relationships: Square Footage, Density, Average Daily Attendance

Elementary Schools

	Total Sq. Ft.	Total ADM	Density
Total Sq. Ft	1.000	.735	.096
Total ADM	.735	1.000	-.504
Density	.096	-.504	1.000

Middle Schools

	Total Sq. Ft.	Total ADM	Density
Total Sq. Ft	1.000	.665	.137
Total ADM	.665	1.000	-.526
Density	.137	.526	1.000

High Schools

	Total Sq. Ft.	Total ADM	Density
Total Sq. Ft.	1.000	.787	1.191
Total ADM	.787	1.000	-.604
Density	-.191	-.604	1.000

suggests that density, or the amount of square footage available to each student, is more a function of enrollment than school size.

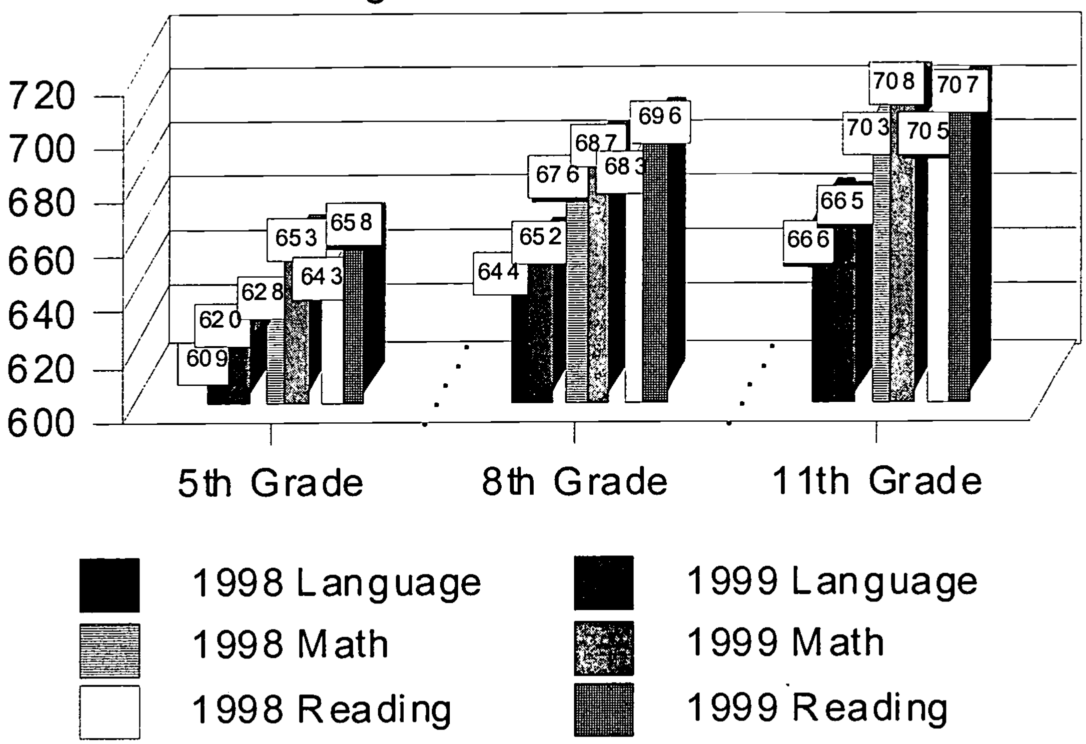
2.3.2 Grade Configuration. We also examined what grade configurations the schools contained. The following are the configurations that students attended (not including kindergarten: Grades 1-6 schools, grades 1-8 schools, grades 7-8 schools, grades 7-12 schools, grades 9-12 schools, and grades K-12 schools.

2.3.3 Student Achievement. Figure 2 depicts Stanford-9 scores for 5th, 8th, and 11th grade students. These are the Spring 1998 (fourth grade) and Spring 1999 (fifth grade) scores for students who are in the 6th, 9th, and 12th grades during the 1999-2000 academic year.

Figure 2 illustrates the 1998 and 1999 Stanford 9 scores by grade and subtest. Table 4 displays the actual gain scores (referred to as academic productivity in the *Students First* legislation). The small average gains from year to year suggest both a ceiling effect and a regression to the mean. Students who start out with the lowest test scores have the most room for improvement, and they are making those gains. Students starting with high test scores, particularly by the time they reach 11th grade, reach a ceiling and have little or no room for growth.

These standard psychometric phenomena make analyzing the relationship between school facilities characteristics and single-year "academic productivity" a complex proposition. Single-year gain scores do not vary much, and may be more a function of standard psychometric phenomena than any independent factors such as school facilities. In fact, Table 4 makes exactly that point. Therefore, when we analyzed relationships between gain scores on the Stanford 9 and student productivity, we were unable to capture the relationships because of the small variance in gain scores. As a result, we have presented relationships of student productivity using 1999 Stanford 9 standard scores as well as gain scores.

Figure 2. Stanford 9 Scale Scores



Sample sizes for Figure 2 are:				
	n	Language	Math	Reading
5	98	9717	9714	9479
	99	9754	9759	9602
8	98	5210	8172	8151
	99	5202	5168	5170
11	98	224	225	225
	99	228	228	226

Table 4. Gain Scores on Stanford 9: 1998 to 1999		
Grade Student Took Stanford 9	Expected Gain Scores	Average Gain Score from 1998 to 1999
Fourth to Fifth Grade		
Basic Skills		17.54
Math		25.50
Language		11.43
Reading		15.28
Seventh to Eighth Grade		
Basic Skills		10.35
Math		9.66
Language		8.41
Reading		12.80
Tenth to Eleventh Grade		
Basic Skills		2.30
Math		6.08
Language		-.95
Reading		2.16

2.3.4 Relationship of School Size, School Configuration, and Student Achievement. Table 5 offers a summary of the means and ranges for size and student achievement in grades 5, 8, and 11. In an attempt to understand how these measures of size and student achievement are related, we first examined bivariate relationships.

Table 6 displays the statistically significant relationships in all grades between 1999 Stanford 9 achievement scores and each of the three measures of size (rows with white background). Although all of the 36 relationships are statistically significant at either the .05 or .01 level, none of these relationships has much practical meaning. Using a guideline of .75 or higher to indicate a strong relationship, it is clear from the table that all of the relationships are relatively weak, ranging from a low of .06 to a high of .207. Additionally, these are simple, bivariate correlations, the strength and direction of which could change when the variables are considered in combination with others.

Table 6 also shows that gain scores (academic productivity) have virtually no significant relationships (either statistical or practical) to any of the school size variables; only 10 of the 36 relationships are statistically significant at either the .05 or .01 level (rows that are shaded). The very fact that 26 of these correlations do not rise to the level of statistical significance in an analysis involving a sample size of over 34,000 students is significant in and of itself. Those that are statistically significant range from r's of .022 to .077. If we use .75 as a guideline for a strong relationship, it is clear that these are very weak relationships. Therefore, it is safe to conclude from Table 6 that none of the school size measures has a meaningful relationship to single-year gain scores (academic productivity).[11] Therefore, further analyses will examine only point in time achievement from 1999.

Table 7 presents the data from the perspective of meaning. In this table, we show the variance in the Basic Skill scaled score that can be explained by enrollment size (ADM), square footage of school, square feet per student, the type of school configuration, and all four variables together. It is clear from this table, that very none of the size variables or the type of school either separately or together explain much about achievement for 5th and 8th grade students. All four variables account for 1.8% of the variance in Basic Skill scores for 5th grade students and 4.5% for 8th grade students.

However, the relationships for 11th grade students are much stronger. For students in

[11]Note that the size may have a cumulative effect over a number of years. For instance, a student exposed to a "poorly designed" school structure from Kindergarten through 5th grade may suffer cumulatively from the standpoint of academic productivity. Our data do not allow us to assess this.

