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New Schools, Overcrowding Relief, and Achievement Gains in Los Angeles – Strong Returns from a $19.5 Billion Investment

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Urban educators have struggled with aging, overcrowded schools since the late nineteenth century. In contemporary Los Angeles, by the mid-1990s, the count of packed campuses operating year-round on multiple shifts had reached unprecedented numbers. Since the 1960s the student population of the Los Angeles Unified School District (LAUSD) had increased by roughly 250,000 students and shifted dramatically from 85% white, mostly middle-class to four-fifths Asian, Black, and Latino families, typically living in low-income neighborhoods (Kerchner et al., 2008). L.A. had not built a new school since the 1930s. So, by the 1990s almost 25,000 children were bused out of high-density areas to faraway schools with sufficient space (Oakes, 2002).

The *Rodriguez* consent decree brought by families living in the most densely populated areas, along with heated civic activism, pushed LAUSD to set goals for reducing overcrowding. This pressing problem, which likely exacerbated achievement gaps among students, caught the attention of voters. The L.A. electorate eventually backed five local and state ballot initiatives, yielding more than $19 billion in fresh bond revenues, to finance an immense facilities construction program. This program involves over 130 new facili-

Executive Summary

Aiming to relieve overcrowded schools operating on multiple tracks, the Los Angeles Unified School District (LAUSD) has invested more than $19 billion to build 130 new facilities over the past decade. District leaders asked researchers at Berkeley to estimate the achievement effects of this massive initiative – benefits that may stem from entering a bright, new school or from exiting an aging, even dilapidated facility bursting at the seams with students. Previous reports from the project examined how new schools and alternative schools have affected rates of student mobility and teacher turnover across LAUSD.[1]

By tracking thousands of students who moved from overcrowded to new facilities over the 2002-2008 period, we discovered robust achievement gains but also uncovered questions related to future deliberations.

Key findings include:

- The steady opening of new schools dramatically relieved overcrowding in elementary and secondary schools and set in motion a complex migration of

Continued on page 2.

Executive Summary (Cont.)

students, both to new facilities as well as to a growing number of charter and pilot schools.

- Significant achievement gains are discernible for elementary-school pupils who switched from an old facility to a newly constructed facility. On average, these 'switching pupils' outpaced the average LAUSD student by a gain equal to about 35 additional days of instruction each year.
- Achievement gains are most robust for elementary students who escaped severe overcrowding by moving to a new elementary school. Relative to the rate of learning for the average LAUSD student, this subset of students enjoyed achievement gains equivalent to about 65 days of additional instruction per year. Students migrating to certain new elementary schools experienced even stronger gains.
- Across new elementary schools, we find no relationship between the per-pupil construction costs directly tied to classrooms and the magnitude of achievement gains. That is, pupils migrating to less-costly new schools saw achievement gains that were no different, on average, from those moving to more expensive new facilities.
- After a new school opened nearby, students who remained in previously overcrowded elementary schools experienced modest gains, compared with the average LAUSD student.
- Although new facilities featured slightly lower pupil-teacher ratios, higher shares of fully credentialed teachers, and lower teacher turnover, these features do not explain the steeper achievement growth of elementary students migrating to these new facilities. Additional research could uncover the deeper factors that explain the buoyant achievements results.
- We could only discern inconsistent and weaker achievement gains for high school students who moved from an overcrowded to a new school facility.

ties, from early learning centers to large, elegant high schools, as well as hundreds of renovation projects (Fuller, Recinos, & Scholl, 2008). With the exception of the federal interstate highway system, LAUSD's construction program is the largest public works project ever undertaken in the United States (Fuller et al., 2009).

But does entering a new school, or moving students out of severely overcrowded conditions, significantly boost student learning? This is the bottom-line question asked by leaders of LAUSD's facilities initiative and the topic explored in this brief.

Do Facilities Contribute to School Quality in Potent Ways?

Convincing evidence has shown that higher-achieving students attend higher quality facilities, while low-performing students often gain access only to aging, often overcrowded schools. However, this does not necessarily mean that shiny, innovative campuses directly raise test scores. Higher-achieving students often benefit from strong family support and other aspects of school quality that contribute to their achievement growth.

