Applications, Enrollment, Attendance, and Student Performance in Rebuilt School Facilities: A Case Study

Sarel Lavy PhD & Jerri L. Nixon MSc


To link to this article: http://dx.doi.org/10.1080/15578771.2016.1245687

Published online: 11 Jan 2017.

Submit your article to this journal

Article views: 11

View related articles

View Crossmark data
Applications, Enrollment, Attendance, and Student Performance in Rebuilt School Facilities: A Case Study

Sarel Lavy, PhD and Jerri L. Nixon, MSc

Texas A&M University, College Station, Texas, USA

ABSTRACT

Public school construction represents a significant portion of all construction spending in the United States; yet, the average age of United States' public schools is 42 years old. This article focuses on magnet schools in a large urban school district in the United States. The study examines whether construction, building age, and building condition have an impact on magnet applications, enrollment, attendance, and student achievement measures. Twenty-eight magnet elementary schools in the school district were chosen for analysis. The experimental group (n=14) included all magnet elementary schools (kindergarten to 5th grade [K-5]) rebuilt under three school bond programs. The control group (n=14) included randomly selected elementary schools (K-5) from the 32 remaining elementary schools in the district that were not rebuilt. Multiple regressions were conducted using building and student data gathered during the 2011-2012 school year. Results indicate that building composite score and building age had no observable predictive effects on magnet applications, student enrollment, or student attendance, in both groups. However, student achievement was positively affected by building composite score as measured by the ability to predict state percentile ranking. This study supports that building and maintaining high quality educational facilities has the potential to raise student achievement levels.

KEYWORDS

Schools; education; building conditions; student performance; building age

Introduction

According to the National Center for Education Statistics (NCES, 1999), public schools in the United States average 42 years old. Of those schools, 28% were built prior to 1950, and another 45% were built between 1950 and 1969 (NCES, 1999). The physical condition of public schools is of great concern due to factors such as aging infrastructure, decades of deferred maintenance, environmental factors, lack of adequate technology, and failure to meet accessibility standards. School funding is a complex issue with few dollars from annual district budgets earmarked for maintenance, let alone capital construction.

The overwhelming majority of public school construction in the United States is funded through local school bond funds requiring public election. For a bond referendum to pass, the public must understand the need for funds, realize how funds will be allocated, believe students and the whole community will benefit from the construction, and trust that projects will be completed on time and within budget limits. The construction

CONTACT

Sarel Lavy  slavy@arch.tamu.edu  Department of Construction Science, Texas A&M University, MS 3137, College Station, TX 77843-3137, USA.

This manuscript derives from a Thesis research conducted by Jerri L. Nixon, MSc, at Texas A&M University.

© 2017 Associated Schools of Construction
industry clearly relies upon school bond funding for both renovations and construction of new or replacement schools, as it represents a significant percentage of the public sector construction in the United States (see Table 1).

Magnet schools are “free public elementary and secondary schools of choice that are operated by school districts or a consortium of districts” (Magnet Schools of America, 2016). Magnet schools typically have a focused theme and aligned curricula in one major aspect of studies, such as Science, Technology, Engineering, and Mathematics (STEM), Fine and Performing Arts, Career and Technical Education (CTE), World Languages, or others. State or district standards are used to evaluate student performance in all subject areas; however, all subject areas are taught within the overall theme of the school. Most magnet schools do not have minimum entrance criteria; instead, schools embody the belief that all students have interests and talents that families and educators believe are better cultivated in a magnet school. Magnet schools often use a random computer-based lottery system for admission; however, “Talented & Gifted” magnet schools may utilize student assessment data and teacher or parent recommendations for selection (Magnet Schools of America, 2016).

This study is expected to identify predictive relationships between replacement school construction and magnet applications, enrollment, attendance, and student achievement. This, in turn, may provide school districts with additional information and data to strengthen public confidence in supporting construction projects through school bond elections. In order to determine whether school bond promises were kept with regards to construction, this study aims to answer four key questions regarding replacement of magnet schools in one Independent School District (ISD) in the United States. The study draws its conclusions based upon data gathered during the 2011-2012 academic year. Following are the four research questions this study aims to address:

- Question #1: Can the number of magnet applications (program interest) be predicted by building composite score and building age?
- Question #2: Can annual school enrollment be predicted by building composite score and building age?
- Question #3: Can annual student attendance rate be predicted by building composite score and building age?
- Question #4: Can student achievement, as measured by state percentile ranking, be predicted by building composite score and building age?
Background

State of schools and school reform

Since the 1950s, Americans have focused on how their schools compare with those of other nations and with one another. Today, in a world economy, success is linked to education and so, the pressure for school performance is still an issue (Orfield, 2009). While public education is largely a state responsibility, the federal government has found ways to impact education policy, practice, funding, and accountability. Research has attempted to diagnose the achievement gap between White and Asian students compared with African-American and Hispanic students, and also between children in poverty and those of middle and higher socio-economic statuses (Barton and Coley, 2010).

