DO REPLACEMENT PUBLIC SCHOOLS DELIVER ON PROMISES AFTER CONSTRUCTION?

A Thesis

by

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ABSTRACT

Public school construction represents a significant portion of all construction spending, ranging 7 percent to 9.5 percent annually from 2008-2013. This study sought to answer four essential questions regarding replacement magnet schools in Houston ISD based upon building and student data gathered during the 2011-2012 school year.

This study examined whether construction, building age, and building condition had an impact on magnet applications, enrollment, attendance, and student achievement measures. Demographic data including minority ethnicity and economically disadvantaged percentages were used to control for other factors impacting dependent variables.

Twenty-eight magnet elementary schools in a large urban school district were chosen for analysis. The experimental group includes all of the magnet elementary schools rebuilt under the 1998, 2002, and 2007 school bond programs between 2004 and 2012. They were not randomly assigned. The control group includes randomly selected elementary schools from the remaining magnet elementary schools not rebuilt.

Multiple and Linear regressions were done on all research questions. For the first three research questions, there was not an observable predictive effect on magnet applications, student enrollment or student attendance evidenced by the predictors of building composite score and building age in the experimental and control schools. However, student achievement was positively impacted by building composite score as evidenced by the ability to predict state percentile ranking. Finally, an exploratory question was examined and it was found that statewide ranking of a school is predicted

by composite building score and percent African-American and Hispanic students among all elementary schools rebuilt.

DEDICATION

This dissertation is dedicated to all of my family and friends who truly believe I can do and by anything I want no matter when I grow up.

To my husband and children, thank you for allowing me to go on another adventure that was much longer than we expected. I finished because letting you all down was never an option.

To my extended family, I appreciate your unconditional support an encouragement in all things.

To my Herod and other HISD family and mentors, I was a strong leader because you each shared your wisdom with me and trusted in me. I carry each of you with me wherever I go.

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NOMENCLATURE

Achievement Gap: refers to the observed and persistent disparity between performance of different groups, especially those of racial, ethnic, socioeconomic, and gender groups

Adequate Yearly Progress (AYP): measurement defined by the No Child Left Behind Act that allows the US Department of Education to determine how every public school and school district is performing academically according to standardized test results

At-Risk Student: students who, through no fault of their own, are at risk of low academic achievement and dropping out before completing high school

Attendance Rate: the average daily attendance for a school year

Building Age: the difference between the replacement year of construction and the original year of building construction

Composite Facility Score: score assigned to each school in Houston ISD during 2012 independent inspection based upon the average of the Inverse Facility Index Score (100-FCI) and the Suitability Score reported as a number 0-100

Comprehensive School Reform (CSR): refers to approaches to improving outcomes for the whole school with the school as the primary source for educational change

Economically Disadvantaged Percentage: percentage of students who meets federal eligibility for free or reduced lunch

Facility Condition Index (FCI): score assigned to each school in Houston ISD during 2012 independent inspection based upon the estimated physical condition of the school and the installed age of its various component building systems compared to industry standard building life cycle and reported as a number 0-100

High-Stakes Testing: a testing system in which test scores are used to determine rewards and punishments

Magnet Application: the completed student application given to a magnet school by the identified deadline

Magnet School: a whole school or school-within-a-school program offering specialized courses in a designated area of study drawing students from across attendance boundaries through an application and lottery process

Minority Percentage: the percentage of students at a school identified in historically underperforming groups of Hispanic ethnicity or African-American race

No Child Left Behind Act (NCLB): main law passed in 2002 for K-12 general education that holds schools accountable for how students learn and perform with penalties for those schools who do not meet established standards

Replacement School: a school built to replace, wholly or substantially, an existing, outdated facility and which continues to serve the same population of students

School Capacity: the number of students the building is designed to hold

School Enrollment: the number of students attending the school by state official snapshot date

School Ranking: ranking determined by adding total Reading and total Math scores across all grades tested on the state standardized assessment ranking within Texas public schools by SchoolDigger.com

School Utilization: percent of building used as determined by dividing the school enrollment by the school capacity

Standardized Test: any test that requires all test takers to answer the same questions in the same way from a common bank of questions and which is scored in a consistent manner thereby making it possible to compare relative performance of individuals

Standards-Based: refers to educational approach and components of instruction, assessment, grading, and academic reporting based upon students demonstration of understanding and mastery of a defined set of knowledge and skills

Suitability Score: score assigned to each school in Houston ISD during 2012 independent inspection scored 0 – 100 based upon weighted factors of: capacity (5%); program support (10%); technology (10%); security and supervision (20%); instructional aids (15%); physical characteristics (15%) learning environment (15%); and relationship of spaces (10%)

Title I: part of the Elementary and Secondary Education Act of 1965 which is the foundation of the federal commitment to closing the achievement gap between low-income and other students.

TABLE OF CONTENTS

LIST OF TABLES

CHAPTER I

INTRODUCTION

1.1 Introduction

Public school construction (PK-12) represents a significant portion of all construction spending, ranging 7 percent to 9.5 percent annually from 2008-2013 (US Census 2014). A 1999 report for the National Center for Education Statistics (NCES), stated public schools average 42 years old. Of those schools, 28 percent were built before 1950, and 45 percent were built from 1950-1969 (NCES 1999). The condition of public schools is of great concern due to aging infrastructure, decades of deferred maintenance, environmental factors, lack of adequate technology, failure to meet accessibility standards, and more. 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 is funded through local school bond funds requiring an election. For a bond referendum to pass, the public must understand the need for funds, know how funds will be allocated, believe students and the whole community will benefit from construction, and trust projects will be completed on time and within budget. The construction industry clearly relies upon school bond funding for both renovations and construction of new or replacement schools (see Table 1). It is less clear whether building a replacement school actually impacts the school in terms of enrollment factors (number of applications, average enrollment, and demographics) and student achievement as measured by standardized test scores for reading and math

Table 1

Annual Value of Construction Put in Place 2008-2013 (in millions of dollars) as taken from US Census, 2014

Type of Construction	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
Total Construction	$1,067,564	$903,201	$804,561	$788,014	$856,953	$899,949
Educational	$86,267	$86,351	$74,986	$70,903	$68,178	$62,630
Percent Educational	8.08%	9.56%	9.32%	9.00%	7.96%	6.96%
Total Public Construction	$308,738	$314,895	$303,966	$286,407	$279,023	$271,432
Educational	$86,267	$86,351	$74,986	$70,903	$68,178	$62,630
Percent Educational	27.94%	27.42%	24.67%	24.76%	24.43%	23.07392

1.2 School District Demographics

The Houston Independent School District (HISD) is the seventh largest school district in the nation with 276 schools serving 203,354 students in 2012-2013. Like other large, urban school systems, HISD serves a largely economically disadvantaged population with 79.7 percent labeled economically disadvantaged and qualifying for federal free or reduced lunch. Houston is an ethnically diverse city which is reflected in the districts demographics from the 2012- 2013 school year: 62.7 percent Hispanic; 24.6 percent African-American; 8.2 percent White; and 3.7 percent Asian. Almost 30 percent 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 percent with 10.8 percent of students labeled as drop-outs while other students remained in school or completed a General Equivalency Diploma (GED). Lastly, 167 schools representing 63 percent of schools failed to meet Adequate Yearly Progress (AYP) based upon state and national indicators.