Table 5 Size and Achievement Summary by Grade

	5th Grade n = 11,803	8th Grade Students n= 12,974	11th Grade n= 9,815
Average Daily Membership (ADM)	663	850	1080
Range of ADM	34 to 1662	100 to 1662	12 to 2811
Average Square Feet in School Attend	65,214	99,583	143,750
Range of Square Feet in School Attend	3,360 to 105174	23,162 to 169,290	1,684 to 418,759
Average Square Feet per Student in School Attend	105	125	134
Range of Square Feet Per Student in School Attend	57 to 422	59 to 422	34 to 912
Basic Skills 1999 average scores Gain	 644 17.74	 678 10.62	 693 2.33
Language Arts 1999 average scores Gain	 621 11.58	 652 8.04	 665 -.91
Mathematics 1999 average scores Gain	 654 25.73	 687 10.80	 709 6.10
Reading 1999 average scores Gain	 659 15.46	 697 12.81	 707 2.17

Table 6. Simple Correlations: School Size and Stanford-9 Scores					
GRADE		Total Sq. Ft. r	Total ADM r	Density R	Enrollment Sq. Footage
5TH	1999 Basic Skill Scale Score	.063**	.088**	-.074**	.104
	1999 Language Scale Score	.051**	.071**	-.062**	.085
	1999 Math Scale Score	.086**	.116**	-.081**	.133
	1999 Reading Scale Score	.043**	.066**	-.067**	.082
	1999 Basic Skill GAIN Score	-.006	-.004	.003	.004
	Language GAIN Score	-.015	-.002	-.001	.012
	Math GAIN Score	.013	.002	-.001	.028
	Reading GAIN Score	-.006	-.003	-.004	.011
8TH	1999 Basic Skill Scale Score	.170**	.078**	.043**	.190
	1999 Language Scale Score	.142**	.066**	.030**	.158
	1999 Math Scale Score	.180**	.090**	.050**	.202
	1999 Reading Scale Score	.155**	.062**	.040**	.170
	1999 Basic Skill GAIN Score	-.056**	-.022**	-.002	.059
	Language GAIN Score	-.020*	-.017	.009	.021
	Math GAIN Score	-.025**	.003	.004	.029
	Reading GAIN Score	-.078**	-.039**	-.012	.084
11TH	1999 Basic Skill Scale Score	.143**	.184**	-.095**	.181
	1999 Language Scale Score	.118**	.158**	-.096**	.157
	1999 Math Scale Score	.169**	.207**	-.096	.203
	1999 Reading Scale Score	.122**	.156**	-.085**	.154
	1999 Basic Skill GAIN score	.012	-.002	.025*	.025
	Language GAIN Score	.001	-.015	.020	.024
	Math GAIN Score	.047**	.058**	-.018	.056
	Reading GAIN Score	-.017	-.053**	.060**	.068

*indicates significance at the .05 level; **indicates significance at the .01 level

11th grade, enrollment, square footage, and kind of school account for 14%, 18% and 22% of the variance. All four variables together account for 23% of the variance of 11th grade Stanford 9 Basic Skill scores. For 11th grade students, large schools with more students are related to higher achievement.

Students FIRST, Chapter 16, §15-2002 A.6. calls for an understanding of the differences in the school facilities characteristics between the highest performing schools and the lowest performing schools. Table 8 shows the school structure characteristics for the lowest and highest achieving schools. The table makes clear that these relationships are complex and not strongly related to size. As a result, we explored the relationships for each grade level in more detail

Size is relative when discussing schools. What might be a large school in one region, might be considered small in another. We examined size in two ways. The first was to categorize the schools in our sample by comparing them with each other. We placed schools, by square footage and enrollment, into four quartiles. Table 7 displays these breakdowns. Comparing enrollments for these categories using the *StudentsFIRST* minimum square footage for enrollments vs. quartile comparisons gives some guidelines for thinking about what is a small school vs. what is a large school. These comparisons can be found in Table 8. Finally, the literature on the relationships of school size and effects on students is inconclusive, but might be summarized using the following guidelines:

- Elementary Schools (Six Grade Levels): 300 to 600 students
- Junior High/Middle Schools (Three grade levels): 400 to 600 students
- High Schools (Four Grade Levels): Up to 250 students per grade, up to 1,000 students

These three size comparisons serve as background for understanding the relationships we recount in this report.

Elementary Students. Achievement scores for fifth grade students were used to represent elementary students. Figure 3 demonstrates that as enrollment size increases so does achievement. We have some concern about these findings since the size category of 1201 to1500 students is represented by only two schools. When we examined 5th grade students in elementary K-6 schools, we found that in schools with more than 1,200 students, academic achievement decreases as size increases. However, this finding is based upon only 1 school.

Figure 3 mostly demonstrates that there aren't very large differences in achievements in schools by enrollment size. Thus, if we examine all the size variables together, the larger the school (in square feet, enrollment, and square feet per student), the higher

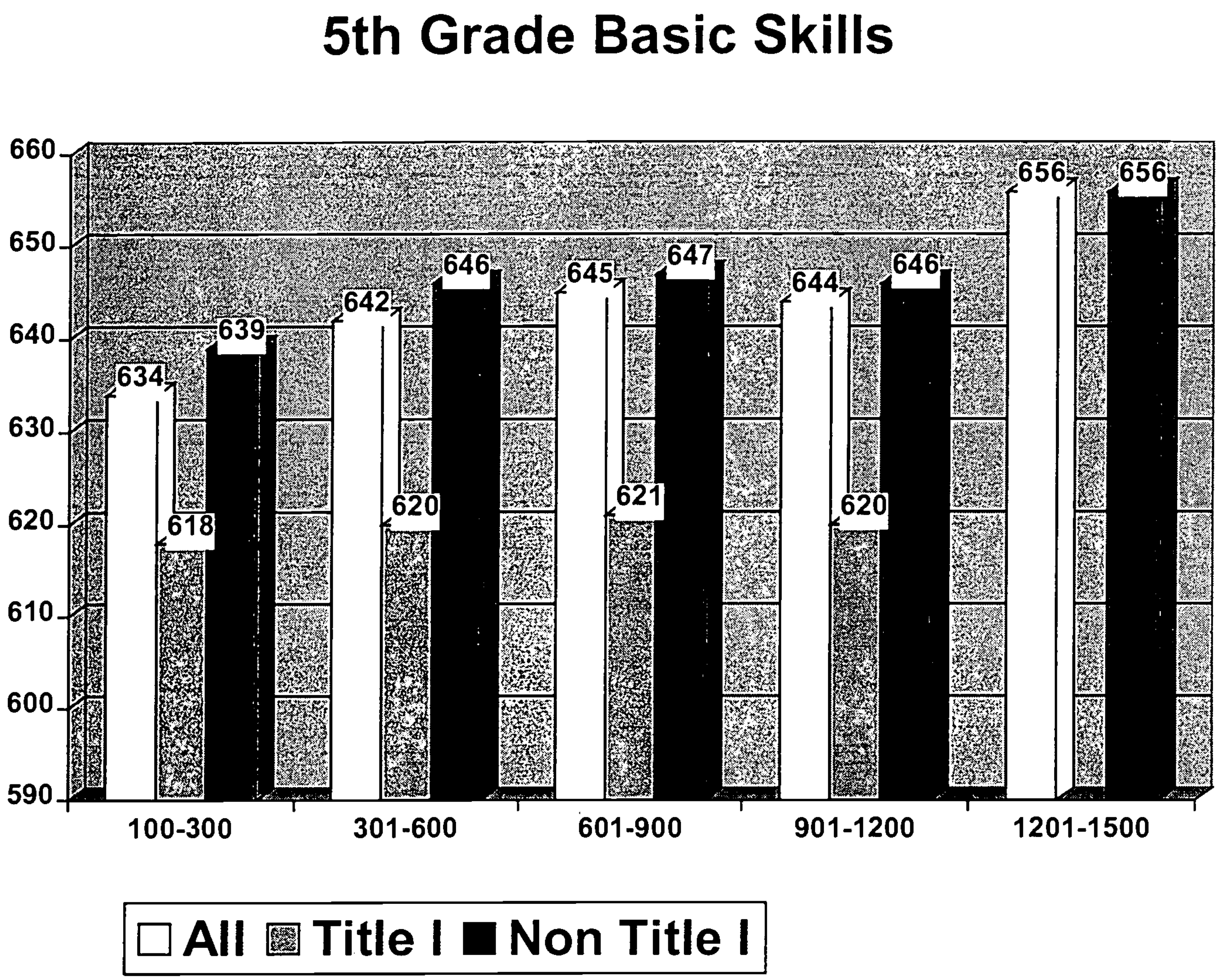
Table 7: School Size Comparisons by Sample Quartiles