In 1965, the federal government began to provide additional funding for schools with high levels of poverty. The Comprehensive School Reform Program under Title I, Part F, began in 1998 to offer grant opportunities to public schools willing to implement research-based school reform strategies in order to improve schools, including reducing the achievement gap. Based upon a grant process, qualifying schools were awarded at least $50,000 per year for a period of up to 3 years (Borman et al., 2003). Title I was reauthorized in 2002 as the “No Child Left Behind” Act (NCLB Act), which “dramatically expanded federal influence over the nation’s 90,000 public schools. The hallmark features of this legislation compelled states to conduct annual student assessments linked to state standards and to identify schools failing to make ‘adequate yearly progress’ (AYP) toward the stated goal of having all students achieve proficiency in reading and math by 2013–2014, and to institute sanctions and rewards based upon each school’s AYP status” (Dee and Jacob, 2011).

Springfield and Land’s (2002) definition of at-risk students is those: “…who through no fault of their own, are at-risk of low academic achievement and dropping out before high school.” Springfield and Land (2002) identified seven risk factors based upon their review of the research literature: disability, poverty, limited English proficiency, race/ethnicity, urbanicity, single-parent status, and low parental attainment. Their research found that poverty was the biggest single predictor of low academic achievement. Urban school districts, such as the one highlighted in this study, are filled with at-risk students from diverse backgrounds, and are therefore inherently challenging to improve. Previous research conducted by Borman and colleagues (2003) included a meta-analysis of 29 comprehensive school reform (CSR) models, and concluded by acknowledging these enormous challenges: “complex education changes demanded by current standards-based reform initiatives, combined with an increasingly heterogeneous population largely comprised of students whom schools have traditionally failed, have pushed… schooling to unprecedented levels of complexity” (Borman et al., 2003).

Reform efforts have targeted multiple factors within the school’s sphere of control, such as school size, school arrangements, teacher preparation, curriculum and assessment, use of technology, parent/community involvement, and others (Louis et al., 2010). States, their school districts, schools, and educators are under tremendous pressure to teach, to set standards, and to reach accepted levels of performance measured by state testing programs (Barth & Mitchell, 2006). Lagana-Riordan and Aguilar (2009) examined the impact of the NCLB Act, including intended and unintended consequences, and found that educators...
are particularly critical of the focus on minimum standards testing and the tendency to “teach to the test” instead of developing higher-level thinking skills. Rothstein (2008) draws the conclusion that: “closing or substantially narrowing achievement gaps requires combining school improvement with reforms that narrow the vast socio-economic inequalities in the United States. Without such a combination, demands, like those of ‘No Child Left Behind’ that schools fully close achievement gaps not only will remain unfulfilled, but will also cause us to foolishly and unfairly condemn our schools and teachers.”

School bond elections

Major school construction and renovation in the United States is predominantly funded using local bond referendums. These bond proposals and elections allow local school boards and superintendents to ask the community for a vote to address specific capital needs. School bonds are typically proposed to alleviate overcrowding, renovate or replace inadequate facilities, and/or improve technology systems within schools (United States General Accounting Office, 1995).

In addition to improvements in student performance to be discussed separately, capital improvement of school facilities can improve non-academic areas, such as student safety and overall appeal of the campus. Multiple studies have linked school facility quality and passage of bond measures to increases in property value. A regression study of all school bond proposals in California from 1987 to 2006 found a 6% increase in property values within 3 years following the passage of a school bond proposal (Cellini et al., 2010). Stated another way, “…marginal homebuyers are willing to pay, via higher purchase prices and expected future property taxes, $1.50 or more for an additional dollar of school facility spending” (Cellini et al., 2010). Offering high quality school facilities within a district and across neighboring districts helps to ensure that all students are afforded similar opportunities. School facilities play a role in school climate, thereby affecting the achievement and behavior of those within it (Jones et al., 2008).