L.A.'s massive experiment in moving thousands of students from severely overcrowded to new facilities offers a rare chance to look at the specific effects of this migration, allowing us to move beyond correlational evidence and make stronger causal inferences. The estimated effects of migrating to a new school also hold immediate implications, as LAUSD shapes new investments in school renovation and increasingly shares new facilities with alternative school managers, including charter and teacher-led pilot schools.

Earlier correlational studies suggest that certain features of school design—such as clean air, good light, and a comfortable and safe learning environment—result in stronger pupil engagement and achievement (Schneider, 2002; Lemasters, 1997; Lackney, 1999; and Cotton, 2001). Other elements of school quality related to better

facilities, such as an enriched academic climate, or higher teacher morale and lower staff turnover, are also associated with better student outcomes, stemming from more robust working conditions (Buckley et al., 2005; Uline & Tschannen-Moran, 2008).

But to date little evidence exists to support the claim that the quality of school facilities directly influences educational outcomes. Earlier work suffers from small samples of schools, lack of control for confounding factors, and scarcity of longitudinal data. More recent studies have a stronger empirical base, but results correlating school facilities and achievement remain inconclusive (Bowers & Urick, 2011; Nielson & Zimmerman, 2011).

This brief uses high-quality longitudinal data recently made available by LAUSD to derive more rigorous estimates of how new facilities affect student mobility and achievement. The study examines enrollment and test scores for nearly 20,000 elementary and high school students from 2002–2008, during the first phase of the new facilities construction project.

Taking the case of densely populated Local District 6 (LD6), we begin by detailing the extent of student movement from old, overcrowded buildings to new schools. Next we examine the achievement effects for elementary and high school students throughout LAUSD, focusing on the discrete benefits for students who left severely overcrowded schools for new facilities. We also ask whether students remaining behind in older schools benefit academically from enrollment relief. That is, gains may be experienced both by those who migrate to new facilities and by pupils who are now served by less-crowded schools.

How New Facilities Relieved Overcrowding

Student movement as new schools and charters open

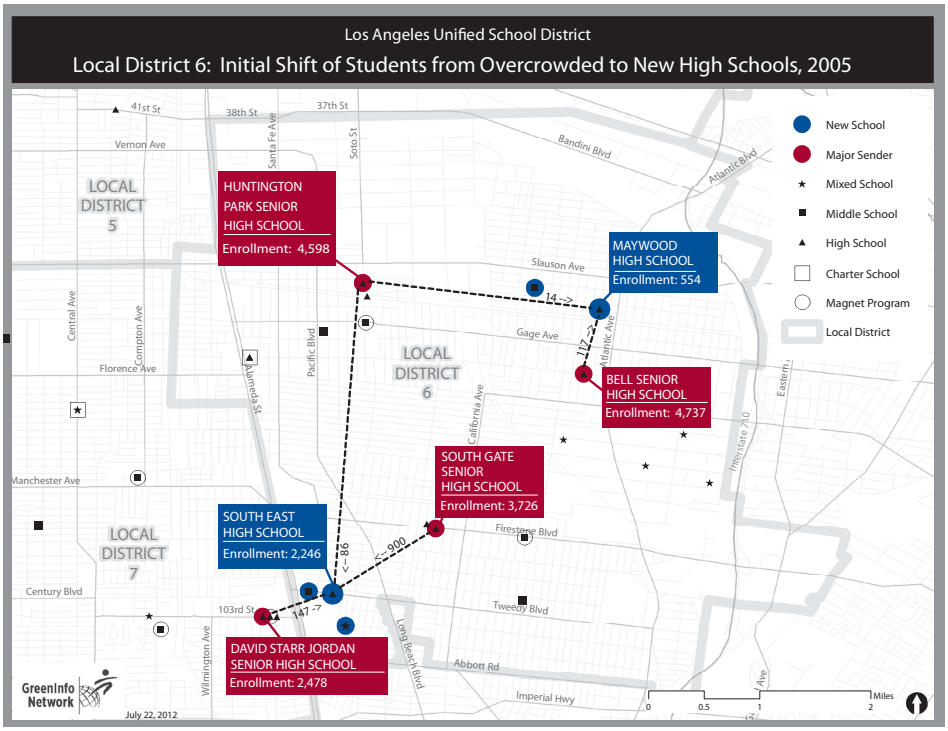
Before estimating achievement effects from student movement, we consider the extent of student migration sparked by the District's ambitious construction program. To illustrate, we analyze student movement in the LAUSD subdistrict that became infamous for its high levels of overcrowding: Local District 6, serving the Southeast Cities of Maywood, South Gate, Huntington Park, Cudahy, Vernon, and Bell. We detail student movement from overcrowded high schools to two new high schools that opened in 2005. This case of student migration, including into the rising count of charter schools, focuses on high schools.