		Quartile I Small School	Quartile II Mid-Size School	Quartile III Large School	Quartil Extra L Schoo
ELEMENTARY SCHOOLS					
	Square Feet	0 to 41,319	41,320 to 57,208	57-209 to 69,484	69,485 larger
	ADM	0 to 338	339 to 514	515 to 697	698 an
ELEMENTARY/MIDDLE SCHOOLS					
	Square Feet	0 to 53,596	53, 597 to 67,838	67,839 to 81,638	81,639 larger
	ADM	0 to 463	464 to 607	608 to 837	838 an
MIDDLE/JUNIOR HIGH SCHOOLS					
	Square Feet	0 to 55,811	55,812 to 91,785	91,786 to 106,644	106,64 larger
	ADM	0 to 400	401 to 642	643 to 940	941 an
MIDDLE/HIGH SCHOOL					
	Square Feet	0 to 51,329	51,330 to 76,005	76,006 to 120,338	120,33 larger
	ADM	0 to 98	99 to 433	434 to 963	964 an
HIGH SCHOOL					
	Square Feet	0 to 92,721	92,772 to 201,837	201,838 to 304,196	304,19 larger
	ADM	0 to 192	193 to 811	812 to 1,771	1,772 a larger

Table 8: *StudentsFirst* Definitions of Enrollment Size vs. Quartile Definitions

	Elementary Schools		**Middle/Junior High Schools**		**High Schools**	
	StudentsFirst	Quartile	*StudentsFirst*	Quartile	*StudentsFirst*	Quartile
Small	< 800	< 338	< 800	< 400	<400	< 192
Medium	N/A	339-514	N/A	401-642	401-1000	193-811
Large	> 801	515-697	> 801	643-940	1001-1800	812- 1,771
Very Large	N/A	> 698	N/A	> 941	> 1801	> 1,772

Figure 3. 5th Grade School Enrollments and Academic Achievement



Sample for Figure 3.			
	# OF SCHOOLS	# OF STUDENTS	
		TITLE I	NON TITLE I
100-300	35	162	613
301-600	69	568	3123
601-900	65	411	4710
901-1200	17	122	1255
1201-1500	2	0	170

Basic Skill scores. Although statistically significant at the .000 level, these three variables, along with kind of school, account for only 1.8% of the variance. For all 5th grade students, those who attend school in elementary only schools do better than 5th grade students who are in schools with middle school and high school students. Although significant at the .000 level, the type of school accounts for less than 1% of the variance in Basic Skill scores. Average Basic Skill scores are 644 and 634 respectively.

Middle/Junior High Students. Eighth grade was the examination point for middle/junior high students. The highest achievement among middle schools students is found in schools with enrollments from 901 to 1500. In schools that are 6 to 8th or 7 to 9th grades only, the highest achievement is found in schools from 600 to 1200 students, with the achievement significantly higher in schools with 901 to 1200 students. Schools of 600 and smaller and more than 1200 report similar achievement rates. Figure 4 illustrates these differences, and demonstrates that, overall, there isn't much variance in academic achievement by size of school.

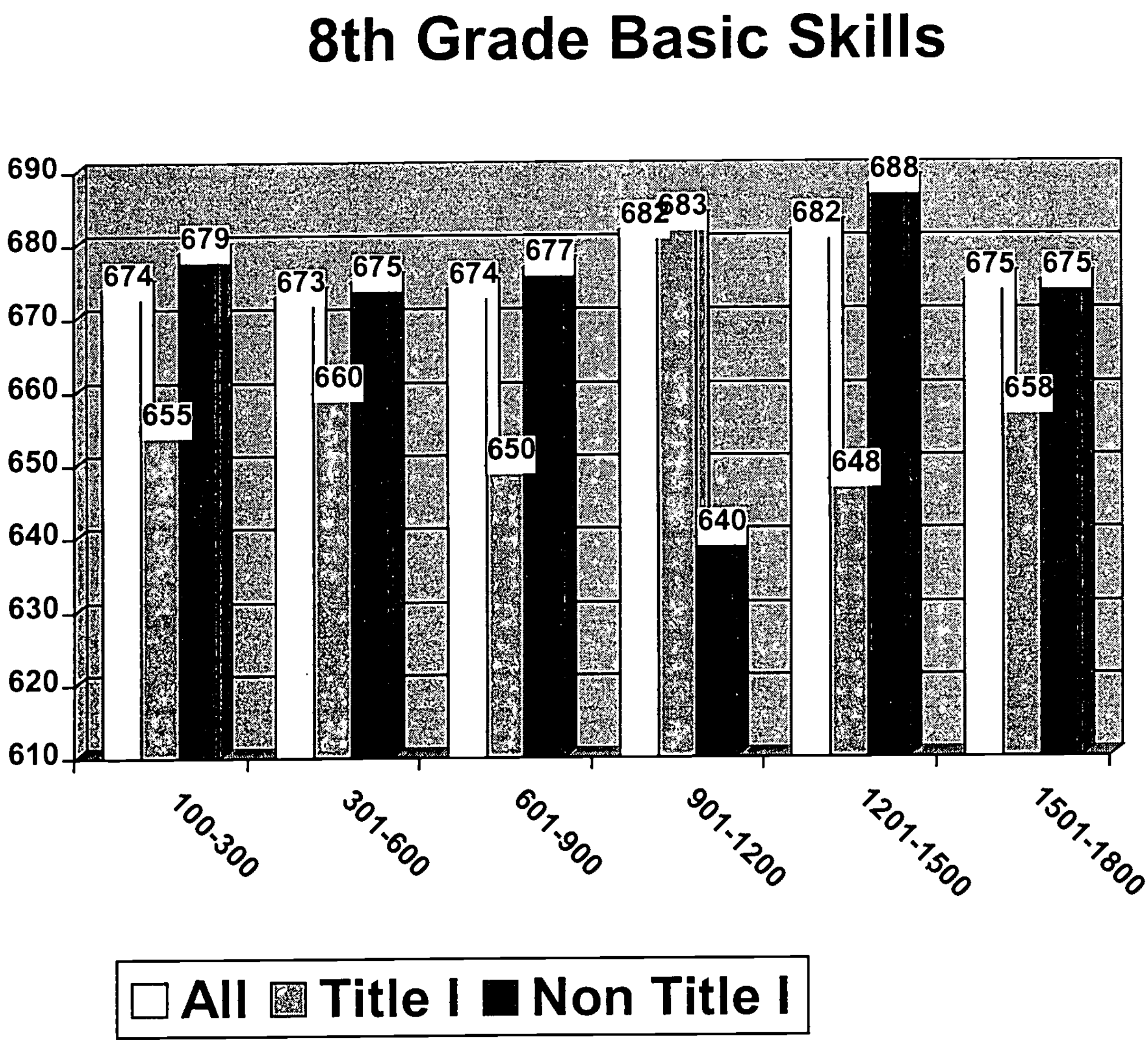
Eighth grade students who attend school with elementary students or other middle school students score higher than those who attend school with high school students do. However, none of these relationships are practically significant, accounting for only 3.4%, .7%, .2%, and .04% of the variance in Basic Skills scores.

