# The Renovation Process and Student Achievement as Measured by Performance on the Virginia Standards of Learning Assessments in Mathematics and Reading at the Eighth Grade Level

John L. Mayo

Dissertation submitted to the faculty of the Virginia Polytechnic Institute and State University in partial fulfillment of the requirements for the degree of

Doctor of Education

In

Educational Leadership and Policy Studies

Glen I. Earthman, Chair
Carol S. Cash
Travis W. Twiford
Michael E. Thornton

March 21, 2012

Blacksburg, Virginia

Key Words: Renovation Process, Student Achievement, Eighth Grade

# The Renovation Process and Student Achievement as Measured by Performance on the Virginia Standards of Learning Assessments in Mathematics and Reading at the Eighth Grade Level


## Abstract

The purpose of this study was to look at the possible influence the renovation process had on student achievement as measured by performance on the Standards of Learning (SOL) in the areas of mathematics and reading at the eighth grade level in the Commonwealth of Virginia.

For purposes of this study a descriptive research methodology was used to determine the possible influences the renovation process had on student achievement. To conduct such research, Standards of Learning (SOL) test scores in the areas of mathematics and reading, from middle schools in the Commonwealth of Virginia were used one year prior to the renovation process, during the renovation process, and one year after the renovation process. Depending on the complexity of the renovation, SOL test scores were collected from two to four years during the renovation process.

Demographic variables were analyzed to ascertain stability of the student populations over the period of time. Variables such as ethnicity, socio-economic factors, and highly qualified teachers served as demographic variables. These variables were used to control the status of each school student population over the period of the stages of the renovation process.

The main research question for this study was: Does the renovation process of a school building influence student achievement? This research question was supported by two sub-questions that guided the study. The first sub-question examined the differences

in student scores as measured on the SOL assessment at the eighth grade level in mathematics prior to, during, and after the renovation process. The second sub-question examined the differences in student scores as measured on the SOL assessment at the eighth grade level in reading prior to, during, and after the renovation process.

Findings from the study indicated that a statistically significant relationship did not exist between the means of student scores when compared over the three stages of the renovation process, in mathematic and reading. A statistically significant relationship, however, was found when comparing the mean student scores in reading before and after the renovation process. Based on the reading findings, this study indicates that building conditions play a vital role on student achievement.

# Dedication

This dissertation is dedicated to my family who encouraged and supported me during the last three years, to finish what I started in 2009. To my wife, my best friend, for understanding the long nights and weekends without spending quality time together. While the days have been long to complete this dissertation, you understood my determination to complete this dissertation in a timely manner. It was because of your support and encouragement along the way that I was able to complete the dissertation in three years. To my mother, for your words of encouragement and reminding me to write clearly and concisely, thanks English teacher. To the late William E. Mayo, Sr., my father, while you may no longer be with us physically, I heard your voice during those late nights telling me that I could do it! I know you are smiling down on me! Thank you and I love each of you.

## Acknowledgement

I would like to thank each of the professors comprising my committee. Dr. Glen Earthman, my chair, for stressing to me that writing is a process. Thank you Dr. Earthman for the guidance and the numerous contacts you have provided to me during the last three years. To Dr. Cash, my advisor, for being available when I needed someone to talk to about my research study and various issues in education. To Dr. Twiford, for sending your encouraging emails of previous cohort members successfully completing all requirements for their doctoral degrees and the constant reminders to register for classes. To Dr. Thornton, for supporting me along the way and sharing strategies to ensure I fulfilled my goal of completing my degree in three years. Last but not least, my cohort members, especially the "*Four Horsemen"*, for the words of encouragement and support along the way.

# TABLE OF CONTENTS

## LIST OF FIGURES

## LIST OF TABLES

# Chapter 1

## Introduction

In 1995, the United States Government Accountability Office (GAO) did an extensive survey and analysis and found that America needed $113 billion ($216 billion in today's construction dollars) to bring its school building inventory into good repair (GAO, 1995). While the physical condition of school facilities continues to cause discussion at the local, state and federal levels, most of the monies spent on public school construction, $550 billion, from 1995 to 2007 went to building new schools and additions to meet the needs of increased enrollment in schools (21st Century School Fund, 2011). With a focus on new facilities, during this time period, a majority of the schools attended by school-aged children have been left neglected and/or minimal repair has been done to ensure the schools are able to remain open.