Houston voters have passed four bond packages on behalf of Houston ISD since 1998 for a total of $4.182 billion dollars.

- 1998 - $678 million to relieve overcrowding and address life/safety issues
- 2002 - $809 million to replace outdated facilities and upgrade technology
- 2007 - $805 million to replace outdated facilities, improve security, update science labs, and address renovations
- 2012 - $1.89 billion – replace outdated secondary schools

1.3 Bonds and New School Construction

With such a large capital outlay, the HISD Bond Department has taken steps throughout the building programs to track progress, expenditures, and successes. However, no steps have been taken to look beyond construction data to see if building and renovating schools has impacted 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). For this study, a replacement schools is defined as a school built to replace, wholly or substantially, an existing, outdated facility and continues to serve the same population. Schools built to consolidate multiple schools or as new schools were not included in the cohort. Magnet schools within HISD are comprised of whole school or school-within-a-school programs offering specialized courses and which draw students from across attendance boundaries.

All 28 magnet schools were compared based upon building condition (composite score) and age as of July 2012 with magnet application figures for 2012- 2013 school year to determine if there was a correlation between building age and condition with interest in programs between the experimental and control groups. Using public data from the school district and state systems, student enrollment, student attendance, and student achievement data were analyzed using regression techniques to determine if building age and building composite made a significant difference in either group. 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.

1.4 Research Objectives

To determine whether school bond promises have been kept by construction, this study sought to answer four essential questions regarding replacement magnet schools in Houston ISD based upon building and student data gathered during the 2011-2012 school year. In all four research questions, student demographic variables of percent Free and Reduced Lunch and percent minority (Hispanic and African-American) were controlled for in the regression models.

1.5 Research Questions

Question 1: Was there a predictable effect on the number magnet applications (program interest) based on the predictors of building composite score and building age in the experimental and control schools?

Question 2: Can the annual school enrollment be predicted by building composite score and building age in the experimental and control schools?

Question 3: Can the annual student attendance rate be predicted by building composite score and building age in the experimental and control schools?

Question 4: Can student achievement be predicted as evidenced by state percentile ranking based upon building composite and building age?

1.6 Summary

The study expected to find predictive relationships between replacement school construction and magnet applications, enrollment, attendance, and student achievement. Finding predictive relationships would provide school districts with additional information and data to strengthen public confidence in past projects and to encourage voters to continue to support school bond elections within Houston ISD and potentially in other districts.

Previous research had fewer schools for consideration, did not include robust magnet data, and did not consider impact against multiple variables included within this study. Although declining slightly in most recent years, the public education sector still accounts for over 20% of total public construction spending (Table 1). The construction industry clearly benefits from this spending and from strong public confidence created by passage of school bond elections. Creating an observable connection between school construction and school and student outcomes serves to strengthen the likelihood of increased spending in this sector of the construction market.

CHAPTER II

LITERATURE REVIEW

2.1 State of Schools and School Reform

Since the 1950s and Sputnik, Americans have been focused on how our schools compare to those of other nations and to one another. Today, the pressure for school performance is again intense even after almost decades of school reform efforts. While public education is largely a state responsibility, the federal government has found ways to impact education policy, practice, funding, and accountability. Researchers, educators, and policy makers have long recognized and attempted to remedy a noticeable and troubling gap in achievement between white and Asian students with African-American and Hispanic students and among children in poverty when compared with those of middle and higher socio-economic statuses.

In 1965 with the passing of Title I of the Elementary and Secondary Education Act, the federal government began to provide additional funding for schools with high levels of poverty. Initially, funding was targeted to individual students within qualifying schools. This approach was later changed to allow funding at high-poverty schools to be spent on school-wide improvement and reform strategies. The Comprehensive School Reform Program under Title 1, 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 the achievement gap. Based upon a grant process, qualifying schools were awarded at least $50,000 per year for three years (Borman et al., 2003). Title I was reauthorized in 2002 as the No Child Left behind Act (NCLB) 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 & Jacob, 2011)."

During these decades, reform efforts that began with largely centralized, top-down efforts gradually segued into more decentralized, school-focused efforts. While schools and districts have made some strides in improving education and meeting standards, the achievement gap is still readily apparent, especially in high-poverty schools with large numbers of at-risk students. Vesley (2010) cited Stringfield and Land's (2002) definition of at-risk students as those "…who through no fault of their own, are at-risk of low academic achievement and dropping out before high school." Stringfield and Land (2002) identified seven risk factors based upon their review of the research: disability, poverty, limited English proficiency, race/ethnicity, urbanicity, single-parent status, and low parental attainment. They found poverty to be the biggest single predictor but noted the compound risk factor of multiple indicators was even more telling. Urban school districts such as Houston ISD are filled with at-risk students from diverse backgrounds and are therefore inherently challenging to improve.

Much research has been done around comprehensive schools models applied under these programs. In a meta-analysis of 29 comprehensive school reform (CSR) models, Borman et al. (2003) acknowledge the enormous challenges of

> "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."

For the purposes of this paper, it is critical to note the complexity in improving schools and increasing student achievement. Reform efforts have largely targeted those 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 more.

NCLB accountability and testing and national educational standards continue to be very hotly debated topics. Legislators and business leaders have become dominant voices in reform efforts with mixed results at best. 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. Lagana-Riordan and Aguilar (2009) examined the impact of NCLB including intended and unintended consequences. Critics of the policy note schools can only do so much alone to close the achievement gap when other fundamental societal issues such as poverty and lack of health care have such a tremendous impact on student success. 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. Repeated test practice also cuts into instructional time. Rothstein (2008) draws the conclusion that:

> "Closing or substantially narrowing achievement gaps requires combining school improvement with reforms that narrow the vast socioeconomic 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."

From a review of the state of US schools and school reform, it is most important to note the complexity and multiplicity of factors impacting student achievement. It is clear from the research, that there are no easy answers and multiple solutions will no doubt continue to be required in order to target the varied issues students and teacher face each day.

2.2 School Bond Elections

A brief explanation of the school bond process and review of recent school bond research is helpful in understanding the necessary conditions and connections between the general public, construction industry and school districts.