School conditions and student outcomes

Much research has been conducted to determine if school facilities impact student achievement and student behavior. One body of school facility research has focused on specific physical factors, such as lighting, acoustics/noise, color, and air quality/temperature (Lewinski, 2015), and their effects on learning. Other studies have extended the research to include the impact of design elements, general building age/quality, and overcrowding (Barrett & Zhang, 2009). In reviewing the body of literature and mixed results concerning a building’s effects on student outcomes, Earthman and Lemasters (1996) point out that, “even if the variance the built environment can account for is slight, the important fact to remember is that there is a portion of the variance that then can be controlled through efforts of educators and design professionals.” Their literature review summarized studies conducted prior to the early 1980s, as summarized and synthesized separately by McGuffey (1982) and by Weinstein (1979), who examined a total of 238 studies and 21 paper presentations around the components of school building and the
impact on student performance and achievement. Following is a summary of the major results of their studies:

- School building age (7 studies; significant impact on student performance),
- Thermal factors (9 studies; significant overall impact),
- Visual factors/lighting (10 studies; positive relationship),
- Color and interior painting (5 studies; positive relationship),
- Hearing factors (7 studies; significant relationship),
- Space (2 studies; no generalized findings),
- Open space (9 studies; mixed results),
- Windows (1 study; no relationship),
- Underground facilities (2 studies; no relationship),
- Building utilization (2 studies; no relationship),
- Site size (3 studies; no clear relationship),
- Building maintenance (1 study; positive relationship),
- Support and special facilities (11 studies; mixed results), and
- School size (16 studies; mixed results).

In their review of research from the 1980s to 1990s, Earthman and Lemasters (1996) concluded that there is a considerable relationship between student performance, student achievement and behavior, and the condition of the built environment. They concluded their study by stating: “Nevertheless, the preponderance of the research cited shows a very close relationship between the built environment and how well students and teachers perform in that environment” (Earthman & Lemasters, 1996). Schneider (2002) also reviewed the body of research around school quality and student achievement and concluded, “School facilities affect learning. Spatial configurations, noise, heat, cold, light, and air quality obviously bear on students’ and teachers’ ability to perform.” Schneider (2002) found that building age alone cannot be used as a predictor. Lyons (2001) also draws similar conclusions after a review of literature focusing on facility condition. Crampton (2009) used longitudinal, state-by-state data about school spending and student achievement from the Institute for Education Sciences and the U.S. Census Bureau to determine the impact of “human, social, and physical capital on student achievement,” where National Assessment of Educational Progress (NAEP) scores for 5th and 8th grade reading and math tests were used as measures of student achievement. Over the years examined (2003, 2005, and 2007), it was found that dollars spent on human, social and physical capital accounted for between 55.8% and 77.2% of the variation in scores. Human capital investment showed the largest effect over time, while social capital and physical capital were both inconsistent in their effects. While human and social capital effects were higher overall, Crampton (2009) concluded that: “…the impact of investment in physical capital… was also a significant contributor… spending on school infrastructure does matter when it comes to student achievement.”

**School studies**

Previous studies have looked at the effects of building improvements and construction, particularly in urban environments. In 1988, the Committee on Public Education (COPE)
was formed to examine all aspects of schools for targeted improvement over a 5-year period. COPE’s analysis determined that the overall system of 199 buildings was over 50 years old and in poor condition, which was compounded by poor maintenance management (Berner, 1993). The findings estimated that $150 million would be needed for overall deferred maintenance with an additional $30 million required to provide immediate air conditioning for summer programs. It was believed that due to the buildings’ poor conditions, students’ attitudes were negatively affected (Berner, 1993).

Lewis (2001) examined 193 Milwaukee public schools (K-12) to look at the effects of building condition on test scores, compared to other factors (family, economic status, race/ethnicity, attendance, and discipline). Focusing on findings between facility measures and student performance using multiple regression techniques, 11 of 36 estimates were found to be significant, explaining between 10% to 15% of the differences in scores after controlling for other variables. Uline and Tschannen-Moran (2008) surveyed teachers at 80 Virginia middle schools using qualitative methods to look at links between school facility and student achievement by using school climate as the mediating variable. In a regression analysis, school climate was determined to be a mediating variable between school facility and student achievement. “Our results revealed... where school buildings are shabby and inadequate, there is less likely to be the kind of community engagement that supports teaching and learning. Teacher attitudes and behaviors are related, as well, as teachers are less likely to show enthusiasm for their jobs and to go the extra mile with students to support their learning when they teach in buildings they judge to be of poor quality” (Uline and Tschannen-Moran, 2008).