Through a detailed analysis of what school districts have spent on maintenance, repair, and capital renewals since 1995, the nation has not reduced its level of deferred maintenance (21st Century School Fund, 2011). To rehabilitate schools today, an astonishing $271 billion would be needed to address the deferred maintenance on America's schools (21st Century School Fund, 2011). While the federal government has made funds readily available through qualified construction bonds, many school districts, specifically, rural and urban school districts continue to need other sources of revenue to maintain existing school facilities.

In most cases, schools within the Commonwealth are in need of repair in urban, suburban, and rural areas. While many schools have undergone partial renovations over

the last fifty years, many of the schools lack modern heating, air and ventilation systems, plumbing, and energy efficient components such as windows, roofing, and proper lighting. By age 40, most buildings start deteriorating rapidly, even if all original equipment is replaced. Typical market forces suggest retiring schools after 40 years (Lyons, 2001). But their usage continues perpetuating crowded classrooms, outmoded designs, poor communication systems, limited technology, and inadequate security (Lyons, 2001).

Schools undergoing full or partial renovations over the years will generally include upgrades to lighting, air quality, size of classrooms, acoustics, heating, ventilation, and air conditioning (HVAC), and natural light enhancements. While renovations are becoming more popular based on the current state of the economy, the challenge of maintaining and/or increasing student achievement during a renovation project can sometimes become a difficult task. Variables such as increased noise, movement disruptions, and multiple classroom assignments can hinder student achievement during a complete or partial renovation project; therefore, a study needs to be conducted to see the relationship building condition plays on student achievement before, during, and after the renovation process.

## Statement of the Problem

With more school divisions looking at renovations as viable options instead of new construction, based on the current state of the economy, insight into the renovation process and the relationship with student achievement needs to be addressed more thoroughly. In those school systems that do renovate a school, the school is generally

fully operational during the process, and potential disruptions to the learning environment can occur.

## Research Questions

Building conditions and student achievement have been linked to having a relationship dating back to the 1960s. There have been many studies replicated in various settings/environments to show a relationship between the two variables. A limited amount of research is available on the effects of school renovations on student achievement. The main research question for this study is: Does the complete renovation process of a school building influence student achievement? This research question is supported by two sub-questions that will guide the study.

a. What difference, if any, is there in student scaled scores as measured by the Standards of Learning assessment at the eighth grade level in mathematics prior to, during, and after the renovation process?
b. What difference, if any, is there in student scaled scores as measured by the Standards of Learning assessment at the eighth grade level in reading prior to, during, and after the renovation process?

## Significance of the Study

This study will look closely at the possible influence the renovation of a school building might have upon student achievement at middle schools within the Commonwealth of Virginia. This particular study will examine student achievement in the areas of reading and mathematics prior to the renovation process, during the renovation, and after the renovation process. Data from this study will serve as a valuable resource for school divisions in determining the impact of the renovation

process on student achievement. This information could lead the school divisions to consider ways to minimize the effect of the stages of the renovation process on student achievement.

## Limitations of the Study

In this particular study, several limitations will exist based on noting a relationship between building conditions prior to, during, and after a renovation to student achievement. This study will include data from only completely renovated middle schools located in the Commonwealth of Virginia.

The first limitation could be the actual physical layout of the schools. Renovated schools in the Commonwealth of Virginia may be comprised of a campus style layout or contained in one enclosed structure. Various renovation factors may be exacerbated in a campus-style setting such as: noise, debris, and the presence of construction workers.

The second limitation is most renovations are comprised of cosmetic and structural changes to the school. Structural changes such as upgrades to the HVAC system, roofing, and enhancements to plumbing and electrical needs are not noticeable items. Cosmetic items such as new floor tile, new restroom fixtures, brighter lights, and variations in paint colors can change the attitudes of stakeholders, since such changes are visible; therefore, impact student learning.

The third limitation is a different cohort of students was reviewed for each year of the renovation process. This study did not look at cohorts of students, only students participating in the eighth grade Standards of Learning assessments in mathematics and reading.

The fourth limitation is the Virginia Department of Education only tracks the scores of students that participated on the online or paper/pencil assessments in regards to the mean scaled scores. Students taking alternate assessments such as the Virginia Grade Level Alternate Assessment (VGLA) and the Virginia Alternate Assessment Program (VAAP) are not calculated in the mean scaled scores used for this study.

The fifth limitation is since only students in eighth grade are studied; one must use caution when referencing this study as being the norm for all renovations that may take place in the Commonwealth of Virginia.