For all students, all three measures of size (total ADM, square footage of schools, square feet per student) and the kind of school (8th graders with elementary students, 8th graders with only middle school students, and 8th graders with high school students) were statistically significant at the .000 level. For these students, the bigger the school in terms of square feet, enrollments, and square feet per student, the higher the Basic Skills scores. However, none of the variables were practically significant. All four variables together account for only 4.5% of the variance in Basic Skills scores.

Title I: For Title I students, the highest achievement is in schools of 600 or fewer students. While it appears that schools of 1500 and more contain Title I students who achieve highly, there are only three students in this category. Therefore, we have discounted this relationship. For Title I students, square footage of schools is related to achievement. For Title I students, these two size variables (total ADM and square footage of schools) are significant, and these two variables account for 3.7% of the variance. In both cases, the smaller the school, the higher the Basic Skill scores.

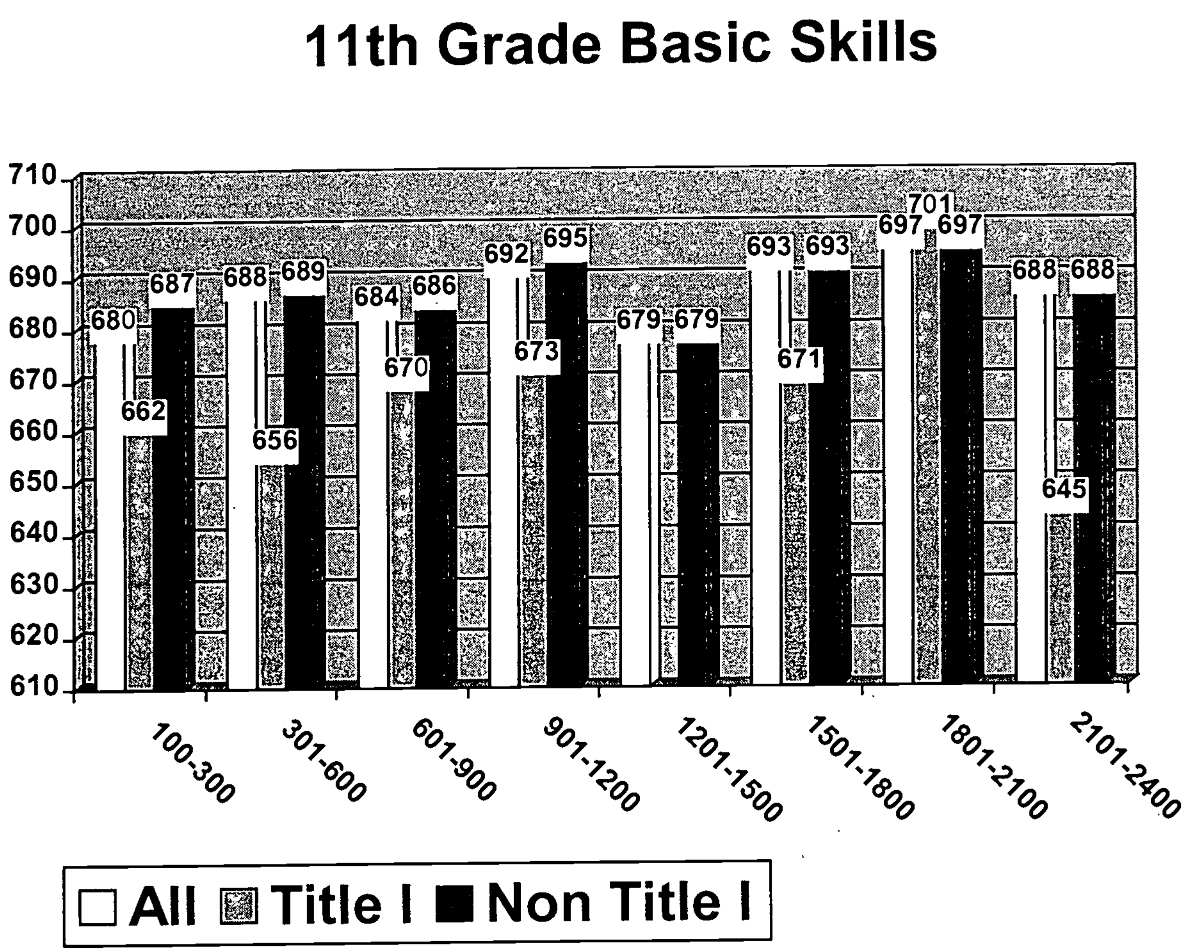
High School Students. Relationships between school size and achievement are stronger for 11th grade students, as is illustrated in Figure 5, than for other students. For the most part, achievement is higher in larger schools. Overall, the

Figure 4. 8th Grade School Enrollments and Academic Achievement



Sample for Figure 4			
	# OF SCHOOLS	# OF STUDENTS	
		TITLE I	NON TITLE I
100-300	18	74	298
301-600	30	294	1894
601-900	27	381	3394
901-1200	20	108	4280
1201-1500	5	188	949
1500-1800	1	4	359

Figure 5. 11th Grade School Enrollments and Academic Achievement



Sample for Figure 5			
	# OF SCHOOLS	# OF STUDENTS	
		TITLE I	NON TITLE I
100-300	11	70	166
301-600	9	14	605
601-900	5	78	685
901-1200	6	186	857
1201-1500	2	0	421
1500-1800	7	11	1777
1801-2100	3	1	953
2101-2400	7	5	1010

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highest achieving students in eleventh grade attend larger schools and the lowest achieving students attend smaller schools. This is statistically significant at the .01 level. Square footage, density and total enrollment, along with the kind of school, account for 23% of the variance.

Eleventh grade students who attend schools with middle school students do better than eleventh grade students who attend schools with just high school students. The average Basic Skills score for all students is 693, with a gain score of 2.34.

Title I: For Title I students, density, total enrollment and total square footage are statistically significant and account for 26% of the variance.

Non-Title I: For non-Title I students, these same variables are also statistically significant, which account for 22% of the variance. For these students, the larger the school (including square footage, enrollment, and density), the higher the Basic Skills scores. The kind of school that eleventh grade students attend is statistically significant.

Size, Grade Configuration, and Achievement Summary. The relationships between size variables, grade configuration within schools, and student achievement are complex. In general, size – whether enrollment or square footage – isn't highly related to achievement. Table 9 lists the variance accounted for by the size and grade configuration. Tables 10 and 11 summarizes these conclusions.

1. Students who attend schools that have very large or very small enrollments tend to do less well than students who attend mid-size schools, although size does not account for much of the variance in achievement.
2. Title I students – more so than non-Title I students -- do better in schools with less enrollment.
3. Larger enrollments and more square footage are the most strongly related to achievement for 11^{th} grade students.
4. For 5^{th} and 8^{th} grade students, relationships between student achievement and size variables are statistically significant, but not practically significant. For these students, size and grade configuration explains 1.5 and 4.5 percent of the variance for 5^{th} and 8^{th} graders.