Earthman and Lemasters (2009) followed up the studies of Uline and Tschannen-Moran (2008) and of Crook (2006), who used the Commonwealth Assessment of the Physical Environment (CAPE) developed by Cash (1993). From the surveys of 165 voluntary respondents from only eight schools, significant differences were found between unsatisfactory and satisfactory schools. Descriptive and correlation data was reported due to small sample size. Generally speaking, teachers in satisfactory schools viewed their classrooms more positively and healthier, as compared to teachers from unsatisfactory schools. They were more positive in their assessments of how the classrooms affected them and their students and looked forward to working in the classrooms. However, teachers in unsatisfactory buildings did not necessarily indicate they were willing to leave their schools. But the cumulative effects of these negative perceptions still require further study (Earthman & Lemasters, 2009).

Reformers and researchers alike have long posited a connection between the school facility and teaching and learning measures. School bond measures provide the opportunity to examine whether new schools can change educational quality. Fuller and colleagues (2009) from the Los Angeles School Infrastructure Research Project studied the effects of new schools built between 2002 and 2007 under a $28 billion bond initiative in the Los Angeles Unified School District (LAUSD). The researcher used both quantitative and qualitative measures to track movement to identify the effects of construction for a largely minority and economically disadvantaged school population. Teacher survey responses noted appreciation of new teacher spaces, higher ceilings, more natural light, quieter air conditioning, and improved parking. Principals and teachers both noted students’ positive attitudes toward new spaces (Fuller et al., 2009). Neilson and Zimmerman (2014) were also able to examine the “before” and “after” effects on school construction in New Haven,
Connecticut. Their study on New Haven Public Schools (NHPS) used an economic framework to measure the effects of school construction projects on three areas: home prices, student achievement, and student enrollment. Moderate to large changes in student motivation and teacher motivation were noted by 9 of 10 principals in terms of infrastructure, and not only due to changes in teaching practices. They identified building features, including library and thermal and ventilation improvements, as important for student achievement. Open ended responses cited student and teacher pride and building visibility as other important factors (Neilson & Zimmerman, 2014).

A recent project called the Holistic Evidence and Design (HEAD) study (Barrett et al., 2015), shows promising progress in understanding how the built school environment can impact student learning. The researchers examined 153 classrooms in 27 primary schools in the United Kingdom comprising 3,766 students. The team posited building factors could be grouped into three broader categories of naturalness, individuality, and stimulation (“SIN model”). They hypothesized that the combination of these factors produces a holistic effect, thereby producing “demonstrable impacts” upon student learning rates. The “SIN model” incorporates factors previously identified in the body of research, such as naturalness (light, sound temperature, air quality, and links to nature), individualization (ownership, flexibility, and connection), and stimulation (the level of complexity and color). Barrett and colleagues’ (2015) analysis of these factors found 7 of the 10 factors across all three categories significantly impacted student performance. The study provides a strong direction to guide classroom design in both existing and new spaces.

**Research methods**

**Population of interest**

The study consisted of elementary schools in the Houston Independent School District (HISD), a large school district in the state of Texas. Like other large, urban school systems, HISD serves a largely economically disadvantaged population with 79.7% labeled economically disadvantaged and qualifying for federal free or reduced lunches. Houston is an ethnically diverse city, which is reflected in the district’s demographics from the 2012–2013 school year: 62.7% Hispanic, 24.6% African-American, 8.2% White, and 3.4% Asian. Almost 30% of students are identified as Limited English Proficient (LEP), meaning they speak another native language at home and do not possess sufficient English language skills for school. In 2012–2013, the high school completion rate within four years was 81.2% with 11.8% of students labeled as dropouts while other students remained in school or completed a General Equivalency Diploma (GED). Lastly, 167 schools, representing 63% of schools, failed to meet Adequate Yearly Progress (AYP) based upon state and national indicators (Houston ISD, 2016).

From 1998 to 2012, Houston voters passed four bond packages on behalf of the HISD for a total of $4.182 billion dollars: in 1998, a $678 million bond to relieve overcrowding and address life/safety issues; in 2002, an $809 million bond to replace outdated facilities and upgrade technology; in 2007, an $805 million bond to replace outdated facilities, improve security, update science labs, and address renovations; and in 2012, a $1.89 billion bond to replace outdated secondary schools (Examiner, 2012).

This study incorporated a sample of 28 magnet elementary schools: 14 of which were replacement (rebuilt) schools, plus 14 schools that were used as the control group. Schools
in the control group were randomly selected from a pool of more than 30 other magnet elementary schools not rebuilt in the HISD. All 14 rebuilt/replacement magnet elementary schools were identified from the three bond elections that the HISD in 1998, 2002, or 2007. Each school that participated in this study served as a complete observational unit; in other words, no school was broken down into smaller segments.