Major school construction and renovation in the US is predominantly funded using local bond referendums. These bond proposals and elections allow the local school board and superintendent to ask the community to vote to address specified capital needs, for a specified value, and at a specified rate of local property tax increase. Historically, bond passage has been challenging and by no means guaranteed. School bonds are typically proposed to alleviate overcrowding, renovate or replace inadequate facilities, and/or improve technology.

In a recent study of 695 Texas school bond measures from 1997-2001, Theobald and Meier (2002) identified five key areas for access needed to be addressed by the district: needs, costs, financial resources, past performance, and self-interest of the voter. These 695 measures had an 83% success rate, identifying positive and negative correlations for success. Positive correlations included tax rate, district resources, number of rented homes, percent of teachers within voting district, and class size. Negative correlations were found with per-pupil proposed expenditures and district population size (Theobald and Meier, 2002).

In addition to improvements in student performance to be discussed separately, capital improvement of school facilities can improve nonacademic areas such 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 discontinuity study of all school bond proposals in California from 1987-2006 found a 6% increase in property value within 3 years following the passage of a school bond proposal (Cellini, Ferreira & Rothstein, 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, Ferreira & Rothstein, 2010). This study points out shifts in the desirability of a school district will be reflected in housing prices.

In considering school bond measures, communities must also examine and address critical issues around equity and neighborhood stratification patterns. 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.

Understanding why and how people choose schools whether by simply selecting a residence or through school choice options like magnet programs can help communities invest bond dollars wisely. Previous research has proven it is difficult to directly connect the school facility to student achievement. However, a study of the California Bay Area in 2004, examined used a general equilibrium model to gauge the indirect effects of school quality on neighborhood stratification and found them to be more significant than estimated direct affects (Bayer et al, 2004). Using 1990 Census data, economists looked at over 240,000 households from 6 contiguous counties gathering information for individuals including race, age, educational attainment, income, household size, occupation, and employment. They also gathered data for each property such as ownership, size, number of rooms, and building age. Using their equilibrium model, they found that neighborhood stratification would decrease by 30 percent by education and by 25 percent on income if school quality was not a factor in determining residence (Bayer, Ferreira, & McMillan, 2004). Given this research and growing trends in school choice, creating schools of high, visible, and equitable quality could have social affects well beyond just achievement.

2.3 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 and impact on learning, such as lighting, acoustics/noise, and air quality/temperature. Other studies have extended the research to also include the impact of design elements, general building age/quality, and overcrowding. The research has been widely varied in focus, methodology, and outcomes making it very challenging to state or generalize findings. The difficulty is compounded by the overall complexity of teaching and learning, making it difficult to isolate the effects of any single component on the learning process. In reviewing the body of literature and mixed significance of results of the impact of the school building on students, Earthman and LeMasters (1996) justly point out,

> "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 previous studies conducted prior to the early 1980s as summarized and synthesized separately by Carroll McGuffey (1982) and Carol Weinstein (1979). Between these two papers, McGuffey and Weinstein examined a total of 238 studies and 21 paper presentations around the components of school building and the impact on student performance and achievement:

- School Building Age (7 studies – significant impact)
- 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 and low relevance today)
- 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)
- School Size (16 studies – mixed results)

In their review of more recent research from the 1980s to 1990s, Earthman and LeMasters (1996) concluded the research,

> "…demonstrated a relationship between student performance, both achievement and behavior, and the condition of the built environment. The relationship has varied from very weak in some of the early studies to the most recent study which demonstrates a considerable degree of relationship. 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."

In 2002, Marc Schneider 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." He also found building age alone cannot be used as a predictor of impact on performance implying a different measure of building quality could be measured and achieved through "adequate funding and competent design, construction and maintenance. (Schneider, 2002). Lyons (2001) also draws similar conclusions after a review of research around facility conditions. He goes on to point out that changes in teaching and learning, technology, and increasing accountability and standards require changes in school facilities to be able to be flexible enough to allow for collaboration.

In a canonical analysis, Crampton (2009) used longitudinal, state-by-state data about school spending and student achievement from the Institute for Education Sciences and US Census Bureau to determine the impact of "human, social, and physical capital on student achievement…" Human and social capital focused on the quality of teachers and professional development, examining dollars spent while physical capital referred to the school infrastructure, condition and adequacy with spending determined by dollars spent for maintenance and capital outlay including construction, renovation, and debt for capital outlay. National Assessment of Educational Progress (NAEP) scores for 5th and 8th grade reading and math were used as measures of student achievement. Over the years examined (2003, 2005, and 2007) and controlling for poverty, dollars spent on human, social and physical capital accounted for between 55.8 and 77.2 percent of the variation in scores. Human capital investments showed the largest effect over time at .890 in 2003 and declining to .648 in 2007. Social capital produced a coefficient of .158 in 2003, dipped in 2005, and rose to .299 in 2007. Physical capital was more varied in its effects, accounting for .236 in 2003, .049 in 2005, and rose back up to 2003 levels in 2007. While human and social capitals affects were higher overall, Crampton concluded, "…the impact of investment in physical capital…was also a significant contributor…spending on school infrastructure does matter when it comes to student achievement" (Crampton, 2009).

2.4 School Studies

An important and growing body of research has examined effects of the school facility at the school and district level using a variety of both quantitative and qualitative approaches. A few of those studies have been able to look at the effects of building improvements and construction, particularly in urban environments.

In 1988, the superintendent of Washington D.C. schools formed the D.C. Committee on Public Education (COPE) to examine all aspects of the schools for targeted improvement over a 5-year period. COPE determined the overall system of 199 buildings was over 50 years old and in poor condition compounded by poor maintenance management. Based on these findings, it was 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. Buildings were crumbling, neglected, and deemed unsafe thereby contributing to poor student attitude, discipline and performance (Berner, 1993).

Based on the belief that environment affects outcome, Berner researched the impact of parental involvement on building conditions by creating a regression model using Parent Teacher Association (PTA) membership, PTA budget, school condition (1=excellent, 2=fair, 3=poor), type of building, school age, percent white, mean household income, and student enrollment. PTA membership and budget from 41 complete Urban League surveys were used to capture the level of parent engagement and interest in improving a school. In this first model, the school's age was significant with each 10 years resulting in a .5 reduction on the scale of 1-3 for building condition. School size was negatively correlated and each increase of 100 students resulted in a -.97 reduction in score which likely resulted from larger resources at larger schools. Parent involvement was also significant; every $10 per student increase in PTA budget created a -.029 reduction in scale score for building condition. For the second part of the study, regression was used to analyze if the overall building condition impacted student achievement as shown by the average school California Test of Basic Skills (CTBS) scores. This second model of all schools found a 5.455 point increase in test scores from poor to fair school rating and a 10.9 point increase in scores from poor to excellent school rating. Berner's findings supported the hypothesis that student scores improved as building conditions improved.