Table 9: Variance of Basic Skills Score Accounted for by Size Variables and Kind of School					
Grade of Students	r^2 ADM	r^2 Total Square Footage of School	r^2 Square Feet per Student	r^2 Kind of School	r^2 Total
Fifth Grade	.011	.006	.0054*	.0076	.018
Eighth Grade	.007	.034	.002	.0004	.045
Eleventh Grade	.14	.18	.033	.22	.23

Table 10: Structural Characteristics of the Schools that the Highest and Lowest Performing Students Attend

GRADE		LOWEST ACHIEVING Students are More Likely to Attend...	HIGHEST ACHIEVING Students are More Likely to Attend...
5TH	Total Sq. Ft. Quartile	large schools	large schools
	Total ADM Quartile	low-med attendance schools	low attendance schools
8TH	Total Sq. Ft. Quartile	mid-large schools	mid-large / small schools
	Total ADM Quartile	low-med attendance schools	low attendance schools
11TH	Total Sq. Ft. Quartile	small schools	large schools
	Total ADM Quartile	high attendance schools	high attendance schools

Table 11: Practical Significance of Size and Grade Variables in Relation to Student Achievement				
Title	Do students in larger square footage schools achieve higher?	Do students in schools with more students achieve higher?	Do students with more space per student achieve higher?	Does school/grade configuration relate to higher achievement?
5th	NO	NO	NO	NO
8th	NO	NO	NO	NO
11th	MAYBE/YES	MAYBE/YES	NO	MAYBE/YES

2.3.5 School Design and Student Achievement. In examining the relationships between academic achievement and other school design factors, we found no relationships. For this analysis, we looked at the relationships between school achievement and the following design variables: Thermal factors, classroom lighting, maintenance schedule, school structure, traffic / crowdedness, parking, furniture, privacy, noise level, aesthetics, technology, available facilities, material, color, interior decoration, flooring.

The measurements for this portion of the study were confined to a small sample. Further examination of these variables might be done with a larger sample and with more exact measurement.

Our findings do not determine whether or not these design features have an effect on student attitudes, productivity, and feelings about school; this analysis found only that there were no significant relationships between these factors and scores on the Stanford 9.

2.3.6 Summary of School Facilities and Academic Student Productivity. Overall, there was little relationship between the facilities variables that we examined and academic achievement. While size accounted for a substantial percentage of the variance in academic achievement for 11th grade students, there was no difference appreciable differences at other grade levels.

In the end, the meaning of these differences are up to educators and parents. For example, while psychometricians would say that the 10 scale score point difference between 695 and 705 has no practical significance, in terms of effect size, we leave it up to educators to decide whether or not ten points has meaning. It is up to educators and policy makers to decide if the achievement gains that might by realized by reducing the size of schools are worthwhile. Further, this study did not examine measures other than scores on the Stanford 9 of academic productivity. These measures might show something entirely different.

Finally, we believe that size relationships should examine both school and district size as well as the influence of SES. The examination of cross-level interactions of SES, school and district size might provide further insights. There is some evidence that scaling is important.

2.4 SCHOOL FACILITIES AND NON-ACADEMIC STUDENT PRODUCTIVITY

This section examines student productivity variables that are non-academic, but nevertheless related to school performance.

2.4.1 School Size and Attendance/Promotion. As described in Table 12, attendance and promotion rates for the elementary, middle, and high schools (numbers of students per total enrollment at each school) ranged from 6 % through 100%. However, the 6% figure was not at all typical, as the median percentages for each type of school were 88% or above.

As described in Table 13, there was a pervasive pattern of significant-but-small correlations in which larger physical size, higher enrollments, and density (fewer square feet of space per student) were associated with higher attendance and promotion rates. Exceptions to this pattern occurred for high schools, wherein prediction from physical size and enrollment to promotion rates increased to moderate strength.

Analyses of school size effects utilizing size-based groupings as reported above produced a pattern of findings represented by the foregoing correlational analyses. Analyses by size groupings are therefore not reported here.

Overall, the combination of physical size, enrollment, and density accounted for a minor amount (3 - 5 %) of the variance in attendance rates across 5th, 8th, and 11th grades; for a minor amount (2 - 3 %) of the variance in promotion rates across the 5th and 8th grades; and for a moderate amount (17 %) of the variance in promotion rates in 11th grade.

2.4.2 School Size and Negative Outcomes. Reported rates of student retention, dropout, and expulsion, tobacco and substance abuse, and violent and destructive behavior were extremely low. Distributions of scores were severely positively skewed, with the vast majority of scores either zero or approximately zero. These distributional characteristics preclude meaningful analyses of the data.

2.4.3 School Design and Attendance and Promotion Rates. The design and feature variables reported above as potential correlates of student achievement were also investigated with regard to attendance and promotion rates. Findings are reported aggregated across grade levels, as analyses separating grade levels reduced the number of schools per design categories to unreliable levels.

As depicted in Table 14, the general picture from these analyses is that there were

Table 12: Attendance and Promotion Rates for 5th, 8th, and 11th Grades				
	MEAN	MEDIAN	MIN	MAX
Elementary (n=188)				
Attendance Rate	.95	.95	.80	.98
Promotion Rate	.98	.99	.70	1.00
Middle (n=38)				
Attendance Rate	.93	.93	.76	.99
Promotion Rate	.94	.97	.74	1.00
High (n=57)				
Attendance Rate	.92	.94	.55	.99
Promotion Rate	.82	.89	.06	1.00

Table 13. Simple correlations: School Size and Attendance/Promotion				
Grade		Total Sq. Ft.	Total ADM	Density
5th	Attendance	.120**	.212**	.125**
	Promotion	.091**	.132**	.102**
8th	Attendance	.147**	.073**	.023**
	Promotion	.085**	.034**	-.051**
11th	Attendance	.149**	.159**	.035**
	Promotion	.322**	.406**	.161**

Table 14. School Design and Attendance and Promotion Rates

	School Shape	
	Round/Circular	Rectangular/Boxlike
Attendance	94%	94%
Promotion	96%	91%

	Building Materials		
	Brick	Concrete Block	Other
Attendance	94%	94%	94%
Promotion	93%	97%	90%

	Windows		
	None	Windows Do not Open	Window's Open
Attendance	95%	94%	94%
Promotion	98%	98%	92%

	Color			
	Brick	Earth Tones	Pastel	Warm, Bright or White
Attendance	93%	94%	94%	94%
Promotion	91%	94%	98%	97%

	Interior Decoration		
	No murals or sculptures	Murals, no sculptures	Murals and sculptures
Attendance	94%	94%	94%
Promotion	91%	95%	96%

	Carpeting			
	None	Teacher Lounge Only	Classroom & Lounges	Whole school is carpeted
Attendance	94%	95%	94%	95%

Promotion	93%	93%	92%	97%

no significant associations between school design variables and attendance and promotion rates.

2.4.4 School Design and Negative Outcomes. As previously noted, reported rates of student retention, dropout, expulsion, tobacco and substance abuse, and violent and destructive behavior were extremely low, precluding analyses.

2.4.5 Summary: School Facilities and Non-Academic Achievement. We found no relationships between school size or design and non-academic achievement measures. However, we believe that the non-academic achievement measures are not robust. With robust measures, we might see other relationships.

3.0 SCHOOL FACILITIES CHARACTERISTICS: Policy Issues and Consequences

3.1 PURPOSE OF THE POLICY ANALYSIS

Arizona educators are in the process of making decisions about the construction and renovation of school facilities including the size of the physical plants they are contemplating. This analysis is designed to inform those decisions by connecting them to national and empirical data and by locating that discussion in an Arizona context.

3.2 THE NATIONAL AND EMPIRICAL LITERATURE ON SCHOOL SIZE AS IT RELATES TO ARIZONA

The studies that were reviewed during the Arizona school facilities analysis have focused on student achievement in relation to size, building condition, behavior, and overall environment in a school. The research has served as guidance for aspects of our analysis, and has also validated that there is a relationship between school facilities and student achievement and behavior.

The studies' cases differ demographically as well as in sample size. The broad range of cases has allowed these studies to correspond with schools and students in Arizona, but as with evidence in many areas of scientific analysis, the findings are sometimes contradictory. The differing findings across studies can be attributed to varying procedures, sample sizes and differences in communities and students. For instance, Weinstein's study has found that variables such as furniture arrangements, aesthetic appeal, and windows in classrooms did not have an impact on achievement; however, other researchers disagree. When looking at contradictory findings, especially in the case of classroom size, it must be acknowledged that student's socio-economic status plays a large role in varying achievement scores.