**Variables and data**

**Data collection**

Due to such large capital outlays, the HISD Bond Department took steps throughout the building programs to track progress, expenditures, and successes. However, no steps were taken to look beyond construction data to see if building and renovating schools has affected stakeholders at a deeper level. In order to examine whether these dollars have impacted schools, students and their communities, the first part of this study examined three cohorts of magnet, replacement elementary schools constructed under the 1998, 2002, and 2007 bond programs as compared to an equal number of randomly selected, magnet control elementary schools (not rebuilt). Within this research, a replacement school is defined as a school built to replace, wholly or substantially, an existing outdated facility that continues to serve the same population.

The study analyzed construction, building age, and building condition (independent variables) to see if they had an impact on magnet applications, enrollment, attendance, and student achievement measures (dependent variables). Details of variables and sources can be seen in Table 2. Demographic data, including minority ethnicity (Hispanic and African-American) and economically disadvantaged student percentage were used to control for other factors affecting the dependent variables. School data was drawn from the following sources: Texas Education Agency (TEA) Academic Excellence Indicator System (AEIS) (TEA, 2016) and other annual reports, district level data, and school rankings from independent sources, based upon standardized test data. Statistical analysis software was utilized to analyze the data. Data was collected for each school for the 2011–2012 school year since at the time this study was conducted, the 2011–2012 school year was the last one for which data was available for all variables included in this study.

Student achievement state percentile ranking was collected from the annual report that provides independent rankings of each school (School Digger, 2015). Annual rankings of schools are based upon state achievement test scores to reflect the student achievement measure of interest as compared to all other schools within the same year. Specifically, schools within each state are ranked by taking the average math score across all grades and the average English

<table>
<thead>
<tr>
<th>Variable</th>
<th>Type</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Magnet applications</td>
<td>Dependent</td>
<td>Houston Independent School District data</td>
</tr>
<tr>
<td>School attendance rate</td>
<td>Dependent</td>
<td>School Digger (2015)</td>
</tr>
<tr>
<td>Student achievement</td>
<td>Dependent</td>
<td>School Digger (2015)</td>
</tr>
<tr>
<td>Free and reduced lunch percentage</td>
<td>Controlling</td>
<td>School Digger (2015)</td>
</tr>
<tr>
<td>Age of original building</td>
<td>Independent</td>
<td>Houston Independent School District data</td>
</tr>
<tr>
<td>Completion date of building</td>
<td>Independent</td>
<td>Houston Independent School District data</td>
</tr>
<tr>
<td>School composite facility score</td>
<td>Independent</td>
<td>Houston Independent School District data</td>
</tr>
</tbody>
</table>
score across all grades, then adding them together and dividing by two to arrive at a composite test average, ranging from 1 to 100. Then, each school is ranked by its combined score in relation to all other public schools within the state. For the State of Texas, state standardized test scores were used and taken directly from the TEA website and based upon Texas Academic Knowledge and Skills (TAKS) test scores.

Since the entire group of schools is in Texas and are equally affected by changes in the state test, using the rankings allows for better comparison of the achievement trend for each school, rather than their raw scores. Student demographic data and school enrollment and attendance data were also taken from the School Digger website, as taken from annual TEA AEIS reports (School Digger, 2015).

Magnet application numbers were pulled from HISD’s raw data, as received in January of 2013 for the 2013–2014 school year. This data was provided to the authors by the Houston School Survey (HSS) group. The applications were impacted by the previous 2011–2012 school and student data, and are therefore relevant to the year of interest for this study.

Building age, school composite facility scores, and building capacity were taken from a district report of a facility survey that was conducted in July 2012 by a private and independent construction and engineering firm (Parsons, 2012). For each school, a building composite score of 0 to 100 was provided. Based on Parsons, 2012, the building composite score is: “a weighted blend of the Facility Condition Index, Educational Suitability Score, and Technology Readiness Score. . . [the score] is intended as the basic resource for HISD to identify schools in need of capital improvements based on physical condition and educational suitability.” A copy of this report for HISD was obtained for the purpose of conducting this study.