Lewis (2001) examined 193 Milwaukee public schools (K-12) to look at building condition on test scores compared to other factors (family, economic status, race/ethnicity, attendance, and discipline). Test scores were taken from Wisconsin Student Assessment System (WSAS) scores in 4^{th}, 8^{th}, and 10^{th} grades in Math, Reading, Science, Language, and Social Studies. In addition to test and other student data, facility scores were collected by a commissioned group of trained evaluators and reported for existing condition (direct examination by facility and architect team) and educational adequacy (teacher and curriculum team). Rating measures were developed by the Construction Control Corporation with standards established for each rating type and level. 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 percent 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. Based upon willingness to respond, the sample was large and diverse in size, composition, and setting. Surveys were given to teachers in attendance at a regular faculty meeting at each site. From this group, a random sample of teachers was chosen to respond to questions about the school facility and school climate using the School Climate Index (SCI). The SCI has 28 items measuring four categories: Academic Press (6 items), Community Engagement (7 items), Teacher Professionalism (8 items), and Collegial Leadership (7 items). In addition, teachers were asked to rate the quality of their school facility on 7 items in three categories (attractiveness, adequacy of space, and maintenance). Three other items as them to rate their levels of resource support. All items used a 1-5 Likert Scale rating system.

Student achievement data was taken from the Virginia Standards of Learning Test (SOL) for 8th grade Reading and Math combined into one measure which accounted for 96% of the variance. In 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 previous study of Uline and Tschannen- Moran and another researcher Crook (2006) who used the Commonwealth Assessment of the Physical Environment (CAPE) developed by Cash (1993). The CAPE asks the school building principal to assess school building components and overall building condition using a 39 item questionnaire. From all those surveyed, 11 principals rated their school as unsatisfactory and were matched with 11 other schools rated by principals as satisfactory. Teachers in these 22 schools then were surveyed to examine differences between two rating types in how teachers felt about their classrooms and resulting attitudes. From a review of previous research, a final survey of 23 building items was developed covering 7 building conditions: thermal control, lighting, acoustics, condition of the furniture/equipment, space, science equipment, and graffiti. To measure teacher attitude, 18 items were developed to see how the classroom condition influenced personal feelings about work/teaching, how the classroom condition affected how they work, and how the classroom condition impacted student learning and health. From the surveys of 165 voluntary respondents from only 8 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 as healthier. They were more positive that the classroom affected them and their students and looked forward to working in them. However, teachers in unsatisfactory buildings did not necessarily indicate they were willing to leave although the cumulative effects of these negative perceptions need further study.

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 (2009) from the Los Angeles School Infrastructure Research Project studied the effects of new schools built from 2002-2007 under a $28 billion bond initiative in the Los Angeles Unified School District. Phase I of the programs called for the construction of 70 new facilities with 95,000 classroom seats and was completed on schedule in 2008. At this time, LA Unified was plagued by overcrowding and had to bus many students out of the inner city. New, smaller secondary schools were built under this program to alleviate overcrowding and to reap benefits of smaller school size. This study used both quantitative and qualitative measures to track movement to identify the effects of construction for a largely minority and economically disadvantaged school population. This initial study looks at early gains and benefits of construction in preparation for the next round of building to not only examine whether gains have been made but also to inform further construction. Research questions focused around migration of students and teachers, easing of overcrowding, increases in school quality, and the impact on student achievement and attendance. After opening new facilities, busing rates due to overcrowding dropped from 16,000 students in 2001 to about 4,000 in 2007. For 2006 10th grade Reading scores, students in new schools had a scale score of 311. Students in old previously overcrowded schools scored 306. This difference equals about one-fourth of a standard deviation in scores even though those returning to central areas had higher levels of poverty than those who remained at outlying schools. Teachers staffing new schools in 2006 reported three years less experience than those in all schools (9.7 as compared to 12.7). A greater portion of elementary teachers at new schools were of Latino heritage. Enrollment counts shifted more slowly to the new schools at the high school level but have provided relief for overcrowding. Teachers in new schools reported positive feelings about the new facilities based upon newness and cleanliness. The likelihood of new building spurring innovation in pedagogy was expressed but effects were not clear at this point. 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 to the new space. Preschool rates are also increasing due to proximity of new schools. Further study of gains will be needed to see effects over time and to explore other areas of study.

Neilson and Zimmerman (2011) were also able to examine the before and after effects on school construction in New Haven, Connecticut on New Haven Public Schools (NHPS). The NHPS system is comprised of about 22,000 students and 42 schools. Of those students, 80% were eligible for free or reduced lunch; 90% were black or Hispanic; about 25% spoke a language other the English at home. In this District, high school drop-out rates were three times the state average and test scores were noticeably lower than other districts. The study examines the effects of primary and secondary school construction from 1998-2010 under a $1.9 billion School Construction Project (SCP). Final projects will be completed by 2014. By 2010, 12 of 42 schools had been rebuilt and 18 renovated at a total cost to date of $1.1 billion. Projects comprised all school levels affecting 5 high schools and 25 elementary and middle schools. Targeted areas for improvement were: technology, air conditioning, community access, maintenance and energy costs, and livable design. School expansion was not a goal since projects took place during a trend of decreasing enrollment. No changes to school zones were made and new buildings were about the same size as those they replaced.

The study uses an economic framework to measure the effects of school construction projects on three areas: home prices, student achievement, and student enrollment. In the area of home prices, researchers looked at relationships between migration, enrollment, and school quality. Researchers examined home sale data in the district from January 1, 1995 to January 1, 2010 using public records. Student residency information was determined from school enrollment information. Student achievement was measured by scores on the Connecticut Mastery Test (CMT) for 2004- 2010 for a total of more than 152,000 observations. School and student demographic factors was also taken from school data. After complex modeling and analysis, changes in home prices per $10,000 of per-capita construction spending increase by .29 percent at filing, .13 percent at start of construction, and .85 percent upon completion of the project. School enrollment gains were measured using inflow and outflow methods for the 4 years preoccupancy and 6 years post-occupancy. In simple terms, enrollment starts to rise in the first year after occupancy and through the 5th year post-occupancy before leveling off. For each $10,000 per-capita student cost, a 4.4 percent increase in enrollment was noted by the 6th year following occupancy. For test scores by the 6th year post-occupancy, each $10,000 of per student construction spending raised scores by .0265 standard deviations. Math measures were less significant and clear. Qualitative information was also gathered through written surveys of 22 principals and in-person interviews of 10 of those surveyed based upon availability. The survey asked them "to rate the contribution of the School Construction Project to student, parent, and teacher motivation, and the timing of any observed changes." Additional questions asked about specific building factors such as libraries and air conditioning. Moderate to large changes in student motivation and teacher motivation were noted by 9 of 10 principals both 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 to student achievement. Open ended responses cited student and teacher pride and building visibility as other important factors.