For many years, the three large high schools in Local District 6 (LD6) were severely overcrowded. South Gate, Huntington Park, and Jordan each served nearly 5,000 students, although they were designed to serve far fewer; each operated multitrack calendars for over 20 years. In 2005, Maywood and South East high schools opened nearby and began to alleviate overcrowding.

New facilities were sited near overcrowded facilities so that their catchment areas would include many of the students previously assigned to the overcrowded facility. When the new facilities opened, catchment areas were redrawn such that some students previously assigned to old facilities were assigned to new facilities. Of course, some students likely moved into a new facility's catchment area, and some parents likely found ways for their students to be assigned to a new facility despite not living in the catchment area. But for the purpose of our analysis, no categorical difference exists between students who could and students who could not attend a new facility. Even small systematic differences would not affect the results of our achievement analysis, because our procedures control for all unobserved characteristics of students.

Figure 1 shows enrollment changes in LD6 when Maywood and South East high schools opened. The arrows show the number of students who transferred from an old high school facility to a new school. (Movement from middle schools into new high schools is not shown.) Within the first year of opening, South East high school enrolled over 2,000 students, drawing a majority of its enrollment from severely overcrowded South Gate High School, neighboring David Starr Jordan, and Huntington Park. Maywood enrolled fewer students in its first year of operation, but drew students from nearby Bell and Huntington high schools. Thus, although Figure 1 only shows movement of students to Maywood and South East, many of the schools in LD6 saw enrollment drops, due to the variety of new schools opening.

FIGURE 1. Local District 6: Students Move from Overcrowded to New High Schools, 2005



Change in student mobility over time

By 2008, two new charters, three new mixed schools, and two new middle schools opened in LD6. By this time, Maywood and South East continued to pick up enrollment from the overcrowded schools as well. South Gate had sent over 1,000 students to South East, David Starr Jordan had sent nearly 200, and Huntington Park had sent over 160 students. Maywood received over 160 students from Bell and 30 from Huntington Park. By 2008, the majority of middle and senior high schools in LD6 had experienced enrollment drops or stability from the previous year, as relief played out.

In summary, we see that both new school construction and the opening of charter schools spurred many families to switch schools. At the same time, enrollments shrank in the previously overcrowded schools. So, the school environments changed for students who migrated and for those who remained behind in now-smaller, older schools.

Did Students Enjoy Achievement Benefits When Moving to New Schools?

The longitudinal student data system, built by LAUSD, allows us to estimate achievement benefits for students who switched from a previously overcrowded school to a new facility. This initial analysis focuses solely on the over 20,000 students who made this switch during the 2002–2008 period. We report results for elementary and high school students separately, using what are called within-individual fixed-effects models. This statistical procedure gauges change in test scores for individual students as they move from an overcrowded to a new facility. The methodological appendix at the end of this brief provides more details.

After controlling for students' previous test scores, the age of the school, whether it was a student's first year of school, the number of instructional days in the school calendar, and all unobserved characteristics of each student (such as parents' press for achievement, student motivation, and peer effects), we estimated average year-to-year growth in student scores on the California Standards Tests (CSTs) as a result of moving to a new facility. Table 1 gives summary statistics for our models.