**Data analysis**

All 28 magnet schools were compared based on building condition (composite score) and age as of July 2012 with magnet application figures for the 2012–2013 school year to determine if there was a correlation between building age and building condition. Using public data from the school district and state systems, student enrollment, student attendance, and student achievement data, a regression analysis was carried out to determine if building age and building composite score made a significant difference in either group. Following were the criterion variables used for the purpose of this analysis: magnet applications, student enrollment, student attendance, and student achievement. For each experimental and control school, demographic data including free and reduced lunch percentage and percent minority (African-American and Hispanic) was used as means to control for student population differences.

The statistical analysis conducted in this study included regression and correlation analyses of the variables, as described above. Such analyses provide the basis for predicting the values of a variable from the values of one or more other variables. This yields the value of R-square \( R^2 \), which is then used to indicate the relationship strength around the regression line between the variables. This can be interpreted as the “proportion of variation in the dependent variable Y that has been accounted for, or ‘explained,’ by the relationship between Y and X” (Hamburg, 1987). In addition, the statistical analysis conducted in this study also included an analysis of variance (ANOVA) using the F-test distribution method. The null hypothesis for this method states that the means of the two population treatments that are under analysis are equal, and the F ratio is used to determine if the null hypothesis can or cannot be rejected, using significance level tables for the F values that were calculated, based on the probability density function (Hamburg, 1987).
Findings

Sample characteristics

Twenty-eight elementary schools were chosen for analysis. The experimental group \( n = 14 \) included all magnet elementary schools (K-5) rebuilt under the 1998, 2002, and 2007 school bond ordinances in HISD (schools were not randomly chosen or assigned). The control group \( n = 14 \) included randomly selected elementary schools (K-5) from the 32 remaining elementary schools that were not rebuilt. These schools were built between 1923 and 1992.

Experimental schools

The average building age for these school facilities was 4.1 years (SD = 2.8), and the average building composite score was 93.0 points (SD = 6.6) out of a maximum of 100 points. The higher the composite score, the better and more suitable the facility is for teaching and learning. The average enrollment for these 14 schools was recorded as 739.2 students (SD = 77.2), and average magnet applications for the 2011–2012 academic year were 237.4 (SD = 207.3). The average percentage of free and reduced lunches was 40.3%, and the average percent of African-American and Hispanic enrollees was 86.9%.

Control schools

An average building age of 61.3 years (SD = 23.5), with an average building composite score of 72.1 points (SD = 11.8) were found for this group of schools. The average enrollment was 695.1 students (SD = 131.0), and applications for the 2011–2012 academic year were 239.6 (SD = 249.2). The percentage of free and reduced lunches was 30.1%, and the average percent of African-American and Hispanic enrollees was 60.2%.

Table 3 shows the data comparison for the experimental and control schools.

Results

Research question #1

The first question studied was whether or not there is an observable effect on magnet applications as evidenced by building composite score and building age in the experimental vs. control schools. There was no observable effect on magnet applications as evidenced by building composite score and building age in either the experimental or control schools, as seen in Tables 4 and 5.

Research question #2

The second question was whether or not student enrollment rate can be predicted by new construction and building composite scores. There was no observable effect on enrollment rate as evidenced by building composite score and building age in the experimental and control schools, as seen in Tables 6 and 7.
Research question #3

The third research question studied was whether or not student attendance rate can be predicted by new construction and building composite scores. There was no observable effect on attendance rate as evidenced by building composite score and building age in the experimental and control schools, as seen in Tables 8 and 9.

**Table 3.** Experimental and control schools: Demographic data.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Experimental Schools (n=14)</th>
<th>Control Schools (n=14)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Min.</td>
<td>Max.</td>
</tr>
<tr>
<td>Building age in 2011-2012</td>
<td>0</td>
<td>8</td>
</tr>
<tr>
<td>Building composite score in 2011-2012</td>
<td>85</td>
<td>100</td>
</tr>
<tr>
<td>Enrollment in 2011-2012</td>
<td>607</td>
<td>918</td>
</tr>
<tr>
<td>Magnet applications for 2013-2014</td>
<td>10</td>
<td>619</td>
</tr>
<tr>
<td>Percent free and reduced lunch for 2011-2012</td>
<td>14.5</td>
<td>53.6</td>
</tr>
<tr>
<td>Percent minority (Hispanic and African-American) for 2011-2012</td>
<td>41.9</td>
<td>99.1</td>
</tr>
</tbody>
</table>

**Table 4.** Model summary for experimental and control schools: Magnet applications.

<table>
<thead>
<tr>
<th>Model</th>
<th>R</th>
<th>R-Square</th>
<th>SE of the Estimate</th>
<th>R</th>
<th>R-Square</th>
<th>SE of the Estimate</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>.168</td>
<td>.028</td>
<td>222.134</td>
<td>.409</td>
<td>.168</td>
<td>247.156</td>
</tr>
</tbody>
</table>