## Definition of Terms

The following terms are used throughout the study:

*Alternate Assessments*: Various assessments used to measure the achievement and progress of students with special needs. The Virginia Alternate Assessment Program (VAAP), an alternate assessment designed to evaluate the performance of students with significant cognitive disabilities and the Virginia Grade Level Alternative (VGLA) assessment, an alternate assessment available for certain Limited-English Proficiency (LEP) students and students with disabilities in grades 3 through 8, were not analyzed for this study.

*Campus-style School*: A school wherein learning occurs in several buildings separated by sidewalks and courtyards. Patrons are exposed to the various weather elements walking from one classroom to the next classroom.

*Deferred Maintenance*: The postponement of repairs to a later time period.

*Middle School*: A school wherein students in the following grading configurations are educated curriculum mandated by the Virginia Department of Education: grades 5-8, 6-8, or 7-8.

*Partial renovation*: The process of improving a structure, such as, a school. Only portions of the building (cosmetic and/or structural) are improved versus the entire the building.

*Complete Renovation*: "The process of improving the mechanical, structural, and/or the addition of educational space within a specific building. Key components would improve every mechanical and structural system, plus change spaces to accommodate newer educational programs" (Earthman, 1994, p. 10). The term renewal can be used interchangeably.

*Rehabilitation*: The completion of improvements, which normally would have been completed under a regularly funded maintenance program. The term is generally used to address maintenance items, which were left undone or deferred in previous years.

*Renovation*: The process of improving a structure, such as, a school. Key components such as lighting, heating, air and ventilation, and energy efficient materials are included in the process. For this study, any renovation covering the aforementioned components were deemed acceptable to study.

*Standards of Learning (SOL)*: An assessment given to all students within the Commonwealth of Virginia to determine the mastery of required curriculum for a specific subject. For this study, the author viewed mathematics and reading SOL Assessments in grade 8. Alternate assessments were reviewed for this study.

*Student Achievement*: The scaled scores of eighth grade students on the Standards of Learning Assessment.

## Theoretical Framework

Researchers have studied the relationship between school facilities and student achievement for approximately sixty years. While some researchers would argue the building itself plays a limited and/or no role at all in student achievement, enough studies have been conducted to note a relationship does exist between building conditions and student achievement. It is important to note the relationship that may exist as many students within the United States continue to be educated in buildings with deteriorating infrastructures.

Since 1993, many studies have used the theoretical model designed by Cash (1993) to explain the roles leadership and financial ability play on the work performed by the maintenance and custodial staffs on building conditions and student achievement. In Cash's (1993) model, noted on Figure 1.1, an emphasis was placed on student achievement and the quality of the school building. As indicated by Cash (1993), "the question of what brought the building to its current condition must be considered" (Cash, 1993, p. 5) when relating building conditions to student achievement. In the model, the leadership in place that ranks the conditions of school facilities high will provide the necessary resources to ensure buildings are maintained versus deferring maintenance projects.

While the financial ability of a school division plays a vital role in this model, the leadership in place must view providing the necessary resources as vital to the success of the school. With the current budgetary constraints faced by many school divisions,

rehabilitation efforts of deferred projects continue to increase, specifically, in school districts lacking capital outlay resources. School leaders must work with local elected officials as well as officials at the state level to ensure that school divisions have the financial ability to fund the needed projects in the many aging schools in the Commonwealth as well as America.

According to the model, ranking the condition of buildings high potentially "affects student achievement directly and indirectly" (Cash, 1993, p. 6). Factors that may influence student achievement directly are: lighting, air quality, sound/acoustics, color, space/density, and infrastructure. Indirect factors such as student attitudes can be influenced solely by the student; however, in most cases the attitudes of parents and faculty members will influence student achievement. The building's appearance in turn "could be viewed as an indication of the importance the leaders place on education" (Cash, 1993, p. 6). Schools that are well maintained send the message that education is important; wherein schools that are not maintained properly through routine cleaning and maintenance make stakeholders feel as though the condition of the building are not important, hence, student achievement can be affected.

For the purposes of this study, the portion of the model that focuses on the possible relationship between building condition and student achievement will be highlighted to see the possible influence of changing the building condition may or may not have on student achievement. Change perceived as positive by stakeholders can potentially result in enhanced student achievement wherein change perceived as negative by stakeholders can potentially result in decreased student achievement. The attitudes of all stakeholders can change during the renovation process based on poor planning,

accidental events, noise, debris, classroom relocation, which can affect student achievement at various phases of the renovation process.