A very recent study called the Holistic Evidence and Design (HEAD) study shows promising progress in understanding the ways a built school environment can impact student learning. Barrett et al. (2014) examined 153 classrooms in 27 primary schools in the United Kingdom (UK) comprised of 3766 students. Schools varied greatly in age, structure and condition. The team posited building factors could be grouped into three broader categories of naturalness, individuality and stimulation (SIN model). They hypothesized 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. Naturalness includes light, sound temperature, air quality and links to nature. Individualization includes ownership, flexibility, and connection. Lastly, Stimulation encompasses the (appropriate level) of complexity and color. The researchers focused on primary students and classrooms since students this age spend the majority of their time in one space and have ready test measures available.

The HEAD study used three ways to assess classroom spaces. Hard measures included a list of items related to built-environment, room arrangement, amount of environmental control of teachers and students, and the appearance of the classroom in terms of color and complexity. Next, spot meter readings of light, carbon dioxide (CO2) level, temperature, and noise were taken 5 times in each classroom. Teachers were also surveyed about their experiences within the space. Student scores on the National Curriculum (NC) levels were used for student achievement metrics. Student demographic data of various types was also included in analysis as control factors.

After analysis, researchers found seven of the ten factors across all three categories significantly impacted student performance with a difference of 7.93 NC points between the most effective and least effective classrooms space.

- Naturalness (49% overall): Light (21%); Temperature (12%); and Air Quality (16%)
- Individualization (28%): Flexibility (17%) and Ownership (11%)
- Level of Stimulation (23%): Complexity (12%) and Color (11%)

2.5 Summary

This study provides strong direction to guide classroom design in both existing and new spaces. With a large sample of schools and students, layered research methods, qualitative and quantitative data, and strong student achievement connections, this study may provide the connection needed within the body of previous research.

CHAPTER III

METHOD

3.1 Population of Interest

The population for this study will consist of all elementary schools in Houston ISD. A sample of 28 magnet elementary schools were gathered. The experimental group was not randomly sampled since all 14 replacement (rebuilt) magnet elementary schools were included; however, the 14 schools in the control group were randomly selected from a pool of more than 30 other magnet elementary schools not rebuilt. All 28 rebuilt replacement magnet elementary schools were identified from the three bond elections (1998, 2002, and 2007). The school will serve as the observational unit. The schools used in this study are listed in Appendix A.

3.2 Variables and Data

3.2.1 Data collection

This study examined whether construction, building age, and building condition (independent variables) had an impact on magnet applications, enrollment, attendance, and student achievement measures (dependent variables). All variables and sources are detailed in Table 2. Demographic data including minority ethnicity (Hispanic and African American) and economically disadvantaged percentages were used to control for other factors impacting dependent variables. School data was used from the following sources: Texas Education Agency (TEA) Academic Excellence Indicator System (AEIS) and other annual reports, district level data, and school rankings from independent sources based upon standardized test data. Data was organized in spreadsheets and analyzed using SPSS Version 21 software. Data was collected for each school for based up data collected during the 2011-2012 school year.

Student achievement state percentile ranking was collected from the annual SchoolDigger.com organization's independent rankings of each school. Annual Rankings 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 score across all grades and adding them together and dividing by two to arrive at a composite test average 1-100. Then, each school is ranked by its combined score in relation to all other public schools within the state. For 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.

School Digger rankings are available for schools beginning in 2004. Since the entire group of schools in Texas is equally affected by changes in the state test, using the rankings allow for better comparison of the trend in achievement for each school than 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.

Magnet application numbers were pulled from HISD's raw data of magnet applications received by January of 2013 for 2013-2014 school year which was recently provided to the Houston School Survey (HSS) group. These applications were impacted by the previous 2011-2012 school and student data and are therefore relevant to the year of interest.

Building age, school composite facility scores, and building capacity were taken from a district report of a facility survey in July of 2012 by Parsons, an independent construction and engineering firm. Parsons conducted physical inspections of all facilities and surveyed principals and key district maintenance personnel to assess conditions for all HISD facilities and schools. For each school, a building composite score of 0-100 was given.

Table 2

Study Variables

Data	Variable	Source	Reference
School Enrollment	Dependent	School Digger website	schooldigger.com
Magnet Application	Dependent	District Data via HSS website	houstonschoolsurvey.com
School Attendance Rate	Dependent	School Digger website	schooldigger.com
Student Achievement	Dependent	School Digger website	schooldigger.com
Free and Reduced Lunch Percentage	Controlling	School Digger website	schooldigger.com
Minority Percentage (Hispanic & African-American)	Controlling	School Digger website	schooldigger.com
Age of Original Building	Independent	District Study	Houston Independent School District and Parsons (2012)
Completion Date of Building	Independent	District Study	Houston Independent School District and Parsons (2012)
School Composite Facility Score	Independent	District Study	Houston Independent School District and Parsons (2012)

3.3 Method of Analysis

The first set of analyses looked at 28 magnet elementary schools (experimental and control) using full and reduced multiple regression methods to examine the connection between the predictors building age and building composite in 2011-2012 with criterion variables of magnet applications, student enrollment, student attendance and student achievement. Minority percentages of combined African-American and Hispanic students and percentages of free and reduced lunch students were included in the full regression model as controlling variables.

CHAPTER IV

RESULTS

4.1 Sample

Twenty eight elementary schools in a large urban county were chosen for analysis. The experimental group (*n* = 14) included all of the magnet elementary schools (kindergarten to 5th grade) rebuilt under the 1998, 2002, and 2007 school bond ordinances. These schools were built between 2004 and 2012. They were not randomly chosen or assigned. The control group is (*n* = 14) included randomly selected elementary schools (kindergarten to 5th grade) from the 32 remaining elementary schools that were not rebuilt. These schools were built from 1923 to 1992.

4.2 Experimental Schools

The average building is 4.07 years old (*SD* = 2.18). The average building composite score is 93.04 (*SD* = 6.56). The higher the composite score the better and more suitable the facility is for teaching and learning. The average enrollment is 739 students (*SD* =77) and applications for the 2011 to 2012 academic year was 237 (*SD* = 207). Magnet applications in 2013-2014 were an average of 237 (*SD*=207). The TEA Rating for 2010-2011 was a 0.43 with a standard deviation of .514. The percentage of free and reduced lunches was 40.27% and the average percent of African American and Hispanic enrollees was 86.88%. Table 3 shows data comparison to Control Schools.