Good news for elementary school students

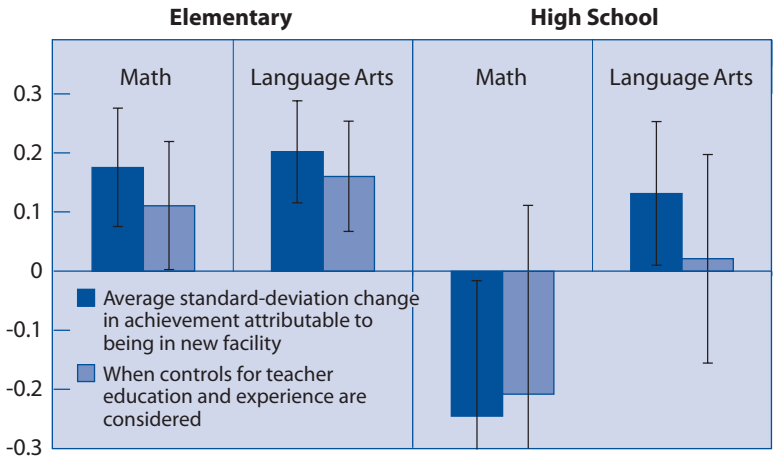
Figure 2 summarizes our results. We found that new *elementary school* facilities, after their initial two years, provided an average boost to achievement of about 0.18 of a standard deviation (SD) in math and 0.20 SD in language arts for each year that the student was in the new facility. Box 1 explains why we standardized the magnitude of achievement effects in this way, equating the gain to additional instructional days.

Students switching into new *high school* facilities was associated with a statistically significant average gain in

TABLE 1. Elementary and Secondary Students Switching to New Schools (excluding middle schoolers)

	Elementary School		High School	
	Math	Language Arts	Math	Language Arts
Number of student switchers	6,105	6,113	6,554	7,148
Average number of observations (years per student)	3.7	3.7	2.7	2.8

FIGURE 2. Achievement Change in Student's Second Year or Greater



language arts of about 0.13 SD units. In mathematics, students migrating to new high schools performed at lower levels, although this difference is not statistically significant. These results did not differ by ethnicity, reduced-price meal eligibility, special education or English proficiency level status.

Pupils switching to a new elementary school experienced their smallest gains in the first year after opening. In subsequent years, achievement gains increased, which we attribute to educators 'hitting their stride' in the new facilities. However, high schools did not show comparable year-by-year increases in the gains of students who switched schools.

Difficult to explain why new facilities lifted achievement

The positive effect of switching to a new elementary school may have been due to new schools attracting more effective teachers than old schools. To test this hypothesis, we reestimated our models, this time controlling in each year for teachers' average level of education and years of teaching experience at each school. Adding these controls reduced the "new school effect" across the board (see Figure 2). In particular, the benefits experienced by students in new high schools can be almost entirely explained by the education and experience levels of their teachers. In elementary school, an additional statistically significant effect of new facilities remains even when teacher-quality controls are included.

This result indicates that new facilities boosted elementary students' achievement growth above and beyond what would be predicted by simply attracting more qualified teachers from elsewhere in the district.

HOW MUCH IS A STANDARD DEVIATION GAIN?

Because the tests that students take in different grades do not measure precisely the same abilities, our analysis depends on "standardizing" students' scores. That is, we scale their raw test scores so that the average score in each grade is zero. Then, the unit we use to measure scores changes from "points" to "standard deviations." Instead of saying that Student A scored ten points better on a test than Student B, we say that Student A scored, for example, 0.25 standard deviations better on the test. Although this metric cannot precisely convert score increases to additional days in school, prior research gives us a rough idea. Using Hill et al.'s (2008) results from national longitudinal data, the elementary "new-school benefit" corresponds to about 35 instructional days in math and 45 days in language arts. Using Rathbun and West's (2004) results revises the estimate downward between 15 and 25 instructional days in both math and language arts.

TABLE 2. Measures of Resource Endowment in Old and New Facilities

	Elementary School		High School	
	Old	New	Old	New
Average Percentage of Teachers with Full Credentials	97%	98%	86%	81%
Average Ratio of Total Students to Total Teachers	17.9	17.4	20.6	20.3
Average Percentage of Teachers Leaving School per Year	12%	8%	25%	19%
Teachers' Average Years of Experience	11.5	8.8	11.6	7.3
Teachers' Average Level of Education (Standardized)	–.06 SD	+.06 SD	–.33 SD	+.32 SD

What could account for this additional effect? One hypothesis is that new schools enjoy stronger resources than old schools, such as better classroom environments and instructional equipment. While our data do not contain highly precise measures of resource endowment by school, we were able to construct four measures that capture different elements: the mean ratio of students to teachers in each school, the mean rate of teacher turnover, the mean percent of teachers with full credentials, and (for new facilities) an average cost per student-year (total construction cost adjusted for inflation and divided by number of seats). Table 2 shows that new and old facilities did not differ appreciably on any of the first three measures, which are weighted by number of students in each school.