## Organization of Study

Chapter 1 of this study introduces the reader to building facilities and student achievement. For this particular study, the topic of renovation is discussed at the middle school level in the Commonwealth of Virginia. The reader is provided content on school renovations. The statement of the problem, rationale of the study, and research questions were addressed, which served as the basis for the problem and why research on the topic of renovation was conducted. Chapter 2 presents the literature review, which focuses on the relationship of building conditions and student achievement. Chapter 3 explains the methodology used in the study. Chapter 4 includes the findings of the study including an explanation of the data collection and data analysis. Chapter 5 includes the summary of findings, discussion, conclusion, and implications for further research.

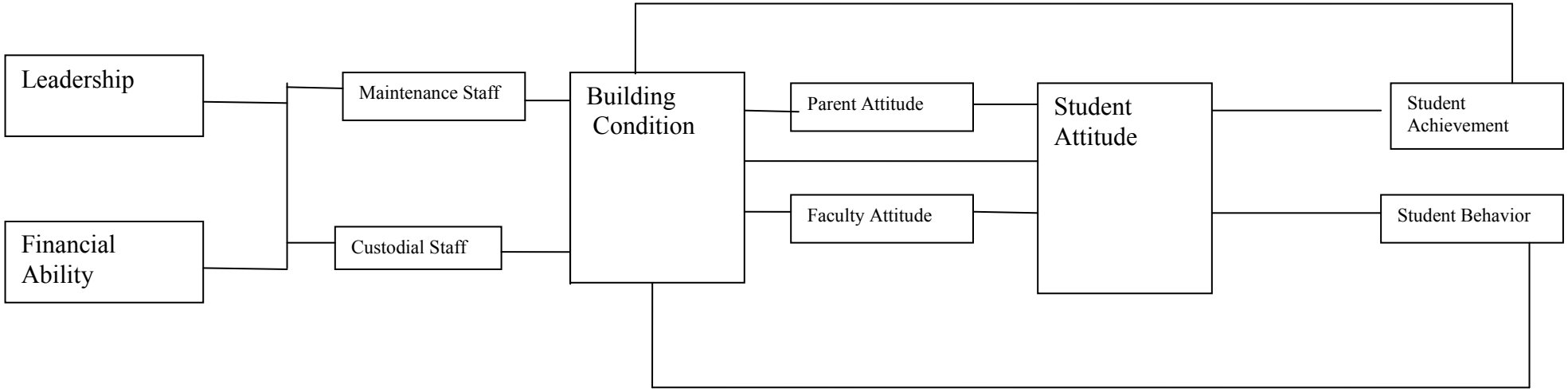


Figure 1.1: Theoretical model design on the relationship of school building conditions and student achievement and behavior.

From: School Building Conditions and Student Achievement and Behavior
(1993) Carol Cash. Unpublished dissertation. Virginia Polytechnic Institute and State University. Used with permission from Dr. Carol Cash.

# Chapter 2: Review of the Literature

## Introduction

Chapter two contains a review of the research that has focused on building conditions and student achievement. Studies on the relationship between building conditions and student achievement have been conducted in Washington, D.C., New York, North Dakota, Pennsylvania, and Virginia, to name a few places. While numerous studies have been conducted on the relationship between the two variables, there have been a limited number of studies looking at the influence the renovation process itself has on student achievement.

Reviewing the influence the renovation process has on student achievement is essential, for the National Center for Educational Statistics (NCES, 1999) noted in 1998, the average public school building was 42 years old (NCES, 1999). According to Ornstein (1994), once a school is 20 to 30 years old, frequent replacement of equipment is needed. Between 30 and 40 years old, the original equipment should have been replaced, including the roof and electrical equipment. After 40 years, a school building begins rapid deterioration, and after 60 years most schools are abandoned (Ornstein, 1994). With these statistics, school planning individuals need to know the ramifications of various building condition variables that could influence student learning.

Based on research, variables such as lighting, paint colors, air conditioning, air quality, acoustical enhancements, and temperature control can play a factor in student learning. All of the aforementioned variables comprise school facilities. Various research studies have indicated relationships between the variables and student

achievement. Cash (1993), Hines (1996), Earthman et al, (1995), and Crook (2006) all noted that the presence of sunlight and the types of classroom lighting have been linked to improved student performance. Jago and Tanner (1999) noted the thermal properties in the classrooms affected the ability of students to grasp instruction. King and Marans (1979) concluded that as temperature and humidity increased, achievement and task performance deteriorated, attention spans decreased, and students reported greater discomfort. Cooler classrooms created increased feelings of comfort, activity, and productivity.