**Table 5.** ANOVA results for experimental and control schools: Magnet applications.

<table>
<thead>
<tr>
<th>Model</th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experimental Schools (n=14)</td>
<td>15,708.2</td>
<td>2</td>
<td>7,854.1</td>
<td>.159</td>
<td>.855</td>
</tr>
<tr>
<td>Residual</td>
<td>542,781.2</td>
<td>11</td>
<td>49,343.7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>558,489.4</td>
<td>13</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control Schools (n=14)</td>
<td>135,263.7</td>
<td>2</td>
<td>67,631.8</td>
<td>1.107</td>
<td>.365</td>
</tr>
<tr>
<td>Residual</td>
<td>671,945.8</td>
<td>11</td>
<td>61,086.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>807,209.4</td>
<td>13</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Table 6.** Model summary for experimental and control schools: Enrollment.

<table>
<thead>
<tr>
<th>Model</th>
<th>R</th>
<th>R-Square</th>
<th>SE of the Estimate</th>
<th>R</th>
<th>R-Square</th>
<th>SE of the Estimate</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>.390</td>
<td>.152</td>
<td>77.225</td>
<td>.371</td>
<td>.138</td>
<td>132.233</td>
</tr>
</tbody>
</table>

**Table 7.** ANOVA results for experimental and control schools: Enrollment.

<table>
<thead>
<tr>
<th>Model</th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experimental Schools (n=14)</td>
<td>11,774.1</td>
<td>2</td>
<td>5,887.0</td>
<td>.987</td>
<td>.403</td>
</tr>
<tr>
<td>Residual</td>
<td>65,602.3</td>
<td>11</td>
<td>5,963.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>77,376.4</td>
<td>13</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control Schools (n=14)</td>
<td>30,781.0</td>
<td>2</td>
<td>15,390.5</td>
<td>.880</td>
<td>.442</td>
</tr>
<tr>
<td>Residual</td>
<td>192,342.8</td>
<td>11</td>
<td>17,485.7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>223,123.7</td>
<td>13</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Research question #4
The fourth research question was whether or not student achievement has been positively impacted by a new facility as evidenced by state percentile ranking based upon building composite scores. In the experimental model, 47.1% of the variance in state percentile ranking was accounted for by building composite scores, while in the control model, 53.4% of the variance in state percentile ranking was accounted for by building composite scores. These findings can be seen in Tables 10 and 11.

Discussion

Interpretation of research questions
Regarding Research Question 1—which asks whether there an observable effect on magnet applications as evidenced by building composite score and building age in the experimental and control schools—the Coefficient of Determination was not significant for the experimental schools or control schools. Therefore, there was no observable effect on
magnet applications as evidenced by building composite score and building age in either the experimental or the control schools. Literature reviewed did not directly discuss the impact of facilities upon magnet interest as evidenced by magnet applications. The single year data in this study, so closely following the completion of many of the replacement schools might have impeded the findings and the significance of the results. The examination of additional years post-construction could provide additional and more detailed results. A survey of parents during the magnet tour process to gain insight into decision-making may also be useful.

Regarding Research Question 2—which asks whether will student enrollment rate be predicted by new construction and building composite scores—the Coefficient of Determination was not significant for the experimental or control schools. Therefore, there was no observable effect on enrollment rate as evidenced by building composite score and building age in the experimental and control schools. HISD enrollment trends are unique since the entire district is considered to be “open-enrollment” with a large percentage of magnet programs and other types of transfers. The Fuller and colleagues (2009) study cited earlier has some parallels regarding indicators of school movement and school quality. The choices within LAUSD are more related to desegregation and school quality vs. simple program choice, although both systems arose from the desegregation movement. There was an observable shift in attendance patterns in the Los Angeles schools studied as new schools closer to students became available: “…many students previously bussed to schools outside their home attendance area, returned to their communities to attend new schools… about 16,000 students were bussed outside their attendance areas in 2001, falling to just over 4,000 in 2007” (Fuller et al, 2009).

Finding effects on enrollment for HISD may require consideration of various other forms of data such as examining whether there was a shift in students choosing to stay within their zoned school instead of attending another school either within HISD or a private school. Enrollment is constrained to a degree by available space, so considering numbers alone for schools previously at or near capacity prior to construction may have influenced results, while exploring attendance in terms of both neighborhood and demographic shifts (race, ethnicity, and income) could show an impact from building a replacement school. It may also be helpful to examine effects on enrollment among replacement schools with previously low enrollment to see if a new building increases numbers.