Although the *average* effect of switching to a new elementary school was positive, different schools showed variation around this mean (again, controlling for school age, student entrance status, prior scores and unobserved pupil characteristics). We attempted to assess whether such variation was associated with the above-mentioned school-level factors. Were the more effective new facilities those that were more expensive, or that had better student-teacher ratios, teacher turnover rates, or teacher credentials?

We found that none of these factors had a statistically significant association with achievement gains. In particular, although inflation-adjusted construction cost per seat ranged from $12,000 to $22,000, students in higher-cost facilities did not show higher growth than peers in lower-cost facilities. Figure 3 displays the achievement gains associated with each individual new elementary school (the same model reported in Figure 2, except run for each new facility separately), plotted against inflation-adjusted construction cost per seat. Similarly, at the high school level, resource endowments were not significantly associated with high-benefit schools.

Bigger gains when moving from a severely overcrowded school

The one factor that significantly predicted stronger achievement gains was the degree of *overcrowding* in the school from which students switched. We quantified overcrowding by measuring the percent enrollment decline in each old-facility school from 2002 to 2008. This procedure is justified by the fact that few new schools opened before 2002, and 2002–2008 was a period of extensive facility construction. Thus, the schools that lost the greatest percentage of enrollment over this time were the most overcrowded ones.

We then divided our sample of students into two groups: those who switched from "severely overcrowded" schools, which lost between 37% and 61% of enrollment, and those who switched from "moderately or not overcrowded" schools, which lost less than 37% of enrollment (or increased their enrollment over time). We ran the same model on each of the two groups of students separately.[2] Those from severely overcrowded schools saw the largest math gains from entering a new school, while the average gain for students from less-overcrowded schools was smaller and statistically insignificant (Figure 4). Even greater differences were observed for language arts, and the effect became more dramatic when schools were broken down into finer gradations of overcrowding (not shown). However, disaggregating high school students in this way revealed no significant effects on achievement.

FIGURE 3. Elementary School Achievement Gains Not Linked to Direct Classsroom Construction Costs (per student)

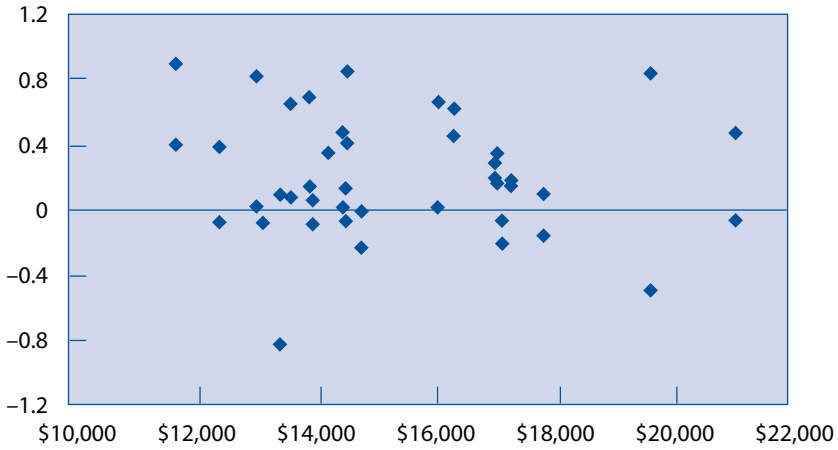
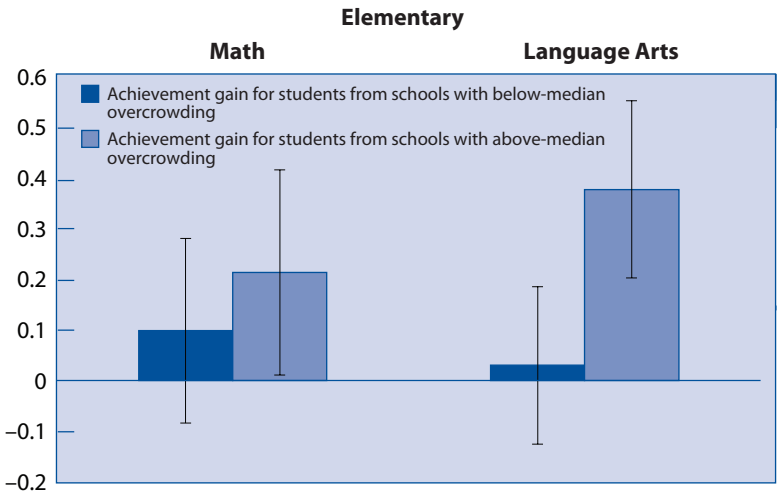


FIGURE 4. Students Switching from the Most Severely Overcrowded Elementary Schools Saw Greater Benefits



Did Relief from Overcrowding Also Yield Achievement Benefits?