There are numerous studies linking various building conditions to student achievement. While the topic has been researched for over sixty years, the topic is still one that is of interest to many educators. Regardless of how small the variance may account for in studies as it pertains to building conditions and student achievement, improving various components of a facility can alter the achievement levels of students.

## Analysis of Research Studies

### Building Conditions Impact on Student Achievement

Edwards (1992) studied the relationship between building conditions of public school buildings in Washington, D.C. and student achievement and parental involvement. Based on the deterioration of school facilities within the Washington, D.C. School System, she hypothesized that student achievement and parental involvement were affected by building conditions.

To test the hypothesis, a multiple regression analysis was conducted on the building conditions, student achievement and parental involvement. Buildings were rated based on the following criteria: poor, fair, or excellent using the District of Columbia

Committee on Public Education (COPE), a building assessment instrument used to rate the conditions of school buildings. The Comprehensive Test of Basic Skills (CTBS), for this particular study, measured student achievement. Findings from the study indicated that as schools improved in conditions from poor to fair, student achievement as measured by the CTBS improved on average of 5.5 percentage points and up to 10.9 percentage points from poor to excellent.

Cash (1993) examined the relationship between the building condition and student achievement and behavior at rural high schools in the Commonwealth of Virginia. In the 1993 study, Cash identified forty-seven high schools in the Commonwealth of Virginia as being rural. Of the 47 schools identified, 43 schools in the population responded. In the schools studied, there were fewer than 100 students in the senior class. The grade configuration of these high schools ranged from grades ten through twelve to kindergarten through grade twelve (Cash, 1993). The total student population ranged from 90 to 695, their high school student populations ranged from 41 to 547, and their senior class populations ranged from 12 to 99 (Cash, 1993).

Cash (1993) determined building condition for each school using the researcher developed building assessment instrument called the Commonwealth Assessment of Physical Environment (CAPE). Division personnel not assigned to the studied schools used the CAPE to answer objective questions concerning the condition of the school facility. The information gathered from the division personnel was used to categorize buildings as substandard, standard, and above standard. The schools with building condition scores in the bottom quartile were identified as substandard, in the two middle quartiles as standard, and schools with building condition scores in the upper quartile

were identified as above standard. The items in the CAPE were subdivided into cosmetic and structural items. There were ten cosmetic items looking at the cosmetic components of the building and sixteen structural items looking at building structure. Division personnel were asked to rate cosmetic items such as exterior/interior wall paint, exterior/interior paint cycle, floors swept, floors mopped, graffiti, and classroom furniture to name some items. Structural items rated by division personnel included building age, windows, flooring, heating, air conditioning, roof leaks, locker condition, and lighting to name a few structural items.

The student achievement was determined by using the means of the scaled scores from the Test of Academic Proficiency (TAP), during the 1991 – 1992 school year. Scores were obtained for mathematics, reading comprehension, written expression, information, basic composite, social studies, science and complete composite scores. The basic composite was an average of scores on the reading comprehension, mathematics, written expression, and using sources of information tests. "The complete composite was an average of scores for the social studies and science tests and the four tests that comprised the basic composite" (Cash, 1993, p. 33).

Student behavior was determined by the ratio of the number of expulsions, suspensions, and violence/substance abuse incidents to the number of students in each school. Student behavior was determined by using all students in high school grades during the 1991 – 1992 school year. The student behavior ratio was indicated as being a dependent variable in the study.

Socio-economic status (SES) was determined by the percentage of students qualifying for free or reduced meals to the number of students enrolled in the high school

during the 1991 – 1992 school year. SES was used as a covariate in the study to control achievement and behavior variances.

Data were analyzed using analysis of covariance (ANCOVA) to compare the adjusted means of schools with different building assessment ratings. The achievement means from the TAP were compared across the three building conditions: above standard, standard, and substandard. The composite total achievement means were also compared between the two cosmetic building conditions and structural building conditions. Behavior ratings means in each of the three areas were compared among the three building conditions using ANCOVA. A covariate of SES was used to adjust the achievement means and behavior rating means for students SES. Regression analysis was used to compare achievement score means to behavior rating means and achievement score means to age of building.