Regarding Research Question 3—which asks whether the student attendance rate can be predicted by new construction and building composite scores—the Coefficient of Determination was not significant for the experimental or control schools. Therefore, there was no observable effect on attendance rate as evidenced by building composite score and building age in the experimental and control schools. Given that this study compared groups of magnet elementary schools, which typically have high levels of attendance, it might have been more helpful to broaden the experimental or control groups to include all school types. Research has proven that environmental qualities, particularly relating to issues of indoor air quality and mold, may affect health. Lyons (2001) discussed the impact of poor air quality on children, particularly those with asthma: “…poor air quality causes drowsiness, inability to concentrate, and lethargy… learning is compromised.” Examining reasons for and patterns of absence for both teachers and school employees for experimental and control groups could identify if building conditions have an effect beyond just attendance rates.
Research Question 4 asks whether student achievement (measured by state percentile ranking) has been positively impacted by a new facility (based on building composite scores). Based on the analysis of this question, a significant finding was that free and reduced lunch status dropped out of the statistical model as a predictor of student achievement. This model seems to indicate that building composite is more significant as a predictor of student achievement than is poverty. Building and maintaining high quality educational facilities for all students could help decrease the achievement gap or at least raise the level of achievement for low income students. In addition to the LAUSD study, Crampton’s (2009) study of all 50 states also found that school facility positively affected student achievement. By examining spending impacts in three categories, namely human, social, and physical capital, on student achievement for each state, Crampton (2009) finds that these three factors account for 55.8% to 77.2% of the variance in the models for 2005, 2007, and 2009. Yet, it fails to offer a separate metric for each year alone. Crampton (2009) also notes that poverty has a large, negative impact on student achievement, and cautions policymakers to be aware of barriers created by poverty. Despite these barriers, it seems clear that investing in education across the three areas does make a difference in student achievement.

**Conclusions**

The main purpose of this study was to assess whether statistically significant, predictive relationships exist between school facility age and physical condition with four areas: magnet applications, school enrollment, student attendance, and student achievement. Research carried out previously was found to not analyze magnet school data.

The construction industry and education researchers are actively involved in research within the area of student performance vs. schools’ physical conditions. Impacting student achievement is considered to have a positive effect on the future lives of students and society as a whole by improving the likelihood of high school graduation, college attendance, and earnings potential. Improving lives, decreasing the cycle of poverty, and improving the national economic picture through improving school facilities lies at the basis of this study.

**Implications**

The high stakes in public education in the United States are ever increasing due to the standards-based movement, testing pressures and persistent achievement gap. Penalties for not meeting AYP are significant. Public confidence in school districts hinges upon a number of factors including student achievement and perceived benefits of investing in bond programs. The achievement gap continues to be a true issue for at-risk, low-income, and minority students. Among magnet elementary schools in HISD, this study found no significant correlation in magnet applications, enrollment, or attendance for experimental (replacement) schools as compared to a control sample of other magnet elementary schools for the year of interest.

However, for the most critical question of student achievement, it was found that building a replacement school did make a significant difference. Interestingly the quality of the school environment has, at least in part, a significant impact on student achievement.
Results such as these could be used to strengthen public confidence in current and future bond programs within and outside of HISD. Creating a connection between school construction and school and student outcomes strengthens the likelihood of increased spending in the education sector of the construction market.

**Future research recommendations**

This study could readily be replicated and even expanded within HISD. Further research could explore additional testing years singly or with a longitudinal approach to see how schools and students fare in the years post-construction. While this study only looked at replacement elementary schools, a broader study could examine all schools based upon building composite scores from 2012 since the effects could also hold for well-maintained or renovated schools, not just new ones. Lastly, with robust, varied, and long-standing standardized testing within HISD, researchers may also benefit from using student-specific test scores instead of overall school rankings.

Post-occupancy surveys of principals, teachers and students could be particularly helpful with explaining why replacement schools make a difference in student achievement. Each school community creates a unique school design; however, HISD had a very comprehensive and well-designed set of specifications for each bond program, including elements of design, space layouts, equipment, lighting, technology and more. The SIN approach (as developed by Barrett et al., 2015, in the UK) could be utilized to examine each school and classroom based upon the elements of naturalness, individualization, and stimulation, to see what components are most highly correlated with student achievement.

**References**