To further investigate the hypothesis that overcrowding relief was an additional factor in raising student achievement, we looked at students who remained behind in the old facilities that sent the greatest number of students to new facilities. If overcrowding relief was a major factor boosting the test scores of students who switched schools, we wanted to know if the students who stayed behind also experienced a boost.

For this analysis, we isolated the old facilities which sent at least 1 percent of their students to a new facility in the years observed. We analyzed the test score growth of students who *stayed* in these "major sending schools."[3] We compared test score growth in the years before the nearest new facility opened against subsequent years.

We found that "stay-behind" elementary students also enjoyed achievement gains after new facilities opened that were statistically significant in the case of language arts. These gains were greater than the gains that all other LAUSD students experienced in the same time period controlling for all student-level characteristics. See Figure 5 for the comparison, noting the modified vertical scale. These results suggest that the students who stayed in the major sending schools also felt the benefits of relief from overcrowding. However, the scores of high school students who stayed at these schools did not differ from average LAUSD student scores at the high school level.

The fact that students in major sending schools saw above-average benefits from having a new school open nearby suggests that overcrowding relief contributed to the achievement gains that switchers experienced. However, the fact that switchers saw much greater benefits than the students that stayed behind in sending schools shows that the newness of the school also contributed.

All-Star Elementary Schools

We identified a small number of new elementary facilities whose students consistently showed achievement

growth at rates far above the mean LAUSD pupil. These results, compared with the mean new-school student achievement gain in three time periods, appear in Table 3. At the high school level, Academic Leadership Community and Academic Performance Excellence Academy stood out as showing positive gains over and above students' previous trajectories in both math and language arts over all three years.

Summary and Implications for Facilities Policy

Our findings reveal strong achievement benefits from L.A.'s $19.5 billion investment in new schools – at least for students migrating to new elementary schools. These young students who switched from overcrowded to new schools during the years 2002-2008 displayed achievement gains equal to about 35 days of additional instruction. The magnitude of this gain was even greater for elementary students who exited the most severely overcrowded schools. We did not find similar gains for high school students who moved from overcrowded to new schools, an empirical mystery that requires additional research.

As enrollment relief was accomplished by opening new schools nearby, students who remained behind in less overcrowded schools also experienced significant gains in achievement. This suggests designers of future efforts – for example, when renovating old schools – should anticipate the tandem benefits expected in both the new and old facilities.

FIGURE 5. Students who Stayed in Major Elementary Sending Schools Experienced Modest Gains from Having a New Facility Open Nearby

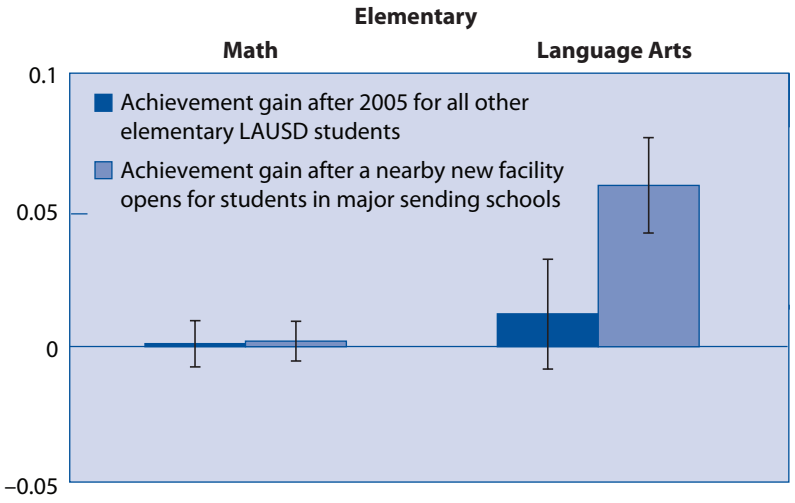


TABLE 3. All-Star New Elementary Facilities: Average Change in Student Achievement Growth (SDs)