4.3 Control Schools

The average building is 54.78 years old (*SD* = 26.74). The average building composite score is 74.46 (*SD* = 13.82). The higher the composite score the better and more suitable the facility is for teaching and learning. The average enrollment is 701 students (*SD* =127) and applications for the 2011 to 2012 academic year was 239 (*SD* = 249). The TEA Rating for 2010-2011 was a 0.43 with a standard deviation of .514. The percentage of free and reduced lunches was 30.13% and the average percent of African American and Hispanic enrollees was 60.17%. Table 3 shows data comparison to Experimental Schools.

Table 3

Experimental and Control Schools Descriptive Statistics

	Experimental Schools (n=14)			Control Schools (n=14)		
Variable	Min.	Max.	Mean (S.D)	Min.	Max.	Mean (S.D)
Building Age in 2011-2012	0	8	4.07 (2.81)	20	92	61.29 (23.53)
Building Composite in 2011-2012	85	100	93.04 (6.56)	38.98	86.80	72.12 (11.80)
Enrollment in 2011-2012	607	918	739.21 (77.15)	518	916	695.14 (131.01)
Magnet Applications for 2013-2014	10	619	237.43 (207.27)	10	677	239.57 (249.18)
TEA Rating for 2011-2012	0	1	.43 (.51)	0	1	.43 (.51)
Percent Free & Reduced Lunch for 2011-2012	14.50	53.60	40.28 (11.24)	5.60	58.30	30.14 (17.66)
Percent AA or Hisp. for 2011-2012	41.86	99.14	86.89 (17.85)	20.83	99.46	60.17 (29.19)

4.4 Research Questions

4.4.1 Research Question 1

Is 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 (R^2=0.028, $F(2,11)$=0.159, p = 0.855) or control schools (R^2=0.168, $F(2,11)$=1.107, p = 0.365). Therefore, there was no observable effect on magnet applications as evidenced by building composite score and building age in the experimental and control schools. See Table 4 for Model Summary for Experimental and Control Schools: Magnet Applications; and Table 5 for ANOVA results for Experimental and Control Schools: Magnet Applications.

Table 4

Model Summary for Experimental and Control Schools: Magnet Applications

	Experimental Schools (n=14)			Control Schools (n=14)		
Model	R	R Square	SE of the Estimate	R	R Square	SE of the Estimate
1	.168	.028	222.134	.409	.168	247.156

Table 5

ANOVA Results for Experimental and Control Schools: Magnet Applications

Experimental Schools (n=14)					
Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	15708.202	2	7854.101	.159	.855
Residual	54278.227	11	49343.748		
Total	558489.429	13			
Control Schools (n=14)					
Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	135263.661	2	67631.831	1.107	.365
Residual	671945.767	11	61085.979		
Total	80209.429	13			

4.4.2 Research Question 2

Will student enrollment rate be predicted by new construction and building composite scores? The Coefficient of Determination was not significant for the experimental (R^2=0.152, F(2,11)=0.987, p = 0.403) or control schools (R^2=0.138, F(2,11)=0.880, p = 0.442). Therefore, there was no observable effect on enrollment rate as evidenced by building composite score and building age in the experimental and control schools. See Table 6 for Model Summary for Experimental and Control Schools: Enrollment; and Table 7 for ANOVA results for Experimental and Control Schools: Enrollment.

Table 6

Model Summary for Experimental and Control Schools: Enrollment

	Experimental Schools (n=14)			Control Schools (n=14)		
Model	R	R Square	SE of the Estimate	R	R Square	SE of the Estimate
1	.390	.152	77.225	.371	.138	132.233

Table 7

ANOVA Results for Experimental and Control Schools: Enrollment

Experimental Schools (n=14)					
Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	11774.058	2	5887.029	.987	.403
Residual	65602.299	11	5963.845		
Total	77376.357	13			
Control Schools (n=14)					
Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	30780.954	2	15390.477	.880	.442
Residual	192342.761	11	17485.706		
Total	223123.174	13			

4.4.3 Research Question 3

Will student attendance rate be predicted by new construction and building composite scores? The Coefficient of Determination was not significant for the experimental (R^2=0.098, F(2,11)=0.596, p = 0.568) or control schools (R^2=0.098, F(2,11)=0.600, p = 0.566). Therefore, there was no observable effect on attendance rate as evidenced by building composite score and building age in the experimental and control schools. See Table 8 for Model Summary for Experimental and Control Schools: Attendance; and Table 9 for ANOVA results for Experimental and Control Schools: Attendance.

Table 8

Model Summary for Experimental and Control Schools: Attendance

	Experimental Schools (n=14)			Control Schools (n=14)		
Model	R	R Square	SE of the Estimate	R	R Square	SE of the Estimate
1	.313	.098	.38553	.314	.098	.50966

Table 9

ANOVA results for Experimental and Control Schools: Attendance

Experimental Schools (n=14)					
Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	.177	2	.089	.596	.568
Residual	1.635	11	.149		
Total	1.812	13			
Control Schools (n=14)					
Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	.312	2	.156	.600	.566
Residual	2.857	11	.260		
Total	3.169	13			

4.4.4 Research Question 4

Has student achievement 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 state percentile ranking was accounted for by building composite scores (F(1,12) = 10.686, p=0.007). The unstandardized regression equation was Y= 14173.313 + -129.010 (X1). This was significant at t=-3.269, p =0.007.

In the Control Model, 53.4% of the variance state percentile ranking was accounted for by building composite scores ($F(1,12) = 13.772$, p=0.003). The unstandardized regression equation was Y= 5570.307 + -62.448 (X1). This was significant at t=-3.711, p =0.003. See Table 10 for Model Summary for Experimental and Control Schools: Statewide Rank; and Table 11 for ANOVA Results for Experimental and Control Schools: Statewide Rank. Table 12 contains the School Regression for Experimental and Control Schools: Statewide Rank.