Most of the research that was reviewed concludes that there is connection between school environment, variously described, and student achievement. However, deciding which variables in a school facility are responsible for the outcomes is not as clear. One variable that most researchers agree is averse to learning is the school building's age. As seen in Earthmann's study (1996) there are negative effects when students are housed in a learning environment that is old and dated. Older buildings may not provide facilities that modern buildings have to support learning, especially learning technologies. A productive classroom environment should provide up-to-date and modern facilities that enrich the learning process. Hines (1996) reports an increase in test scores when building conditions improved from substandard to above standard.

The size of a school also impacts students. School size recommendations vary among researchers, but most agree that there should be no less than 300 or more than 900 students in a school unit. The Carnegie Foundation, which had in the past advocated larger schools now joins the National Association of Secondary School Principals in recommending smaller schools. Those organizations believe the optimal elementary and middle school size should be no more than 400, and the optimal high school size should be no more than 600 students.

Research has found that students in all socio-economic levels do well in smaller schools, and students from low-income families, unlike students from middle and upper class status, function poorly in large schools. A four-state study on the effects of school size on students from low-income families has shown the negative effects of larger schools. Howley concluded from this study that socio-economic status is related to the effectiveness of the size of a school. In general, Howley argues, the less affluent a community, the smaller the school size.

Weinstein (1979) concluded that high density in schools also contributes to a greater occurrence of violence and disruptive behavior as well as to increased involvement in risk behavior.

One positive outcome of large schools, is that as size increases, some school program costs decrease. Fowler, however, concludes that only a small number of students benefit from the large number of course offerings in a large school. This includes students from middle- to upper-income families, who are better equipped to do well in large schools. "A number of studies conducted during the past 20 years, particularly at the elementary-school level, have found small school size to have an independent, positive effect upon student achievement (Fowler and Walberg, 1991)." Another study that supports small schools is Stiefel's (2000) work on high school size and its effects on budgets and student performance. This study has shown that the large and small schools that were analyzed had similar budgets, and both school sizes were cost effective. In all, the Stiefel had concluded that New York City would benefit in continuing to support small high schools. Cushman's report (1999) has concluded that small schools are less expensive when costs are calculated by graduation rate, rather than by student. Cushman based her findings on the fact that smaller schools have a lower drop out rate than larger schools.

Because of the abundance of large schools throughout the U.S., the NASSP has recommended breaking schools into units or "house plans". Cushman reported how one elementary school in Philadelphia experienced positive outcomes after

restructuring the school. Once a large school consisting of 900 students, the school was divided into units or houses, with a student population less than 250 each. Since the induction of the smaller "learning communities," the principal has seen an increasing feeling of community between teachers and students and a decrease in student behavioral issues. Students are more likely to become involved with the "community."

After studying the effects of school size on achievement, Luyten (1994), like Cushman, found that a sense of community was apparent in small schools, a characteristic that larger schools lack. Small school size has positive effects on student participation, satisfaction, and drop out rates. A number of American studies have corroborated Luyten. Meier (1996), for example, concurs that small schools work best because

- communication between staff is better;
- students and teachers are able to get to know one another;
- there is less bureaucracy;
- parents and teachers form a union;
- everyone knows how the students, teachers and school is doing; and
- students feel part of a community.

However, McGuffey's study (1991) states that as school size increases and costs are held constant
- teachers are more likely to hold higher degrees;
- students taught by faculty teaching out-of-field decreases;
- average number of courses increase; and
- average number of subjects increase.

But are these advantages, which McGuffey points out, really beneficial if achievement scores are showing that not all students are capable of succeeding in large schools.

As well as size and age of a school, research has been conducted regarding the cosmetic condition of the facility. Cash (1993) has found that improved cosmetic conditions in a school were associated with increased mean TAP scores. Dunn (1985) has reported that lighting is highly correlated with student achievement. In a study of 5th and 6th grade students, Luckiesh and Moss (1940) found an increase in test scores on the "New Stanford Achievement Test" for students who were in well-lighted classrooms. As well as fluorescent light, natural classroom light was found to be associated with increased learning. It is recommended by the SDPL that at least 20% of wall space be assigned to windows.

Like light, color can also contribute to student achievement. Sinofsky and Knirck (1981) believe that color is responsible for affecting learning and behavior. They reported that color influences the attention spans and affects a teacher's and student's perception of time. Wohlfarth (1986) and Sydoriak (1987) found "cooler colors" were associated with lower blood pressure, where warm colors were associated with higher blood pressure in children. Hines' study has found that cosmetically superior schools are correlated with higher levels of disciplinary incidents being reported. Light and color are just two factors that have been associated with increased student achievement in schools.

The literature cited was also part of the basis for Interactive's telephone survey. The school and classroom variables that were included in the survey were generated from the studies. All school factors that had been previously shown to have an effect on student achievement were included. The key studies were Cash (1993), and Hines (1996).

One-third of America's schools face extensive repair, with many needing replacement of the entire building. "Educators should view the building of a new school or the renovation of an older one as an opportunity to advance reforms (Uline, 2000)."

3.3 THE NEED FOR SCHOOL CONSTRUCTION AND RENOVATION IN ARIZONA

Nationally, by the year 2010, the United States will need an additional 6,000 school buildings at an estimated cost of $60 billion. There are 228 public school districts and 1200 public school buildings in Arizona. The State legislature has established minimum standards for school spaces. Schools that are below those minimums (discussed below) are described as "deficient."

The state is to allot enough money so that all schools in the state will have their facilities deficiencies corrected by June 30, 2003, [1149 days from April 17, 2000]. The types of building actions eligible for State aid are:

X deficiencies corrections
X building renewal, and
X new school facilities.

Arizona will need to create 150 new schools (95 million square feet of instructional space) and to reconstruct and renovate existing schools. The School Facilities Board is obligated to determine the cost of remedying all school facilities deficiencies.

Through the first cycle and a half of New Construction applications the SFB has obligated funding for the schools listed in Table 11. Another 63 schools have requested aid for facilities that would open during the Fall of 2003 or later but have not

yet been reviewed by staff---44 are Elementary Schools: 7 are Middle Schools; and 12 are High Schools

3.4. *Students FIRST*

3.4.1 Assumed Economies of Scale. In general, administrators try to build the biggest possible school for the least cost and use the difference between the State Facilities Board-allowed construction aid and their actual construction cost to fund other spaces for which there is no state aid.

Also, in general, the State Facilities Board [hereafter, SFB prevents overspending but allows underspending. As long as a district's proposed construction bid does not exceed the formula-allowed total and meets adequacy requirements, then it can be funded. If subsequently, the project can be built for less than that amount, districts are allowed to spend the difference for other construction-related costs. One effect is to reward efficiency and provide flexibility.

3.4.1.A <u>Determining school size</u>. "Bigger schools are less expensive to operate and provide more programs that parents want." (A school architect) The wishes and needs of parents and communities are reinforced by the dynamics of state guidelines and regulations.

There are two numbers that are important, both expressed in terms of square feet per pupil:

	Total school size:	90 sf/pupil
	Instructional space per student:	30 sf/pupil

The difference between the 30 sf/elementary pupil for instructional space and the 90 sf/pupil for total school space is available to be used for hallways, bathrooms, common space, special space, etc.

Determining adequacy for existing facilities. *Students FIRST* charged the SFB with determining minimum facilities standards that were to be met by all school buildings, for example, minimum square feet for instruction, equipment availability, air quality and temperature, etc.

Determining adequacy for new construction. A separate part of statute described parameters for new construction e.g., a total 90 sf/elementary pupil for a school building. To be deemed adequate, a building had to meet that standard. If it did not, the district would be eligible for State renewal aid. Immediately after the passage of the legislation (the end of 1998), the SFB determined the 90 sf/student to be the approximate average of Arizona schools.