	Math			Language Arts		
	Year 1	Year 2	Year 3+	Year 1	Year 2	Year 3+
Charles White Elementary	0.45	0.58	0.84	0.80	0.96	0.90
Maywood Elementary	0.70	0.88	0.69	0.70	0.53	0.66
Madison Elementary	0.53	0.62	0.65	0.50	0.47	0.56
Mean for All New Elementaries	0.12	0.16	0.18	0.17	0.19	0.20

We could not pinpoint the determining factors that explain the positive effects experienced by students. The collateral improvement in teacher qualifications displayed by new schools appears to have played a role, especially in attracting younger teachers with masters-level training. However, more research is required to understand the ingredients of quality or social relations that mark new or less crowded facilities that in turn pay off in higher achievement.

We found no relationship between the direct cost of construction related to classrooms and instructional space and achievement gains among new schools. More work is required here as well. But this null finding does suggest that LAUSD and other urban districts might systematically experiment with less costly facilities, perhaps managed by charter or pilot school leaders, to arrive at more cost-effective buildings. Such careful experimentation could lead to more cost-effective investment of renovation dollars as well.

The fact that some new elementary schools achieved even stronger achievement effects for students invites more fine-grained research on how facilities quality interacts with teacher quality and school community to yield remarkable results.

LAUSD faces several policy decisions with implications for its wide array of more than 850 campuses and allied facilities. The District has handed off new schools to charter and pilot-school managers. These alternative forms of schooling already experiment with storefront and other novel facilities. Billions of additional dollars will become available, as the bond market and tax rates permit, to renovate old, often dilapidated schools. As District enrollment continues to slip, some facilities are now underutilized, a dramatic turnaround from the severe overcrowding that the massive building program has all but alleviated.

Policy Implications

As these issues are taken up and policy options weighed, these findings offer important evidence and prompt future lines of inquiry:

- Higher quality facilities offer necessary but insufficient conditions for raising achievement. Teacher quality and relief from overcrowding play significant roles as well. The distinct role of facilities in concert with other teacher and instructional resources should be considered, especially when the District considers handing schools off to alternative providers.
- The fact that construction costs per pupil are unrelated to the magnitude of achievement gains for elementary students suggests that marginal returns to more expensive facilities may be low. Both charter and pilot school leaders are experimenting with lower cost facilities. Studying the discrete achievement patterns associated with such innovative facilities would be informative
- As LAUSD moves from constructing new schools to renovating old facilities, scope and cost options should be weighed carefully. Maintenance remains a competing need across the District as well. Underutilized facilities represent an emerging issue, while how innovative designs are blended with inventive teaching methods – especially in high schools – offers a new frontier, including small learning communities and the Linked Learning initiative. The positive effects for elementary students whose schools experienced relief from overcrowding suggests that taking further steps to reduce enrollment in still densely packed schools could result in additional gains.
- The lack of robust achievement benefits for students who moved to a new high school facility is cause for concern. Other student outcomes might be studied, and data should be updated by LAUSD to check for effects as the final third of new facilities have come on line since 2008. Still, something is missing beyond fresh facilities as the district attempts to lift achievement inside high schools.
- As other urban districts attempt to remedy overcrowding or to renovate old facilities, the eventual effects on achievement should be carefully studied and not taken for granted.

Endnotes

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[1] All research reports from the Los Angeles School Infrastructure Project appear at: http://gse.berkeley.edu/research/laschoolreform.

[2] We tested this operationalization for robustness by re-running the analysis using the district's school-level classification, a binary variable identifying 80 schools as "previously overcrowded." We then divided our sample of students into those who switched from overcrowded schools, and those who switched from not-overcrowded schools. While the lists of schools were not identical, the effect sizes, directions, and significance levels were nearly exactly the same as when using our classification.

[3] Note that this sample of students is not the same as the samples of students discussed above, and a proper subset of the sample discussed in the last section.

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Methodological Appendix

All LAUSD students who switched from old to new facilities between 2002 and 2009 are included in the model. In the process of determining which students were "switchers," we excluded many new facilities from our list of new schools whose achievement effects we could not estimate. First, because no test-score data exists for their students, early-education new facilities (schools only serving pre-K, kindergarten and first-grade students) were excluded. Second, because we wished to focus on elementary and high school students, we did not examine new junior high facilities (serving grades 6–8 only). Finally, we did not include new facilities that housed continuation high schools, special education facilities, opportunity schools, newcomer centers, or community day schools. Out of 73 total new facilities open during 2002–2009, 44 met our criteria.