Table 10

Model Summary for Experimental and Control Schools: Statewide Rank

	Experimental Schools (n=14)			Control Schools (n=14)		
Model	R	R Square	SE of the Estimate	R	R Square	SE of the Estimate
1	.686	.471	933.764	.731	.534	715.663

Table 11

ANOVA results for Experimental and Control Schools: Statewide Rank

Experimental Schools (n=14)					
Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	9317339.729	1	9317339.729	10.686	.007
Residual	10462991.200	12	871915.933		
Total	19780330.929	13			
Control Schools (n=14)					
Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	7053564.429	1	7053564.42	13.772	.003
Residual	6146099.285	12	512174.940		
Total	13199663.71	13			

Table 12

Experimental and Control School Regression Models: Statewide Rank

Experimental Schools (n=14)				
Model	B	SE	t	Sig
Constant	14173.313	3680.406	3.851	.002
Building Composite	-129.010	39.465	-3.269	.007
Control Schools (n=14)				
Model	B	SE	t	Sig
Constant	5570.307	1228.510	4.534	.001
Building Composite	-62.448	16.828	-30711	.003

4.4.5 Exploratory Question 1

Is statewide ranking predicted by composite building score and percent African-American and Hispanic among all elementary schools rebuilt (*N*=35). In the Experimental Model, 48.6% of the variance state percentile ranking was accounted for by building composite scores (F(2, 31) = 14.653, p=0.000). The unstandardized regression equation was Y= 2919.615 + -47.559 (X1) + 44.056 (X2). Both slopes were statistically significant. See Table 13 for Model Summary for Experimental (All Schools Rebuilt): Statewide Rank; and Table 14 for ANOVA Results for Experimental Schools (All Schools Rebuilt): Statewide Rank. Table 15 contains the School Regression for Experimental Schools (All Schools Rebuilt): Statewide Rank.

Table 13

Model Summary for Experimental Schools (All Schools Rebuilt): Statewide Rank

	Experimental Schools (n=34)		
Model	R	R Square	SE of the Estimate
1	.697	.486	791.842

Table 14

ANOVA Results for Experimental Schools (All Schools Rebuilt): Statewide Rank

Experimental Schools (n=34)					
Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	1874877.963	2	9187438.98	14.653	.000
Residual	19437430.508	31	627013.887		
Total	37812308.471	33			

Table 15

Experimental Schools Regression Model: Statewide Rank

Experimental Schools (n=34)				
Model	B	SE	t	Sig
Constant	2919.615	1880.653	1.552	.131
Building Composite	-47.559	18.964	-2.508	.018
Percent AA and Hisp.	44.056	8.811	5.000	.000

CHAPTER V

DISCUSSION

The purpose of the study was to find analyze whether statistically significant, predictive relationships existed between school facility age and condition with four areas: magnet applications, school enrollment, student attendance, and student achievement. Finding a relationship(s) provide school districts with additional information and data to strengthen public confidence in past projects and to encourage voters to continue to support school bond elections within Houston ISD and potentially in other districts, thereby bolstering the construction industry. Previous research had fewer schools for consideration, did not include robust magnet data, and did not consider impact against multiple variables included within this study. Although declining in most recent years, public education still accounts for over 20% of total public construction spending. The construction industry clearly benefits this sector and from strong public confidence created by passage of school bond programs. Creating an observable connection between school construction and school and student outcomes serves to strengthen the likelihood of increased spending in this sector of the construction market.

5.1 Interpretation of Research Questions

Research question one asked: Is 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 the experimental and control schools.

None of the literature reviewed directly discussed the impact of facilities upon magnet interest as evidenced by magnet applications. The single year data used in this study so close to the completion of many of the replacement schools may have impeded findings and significance. Examining additional years post-construction could provide different results. It would also be useful to survey parents during the magnet tour process to gain insight into decision-making. One might ask parents to rate factors in terms of importance to determine to what extent the building space influences choice to apply. In addition, parents could be asked to rate and provide other feedback regarding facility and other factors once they have selected their magnet program of choice.

Research question two stated: 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.

Houston ISD enrollment trends are very unique since the entire district is considered “open-enrollment” with a large percentage of magnet programs and other types of transfers. In addition, principals have a high degree of discretion in Houston ISD about enrollment and programs unique to other districts nationwide. Of the studies reviewed. The study of the Los Angeles Unified School District cited here has some parallels regarding indicators of school movement and school quality. The choices within LA Unified are more related to desegration 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 LA 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 Houston ISD would likely require consideration of other 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 Houston ISD 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 flattened results while looking at who is attending in terms of both neighborhood and demographic shifts (race, ethnicity, and income) could show an impact from building a replacement school. It may have also be helpful to look at effects on enrollment among replacement schools with previously low enrollment to see if a new building increased numbers.

Research question three asked: Can student attendance 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 attendance rate as evidenced by building composite score and building age in the experimental and control schools.

This study compared magnet elementary schools which typically have high levels of attendance. It may have been more helpful to broaden the experimental or control groups to include all school types. The range of attendance rates is fairly small with schools averaging between about 96 – 97.5% daily which could have made it difficult to see a significant correlation between the facility quality and attendance. Examining the rates of attendance for randomly selected schools with a very low building composite score (control group) vs. replacement schools (experimental group) may have different outcomes. Research has proven that environmental qualities can affect health, particularly relating to issues of indoor air quality and mold. The Lyons study (2009) 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 affect beyond just rates.

Research question four asked: Has student achievement 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 state percentile ranking was accounted for by building composite scores which was statistically significant. Based upon the findings from research question four, an exploratory question was asked: Is statewide ranking predicted by composite building score and percent African-American and Hispanic among all elementary schools rebuilt (N=34). In the Experimental Model, 48.6% of the variance state percentile ranking was statistically significant in accounting for by building composite scores. Both slopes in the regression equation were statistically significant. Perhaps even more significantly, free and reduced lunch status dropped out of the statistical model as a predictor of student achievement. This model seems indicates building composite is more significant predictor of student achievement than 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.

These findings are quite notable among the body of research. Few, if any, previous studies reviewed showed such a marked correlation between student achievement and the building itself. The large amount of student and building data available for multiple years within Houston ISD allowed for a fresh comparison.

The Yale study of New Haven Public Schools did find reading gains (.027 standard deviations) for schools for every $10,000 spent per child (Neilson & Zimmerman, 2011). The very recent HEAD study (Barret et al, 2014) found classroom parameters in the SIN model explained 25% of the variance in learning progress. Further, in Phase 2 which included student factors of Free School Meal status, English as an Additional Language status, and Special Educational Needs status, the goodness of fit in the regression model improved from 51% to 58% (Barrett et al, 2015). In other words, when controlling for student variance, the effect was strengthened. Like the other research reviewed, the Yale model used much more complex modeling based upon individual test student scores. The Yale study found by six or more years after occupancy, reading scores rose 0.0265 standard deviations in fixed model and 0.0236 standard deviations for the value added model for every $10,000 spent on construction.

For the same period, math scores were less marked and began to trend upward at three years after construction to 0.0172 standard deviations per $10,000 six years post-occupancy.

In comparison, this study used a simple, whole school ranking metric as a means of showing holistic school-wide achievement and the number of years of occupancy varied since all data was based on 2012-2013 school year while schools were completed at different times. Despite the simplicity of the model, the results are comparably positive and easier to analyze and interpret.