Table 15. New Construction Requests Reviewed and Obligated by State Facilities Board by Level or Organization (March 30, 2000)	
ELEMENTARY SCHOOLS (76 total)	
New Schools	52
Replacement Schools	15
Additions	9
MIDDLE SCHOOLS (8 total)	
New Schools	7
Additions	1
HIGH SCHOOLS (14 total)	
New Schools	13
Additions	1

While the overall guideline is not enough to generate, for example, space for an elementary school to have a gymnasium, districts have accepted the guideline at the same time that they seek to use its provisions to create more flexible funding. There is a per student allowance for "multi-purpose rooms" for 33% of the student body. ["Adopted Building Adequacy Guidelines"] For elementary schools, the SFB supports only space that is multi-purpose, not space that is dedicated as a gymnasium or an auditorium. Districts are also free to exceed these minimums. If a district chooses to build an elementary school with 140 sf/student, it must pay for the additional space.

The second number, 30 sf/elementary pupil of instructional space is stated in the "Adopted Building Adequacy Guidelines." If a district is maintaining a school with 600 sf classrooms and 27 students in them, that building falls short by 210 sf (27 students X 30 sf of instructional space per student = a required minimum of 810 sf). In that case, the SFB is obligated to help the district meet the standard.

3.4.1.B <u>District preferences for school size</u>. Districts decide the enrollment size of their schools based on a number of factors. For example, they may determine that 800 students is an optimum number that can be accommodated and controlled on a campus. When the district informs the SFB of its projected enrollment growth, the SFB also determines what the district's wishes are with respect to school enrollment size. The district designs the school at that level and the SFB reviews and determines the eligibility of the proposed design.

Districts also try to plan for the maximum enrollment because they need to provide for future growth. Larger facilities are a prudent hedge. Even districts with little or no space available for new development can and do grow if single family homes are converted to multiple family dwellings. In some cases, schools that were built for 700 students now enroll almost twice that.

One major concern of the SFB is the number of classrooms in relation to the enrollment---are there enough? School architects assume 25 students per K-3 classroom and 28 students per grades 4-8 classroom. Those numbers are used by the SFB to determine whether or not the school has enough classrooms.

3.4.1.C <u>Spreading the cost of non-eligible co-curriculum space over more students</u>. Thirty sf/pupil of the total per pupil allotment of 90 sf must be instructional space. Satisfying the exact dimensions of every requirement (including instructional), takes an estimated 74.5 sf. In a 1000 seat school, that balance yields 15,000 sf: in a 400 student school, it is 600 feet, less than the space of a single classroom. "You have to propose enough enrollment in order to qualify for the other facilities you need, a library, a computer room. With a 400 student school you can have only one of the following...(a) glee club, (b) band, (c) art, (d) newspaper."

For example, co-curricular space such as dedicated rooms for Art, Foreign Language, Physical Education are not eligible for construction assistance under *Students FIRST*. If a district builds two, 500-seat schools, there may be pressure to include an "Art classroom" or a "Choral Music classroom" in each of the schools. Instead, districts opt to build larger schools where the expense of space dedicated to co-curricular activities can be spread over more students.

3.4.1.D Building at less cost than the SFB-construction allowance. The belief here is that larger projects are more economical to build and to operate than are smaller projects.

3.4.1.E Space restrictions and curriculum consequences. The most important relation here is the possible interaction between space and achievement. Additionally, the operation of the guidelines makes it difficult to dedicate instructional space to particular curriculum topics, for example, a room used only for foreign languages with graphics, displays and audio equipment that support language instruction. That sort of facilitation is not feasible if the language teacher is an "itinerant" moving from one room to another over the course of the day.

While a pattern of space reserved for particular instruction may facilitate learning and teachers' working conditions, if the language teacher has two "prep periods" in an eight period day that room will be unused for instruction 25% of every day.

If a district wants to use a school as a more general community facility, there are added space requirements. Teachers are reluctant to have their rooms used "after hours" unless they can store supplies, displays, etc., in a secure space. Without flexibility and enhancement in using space, the contribution of a school building to a wider community agenda is lessened.

3.4.1.F Small districts. Small districts are the least able to avoid the structures of the dynamics just described. Big districts can redraw attendance lines to increase school size; small districts are blocked from, e.g., adding 200 more students to a building because that number of students are simply not geographically available. Similarly, small districts and small schools are less able to deal with incremental growth of classes above desirable maximum numbers. In a building with only one grade and a second grade class that is about to go to 33 students, it is seldom feasible to hire another second grade teacher (and reduce both classes to 16 or 17 students). The

SFB tries to recognize those circumstances by justifying building plans on a needs basis.

Third, small districts have fewer dollars to begin with and thus, less flexibility.

Provisions of *Students FIRST* are intended to compensate for the disadvantages of small size. For example, the effect of the more generous minimum required size allowance for districts enrolling fewer students, is that it takes fewer new students than in larger district to put the district into a deficiency situation and thus smaller districts qualify for building aid more quickly than do larger districts. [Minimum Square Foot per Child Requirements By Enrollment Sizes of Districts (15-2011 C. 1-7), Table 16] Additionally, smaller districts qualify faster because their square foot amounts are more sensitive to small changes. For example, 50 extra students in a population of 450 is a bigger burden than 50 extra students in a population of 1,500. As district enrollment size increases, minimum square feet required per child gets smaller. Therefore, more pupil growth is required to qualify larger districts for assistance.

Part of the rationale for that asserts that because larger districts have more classrooms and more schools, they also have more flexibility in absorbing enrollment increases by balancing enrollment growth across unevenly used space.

3.4.2 Excluded Costs: Support Costs and Enhancements. The current statute limits the amount of space that the State will aid. When instructional and other required uses are accommodated, only a small fraction of the allowance is available for additional purposes. Operating a district also requires bus barns, administrative office, maintenance shops, etc. but there is no specific legislative provision for those expenses. In order to fund those additional costs, districts propose school buildings that are as large as can be allowed, build them for less money (than initially "allowed") and use the surplus to build the other spaces.

Similarly, built-in shelving or seating areas, AV provisions, etc. are desirable but not specifically eligible in *Students FIRST*. Larger schools enrolling more students may generate the surplus funds to support such enhancements. The bigger the school, the greater the possible efficiency or surplus available for these purposes.

3.4.3 Transportation. Some administrators believe that a series of smaller, 500 student schools in a new housing development will require more busing than one large school serving the same area. Thus, to minimize transportation costs, they build fewer and larger schools in central locations where more students can walk. The extent to which a single large school, in fact, has this transportation-reducing effect varies by the particular circumstances of the development.

3.4.4 Land Purchases/land Donations. The SFB has a fund that is to be used

Table 16. Minimum Square Foot per Child Requirements By Enrollment Sizes of Districts (15-2011 C. 1-7)		
District Enrollment	**Minimum Gross Square Footage per Student**	**New School $ Amounts Per Square Foot**
	ELEMENTARY (Pre-K to 6)	
Small: <800	80	$93.15
Large: >801	80	
	MIDDLE (7-8)	
Small: <800	84	$96.50
Large: >801	80 or 67,200 gross sq. ft., whichever is larger	
	HIGH (9-12)	
Small: up to 400	125	$113.85
Med: 401-1000	120 or 50,000 gross sq. ft., whichever is larger	
Large: 1001-1800	112 or 120,000 gross sq. ft., whichever is larger	
extra large: 1801+	94 or 210,000 gross sq. ft., whichever is larger	

***NOTE: Schools in rural areas are allowed a 1.05 sq. ft multiple.**

to purchase land for new schools, typically in areas where real estate developers are building homes. State law says that the SFB may pay "up to fair market value for the [land at its] highest and best use." Calculating the "highest and best use" for land in the future, after it has been developed with new homes and commercial facilities yields a current purchase price that is much greater than the value of raw land or land in agricultural use.