To assess effects on achievement, we first had to create a common scale for each of our two dependent variables, the CST math and language arts scores. Because the tests in each grade are not vertically equated (the items measure different concepts), we standardized all scores, converting them to a common z-score metric. For Language Arts CST tests, which are the same for each student in a given grade and a given year, we standardized by grade-year: in each calendar year, we converted each grade's test scores to a distribution with a mean of zero and standard deviation of one. For Mathematics CST tests, we standardized by grade-year-test; that is, in each calendar year, and in each grade, we converted the scores of students taking each test to a distribution with a mean of zero and standard deviation of one. In this way, we minimize distortion in our data caused by differences between tests. For example, a student who ranked highly in 10th grade in 2003 taking Geometry, and who ranked even higher in 11th grade in 2004 taking Algebra II, will show the appropriate increase, even if her raw CST scale score is lower in the second year. In addition, for our model of high school math achievement, we included controls for student's different *progression* through the mathematics sequence. Finally, the dependent variable in our model is *achievement growth*, the difference between the current year's test score and the score on the last test that the student took.

$$
\begin{aligned}
Dit \quad &= Y_{it} - Y_{it-1} \\
&= \beta_1 * newschool + \beta_2 * firstyear + \sum_{j=1}^{2} (\beta_{3j} * newschool * schoolage_j) \\
&+ \sum_{k=g_{min}}^{g_{max}-1} (\beta_{4k} * grade_k) + \beta_5 * shortcal + \beta_6 * (shortcal_t - shortcal_{t-1}) \\
&+ \sum_{h=1}^{m} (\beta_{4h} * teacherchar_h) + u_i + \varepsilon_{it}
\end{aligned}
$$

To find the effect on achievement of switching to a new school, we used a fixed-effects model of achievement growth. A fixed-effects model takes advantage of the fact that we have multiple observations for each student to control for all unobserved, time-invariant characteristics (UTICs) that might have an effect on the dependent variable (achievement). The model controls for UTICs by subtracting students' individual means for the dependent variable from each of their time-specific observations. The same is done for independent variables. As a result, the effects of UTICs (or "fixed effects") that led a given student to have an individual mean that is above or below the grand mean on any variable are dropped from the analysis. This leaves only the effects of changes in the independent variables on changes in the dependent variable. In the present paper, the independent variable of interest is a change in student enrollment from an old facility to a new facility. Thus, to isolate the effect of this switch, a fixed-effect model is most appropriate.

To specify our model, we used the Stata statistical package to estimate coefficient values for the following equation:

Where Y_{it} is the z-scored test score (either math or language arts, standardized as per above) for student *i* in time *t*; *newschool* is a dummy variable coded 1 if the student is enrolled at a new facility and 0 otherwise; *firstyear* is a dummy variable coded 1 if the observation was made during the student's first year at a given school and 0 otherwise; $schoolage_j$ is a dummy variable coded 1 if the observation was made in the school's *j*th year of operation and 0 otherwise, (the reference category thus being new schools' third or greater year of operation); $grade_k$ is a dummy variable coded 1 if the student's current grade is *k* and 0 otherwise; g_{min} is 2 for elementary students and 9 for high school students; g_{max} is 5 for elementary students and 11 for high school students; *shortcal* is a dummy variable coded 1 if the student was on a shorter, 163-day calendar in that year and 0 if the student was on a 180-day calendar; $teacherchar_h$ are a list of teacher characteristics (education and experience, omitted in the dark bars of Figure 2); u_i is a student-level "fixed effect" (the student's mean standardized change from year to year); and ε_{it} is the observation-level error.

Thus, β_1, the coefficient of interest for this brief, reports the average change in students' relative standing among district peers upon moving to a new school if the school has been in operation for more than two years. The statistic is adjusted for the downward shock of it being the first year at a new school, students' current grade level, the calendar track of the school, and all time-invariant unobserved characteristics of the student. Mean estimated values of β_1 are what is reported in all bar graphs in this brief. Table 1 shows sample sizes for each of the models reported in Figure 4.

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