In addition to the LA Unified study, Crampton's study of all 50 states also found the school facility positively impacted student achievement. Crampton examines spending impact in three categories: human, social, and physical capital on student achievement for each of the states. While the study finds these three factors account for 55.8% to 77.2% of the variance in the model for 2005, 2007, and 2009, it fails to offer a separate metric for each alone. Crampton also notes poverty has a large, negative impact on student achievement and cautions policymakers to be aware of barriers created by poverty. Despite these barriers, it is clear that investing in education across the three areas does make a difference in student achievement.

5.2 Implications

Public education in the United States is more high-stakes than ever before for states, school districts, and schools due to the standards-based movement, testing pressures and persistent achievement gap. Penalties for not meeting AYP are significant. The stakes and penalties are just as high for the people involved including principals, teachers, and above all students who fail to meet minimum standards. The cost of constructing new schools to replace old ones is also steep. The average cost of a new elementary school in Houston ISD within this study was about $16 million including furniture and technology. A new high school under the $1.2 billion HISD 2012 bond program will cost exponentially more with several costing more than $100 million depending on size. 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. Research shows a number of societal and school factors contribute to this gap and a multi-pronged approach appears to be the only way to narrow it. Among magnet elementary schools in Houston ISD, 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, building a replacement school did make a significant difference in student achievement, explaining 47.1% of the variance in scores. In this model, other previously significant factors such as minority and free and reduced lunch percentages no longer held the same level of significance or dropped from significance all together. It is encouraging to find the quality of the school environment can, at least in part, have a significant impact on student achievement and the achievement gap by creating comparable high-quality, learning environments. These results could be used to bolster public confidence in current and future bond programs within and outside of Houston ISD if shared with school board members, district personnel, and public stakeholders. Successful bond programs that produce results beyond just construction are definitely good for the construction industry as a whole.

5.3 Future Research Recommendations

This study could readily be replicated and even expanded within Houston ISD. Research could look at additional testing years singly or consider a longitudinal approach to see how schools and students fair in the years post-construction. While this study only looked at replacement elementary schools, a broader study could look at 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. It would be interesting to see if the same results will be produced when Houston ISD replacement high schools are complete in the coming years. Lastly, with such a robust, varied, and long-standing standardized testing within Houston ISD, researchers may also benefit from using student-specific test scores instead of overall school rankings.

Combining qualitative research methods with quantitative ones could further explain why replacement schools are making a difference in student achievement. Post-occupancy surveys of principals, teachers and students could be particularly helpful, especially at the high school level since students have a greater ability to respond.

Even though each school community creates a unique school design, Houston ISD has a very comprehensive and well-designed set of specifications for each bond program including elements of design, space layouts, equipment, lighting, technology and more. One could likely apply the SIN approach in the UK study and examine each school and classroom based upon the elements of naturalness, individualization, and stimulation to see what components are most highly correlated to student achievement.

Other school districts across the nation have similar standardized testing programs due to national requirements. School infrastructure is aging nationwide, resulting in widespread bond elections to replace poor facilities. It is likely districts have some individual means of assessing facility quality or could apply one to facilities similar to the building composite score obtained in Houston ISD. The combination of these readily available or easily obtainable methods make replication in other districts very possible.

The construction industry, along with education researchers, could and should be an active part of the research in this area. Showing new buildings benefit students and the greater public benefits the industry financially and could also boost the morale of construction professionals who rarely get to see the difference spaces make once the punch list is done. Even more importantly, impacting student achievement impacts 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 schools facilities is truly priceless.

5.4 Conclusions

Research question one asked: Is 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. Research question two stated: 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. Research question three asked: Can student attendance rate be predicted by new construction and building composite scores? The Coefficient of Determination was not significant for the experimental or control schools. Research question four asked: Has student achievement 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 state percentile ranking was accounted for by building composite scores which was statistically significant. Based upon the findings from research question four, an exploratory question was asked: Is statewide ranking predicted by composite building score and percent African-American and Hispanic among all elementary schools rebuilt (N=34). In the Experimental Model, 48.6% of the variance state percentile ranking was statistically significant in accounting for by building composite scores.

These findings are quite notable among the body of research. Few, if any, previous studies reviewed showed such a marked correlation between student achievement and the building itself. The large amount of student and building data available for multiple years within Houston ISD allowed for a fresh comparison.

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APPENDIX A

LIST OF SCHOOLS

Houston ISD Elementary Magnet Schools (Research Questions 1-4)	
Experimental Schools (n=14)	**Control Schools (n=14)**
Berry Elementary School (2011)	*Bell Elementary School (1978)*
Bruce Elementary School (2007)	*Burrus Elementary School (1926)*
Cook Elementary School (2006)	*Codwell Elementary School (1977)*
Herod Elementary School (2011)	*Cornelius Elementary School (1960)*
Horn Elementary School (2011)	*Crespo Elementary School (1992)*
Lantrip Elementary School (2007)	*DeZavala Elementary School (1920)*
Lockhart Elementary School (2012)	*Elrod Elementary School (1964)*
Longfellow Elementary School (2007)	*Harvard Elementary School (1923)*
Lovett Elementary School (2011)	*Kolter Elementary School (1960)*
Oak Forest Elementary School (2004)	*Parker Elementary School (1959)*
Patterson Elementary School (2011)	*Poe Elementary School (1928)*
Roosevelt Elementary School (2011)	*River Oaks Elementary School (1928)*
Travis Elementary School (2006)	*Roberts Elementary School (1936)*
Twain Elementary School (2006)	*Sinclair Elementary School (1959)*

Houston ISD Rebuilt Elementary Schools (Exploratory Question) (n=34)	
Almeda Elementary School (2011)	*Lantrip Elementary School (2007)*
Atherton Elementary School (2012)	Lewis Elementary School (2011)
Bastian Elementary School (2007)	*Lockhart Elementary School (2012)*
Berry Elementary School (2011)	*Longfellow Elementary School (2007)*
Briargrove Elementary School (2007)	*Lovett Elementary School (2011)*
Bruce Elementary School (2007)	Mading Elementary School (2006)
Cook Elementary School (2006)	*Oak Forest Elementary School (2004)*
Coop Elementary School (2007)	Paige Elementary School (2006)
Cunningham Elementary School (2011)	Park Place Elementary School (2002)
DeChaumes Elementary School (2011)	Patterson Elementary School (2011)
Dogan Elementary School (2012)	Peck Elementary School (2011)
Frost Elementary School (2011)	Piney Point Elementary School (2011)
Gregg Elementary School (2011)	*Roosevelt Elementary School (2011)*
Herod Elementary School (2011)	Thompson Elementary School (2007)
Highland Heights Elementary School (2006)	*Travis Elementary School (2006)*
Horn Elementary School (2011)	*Twain Elementary School (2006)*
Kennedy Elementary School (2012)	Walnut Bend Elementary School (2007)

Note: Magnet schools are italicized.