That creates the possibility that school districts will support a developer's current asserted valuation of raw or agricultural land as though it were built out. If the SFB purchases a school site at that future value, it can create an unintended bonanza if the district asks the developer to pay the district the difference between the 'as if developed' high price and the lower 'raw land' price.

Thus, the SFB takes the position that it is not required to support the construction of schools in locations that are determined by developers, not by the State. If the SFB does not support purchase of a school site within the real estate development, then the value of new residential units fall because there will not be a conveniently located school.

Thus, developers have been persuaded to forego asking for 'as if developed' purchase prices and instead to donate land for schools. (The SFB returns 20% of the donated value to the school district.) The practice saves SFB funds for other uses.

3.5 *Students FIRST* AND M&O

3.5.1 SFB Construction aid by enrollment and M&O state aid by attendance. SFB school construction and renewal are based on projected **enrollment**. The State Department of Education's M&O aid is determined by actual **attendance**.

The interaction produces a kind of gamble. Districts build to the largest enrollment estimate and try to staff to the lowest. In effect, they have to hope that not everyone comes to school.

If a district has built a school to meet an expected enrollment target but then experiences high absentee rates, the district ends up with less M&O money to support the larger school. For example, a school built to house 1000 students and staffed for a 1000 students opens with a 10% absentee rate. That school will get funded as though it were a 900 student school although it has been built and must be maintained and staffed for 1000. The bigger the absentee rate, the greater the shortfall between building capacity, resource requirements and M&O assistance. Administrators feel that they are being forced to build schools larger than what state aid will eventually support.

They have no choice but to assume that all eligible children will come to school. "You have to resource for 100% but you will get paid for 90%."

3.6 M&O, MANAGEMENT AND OPERATIONS

Management and Operations "M&O" is defined as expenditures for:

X regular education

X special education (with "classroom instruction expenditures" "clearly distinguished" in each subsection)

X pupil transportation

The M&O part of the state-prescribed school-by-school budget is separate from capital outlay, debt service, special projects and "adjacent ways."

"Capital items" (for purchase, lease/purchase or lease) are:

X land, buildings, improvements including labor, employee benefits and materials

X furniture, equipment including computer equipment

X transportation vehicles and equipment

X textbooks and print

X instructional aids

X library books

X payment of principal and interest on bonds

X emergency administration

"Soft capital" outlays are "short-term capital items that are required to meet academic adequacy" and include:

X technology

X textbooks

X library resources

X instructional aids

X pupil transportation

X vehicles

X furniture and

X equipment

3.6.1 Soft Capital Restrictions. Soft capital cannot be used for M&O expenses. Prior to *Students FIRST,* allowances for soft capital could be used to pay for M&O expenditures including salaries. When districts used soft capital as a kind of emergency fund, they were often unable to pay for the things for which the soft capital allocation had originally been established—textbooks and pencils. Thus, the current restriction.

The state average for M&O is $4,600 per pupil of which $210 is soft capital. "Soft capital" is intended for items with a use expectancy of three years or less. Soft capital can be used for textbooks, instructional supplies, etc.[12], but it cannot be used for administrative costs or for salaries. [Neither the SFB nor the Department of Education cover such costs.]

If the legislature passes a law capping additional and particular kinds of M&O expenditures (for example, administrator salaries), then the drive to find flexible dollars by building larger and larger schools will be exacerbated.

3.6.2 M&O: Funding Delays. All districts must deal with the uncertainty of operating a school for almost the entire school year before they know how much State aid they will receive. The delay is built into the practice of determining state aid amounts as a result of counting enrollments at the 100th day of school. After the count is established the process of assigning weights to students in different categories further delays the process. Typically, a district does not know how much aid it will receive until May for a year that begins in September.

The first problem of delay begins when a district opens a new school but will not begin receiving M&O aid until the 100th day attendance count is established. In effect, districts with new schools begin by being one year in arrears.

Similarly if a district is growing quickly but its aid is determined only by pupil attendance at the 100th day, the district has to finance the first 100 days of increased enrollment. For growing districts, state aid is always supporting a smaller school than the district is running. To anticipate growth, districts want to build schools that will accommodate the projected numbers. But when they open a building that is larger than the current attendance, they will not get M&O funding for the larger building.

3.6.3 The Cumulating Problem of Building Maintenance. M&O money has no amount dedicated to maintenance. The relative flexibility of those dollars allows districts to spend them for other purposes. Without proper maintenance, the State's

[12] Some items appear on both the M&O "Capital" list and on the "Soft Capital" list. The duplication was intended to give districts two sources of support for major acquisitions, for example in years in which the district had a new textbook adoption to fund.

investment in new and renovated facilities will be reversed by the effects of age and wear. Examples are roofs, oiling, patching and painting.

One method would be to allow soft capital dollars and "Renewal" dollars to be dedicated to maintenance. Currently, "Renewal" dollars cannot be spent on daily

maintenance.

3.6.4 When Growth Stops. Some Arizona districts have stopped growing. One effect of the delay in the M&O funding is that there is a 'bonus' in the next year from the underfunded expenses associated with the 100^{th} day counting procedure. That "bonus" occurs every year as long as enrollment grows. But when enrollment growth stops, the teachers that were previously hired continue to move up the salary schedule and become more expensive each year. Pension costs continue to increase (and so also are building maintenance problems likely to multiply).

4.0 SUMMARY AND CONCLUSIONS

The relationships between and among size variables, grade configuration within schools, and student achievement are complex and are probably not able to be adequately explored with the data available. In general, size – whether enrollment or square footage – isn't highly related to achievement. For 5th and 8th grade students, the relationships are statistically significant, but not meaningful, with size accounting for less than 5% of the variance in Stanford 9 achievement. For 11th grade students, size accounts for about a quarter of the variance, a strong finding. Size of school enrollment is significantly more important to student achievement for Title I students than for non-Title I students.

In examining the relationships between academic achievement and other school design factors, we found no relationships. For this analysis, we looked at the relationships between school achievement and the following design variables: Thermal factors, classroom lighting, maintenance schedule, school structure, traffic / crowdedness, parking, furniture, privacy, noise level, aesthetics, technology, available facilities, material, color, interior decoration, flooring.

Relationships between school size and student productivity measures of attendance and promotion (non-academic measures of student productivity), we found statistically small but significant correlations, with larger physical size, higher enrollments, and higher density associated with higher attendance and promotion rates.

Although we attempted to examine the relationships between school design features and negative student outcomes such as student retention, dropouts, expulsion, tobacco and substance abuse, and violent and destructive behavior, the small distributions and equally small reports of such behaviors made such an analysis meaningless.

In the end, the meaning of these differences are up to educators and parents. For example, while psychometricians would say that the 10 scale score point difference between 695 and 705 has no practical significance, in terms of effect size, we leave it up to educators to decide whether or not ten points has meaning. It is up to educators and policy makers to decide if the achievement gains that might by realized by reducing the size of schools are worthwhile. Further, this study did not examine measures other than scores on the Stanford 9 of academic productivity. These measures might show something entirely different.

We believe that size relationships should examine both school and district size as well as the influence of SES. The examination of cross-level interactions of SES, school

and district size might provide further insights. There is some evidence that scaling is
important.

Although we attempted to examine the relationships between school design features and negative student outcomes such as student retention, dropouts, expulsion, tobacco and substance abuse, and violent and destructive behavior, the small distributions and equally small reports of such behaviors made such an analysis meaningless.

The national empirical literature on school design issues was somewhat similar to the findings of this analysis. The relationship between school size -- particularly student enrollment - - and student academic productivity is considerably more complex in this study than is reported in the national literature. This finding might be explained by the detail of the analysis in this study, including a student level analysis rather than an aggregate school level analysis, as has been done in the majority of other studies.

These findings have implications for school facility policies, particularly as related to incentives for building size.

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