Cash found student achievement was higher in buildings with above standard ratings than student achievement in substandard school buildings on every subtest of the TAP. A steady increase in mathematics, sources, science and complete composite scores was noted when comparing the three building categories. There was no change between substandard buildings and standard buildings in reading comprehension, basic composite, and social studies. A decline was noted in written expression from substandard buildings to standard buildings. The largest increase in percentile rank from substandard buildings to above standard buildings was five percentile points in the science subtest.

Schools were divided into upper and lower scoring schools based on responses to the cosmetic items. The mean scale scores were higher in the above standard buildings in every subtest except for social studies. The students attending schools in the lower

scoring schools only had a higher mean in social studies, 50 percentile points compared to 48 percentile points in the upper scoring schools. Scores were almost identical for both lower and upper scoring schools on structural ratings; indicating student achievement was more directly related to cosmetic factors.

Cash noted increased incidents of student disciplinary actions in higher quality buildings. When analyzing cosmetic and structural subgroups, Cash noted higher ratios of incidents per student on the three behavior factors: suspensions, expulsions, and violence/substance abuse for cosmetic and higher ratios in the area of violence/substance abuse in better structural facilities. Violence/substance abuse noted a higher correlation among overall, structural, and cosmetic building conditions.

Earthman, Cash, and Van Berkum (1995) conducted a statewide study of high schools in North Dakota to investigate the relationship between student achievement and behavior and school building condition. The study used the theoretical construct and methodology from the Cash (1993) study to examine the relationship between building conditions and student achievement in a larger and more homogenous population. The selection of North Dakota was noted because of the high scoring of students on the Scholastic Achievement Test (SAT) and the relative homogeneity of the population of the state.

A modified version of Cash's Commonwealth Assessment of Physical Environment (CAPE), called the State Assessment of Facilities in Education (SAFE) was used to gather data on building conditions. The SAFE was divided into three categories: overall building conditions, cosmetic building conditions and structural building conditions. Of the 199 high schools in North Dakota at the time of the study, a response

was received from 120 school principals wherein they were asked to record the presence or absence of selected building conditions. The results of the survey were used to rank school buildings in one of three conditions: above standard (top 25 percent), standard (middle 50 percent), and below standard (bottom 25 percent). The three categories making up the SAFE coupled with the three building condition categories were used to compare the results of the Comprehensive Test of Basic Skills (CBTS) administered to eleventh grade students.

The findings were divided into three categories based on overall building conditions, cosmetic building conditions and structural building conditions compared to student achievement with all sections of the CTBS. In the overall building conditions category, students in schools rated as having above standard building conditions scored one to nine percentile points higher on all but two sections of the CTBS than students in the substandard buildings. In the area of mathematics students in the substandard buildings scored one percentile point higher than students in above standard buildings. There were no differences noted between above and substandard buildings on the social studies section of the CTBS. In the cosmetic building conditions category, students in above standard buildings scored one to eleven percentile points higher on all but one section of the CTBS compared to students in substandard buildings. There was no difference in the percentile points between the substandard and above standard buildings in language mechanics. The last category, structural building conditions, noted different results than the overall and cosmetic building conditions. Students in the above standard buildings scored one to eight percentile points higher than students in substandard building conditions in eight of the subtests on the CTBS. Students in substandard

buildings scored between three and twelve percentile points higher than students in the above standard buildings on four of the subtests (Math Comprehension, Math Concepts and Applications, Math Total, and Social Studies).

Hines (1996) replicated Cash's study by analyzing the relationship between building conditions and student achievement and behavior in urban high schools in the Commonwealth of Virginia. The study included a revised Commonwealth Assessment of Physical Environment (CAPE). The study included 88 urban high schools in the Commonwealth of Virginia identified as being urban with 66 responding for the study. The revised CAPE was adjusted "in an attempt to make it more applicable to an urban setting" (Hines, 1996, p. 36). Hines also modified the CAPE based on issues that arose during Cash's study such as: using scaled scores instead of percentiles and wording of the number of suspensions. Student achievement was determined by the scaled scores of students being assessed on the Test of Academic Proficiency (TAP) for the 1992 – 1993 school year. Scores were adjusted based on the percentage of students participating in the free or reduced meals program based on socio-economic status. An ANOVA was used to compare the adjusted means of achievement scores with the three building condition ratings (substandard, standard, above standard).

Hines (1996) noted an improvement of student scaled scores on every subtest of the TAP when substandard buildings were compared to above standard buildings. Hines indicated that when building conditions were analyzed separately, cosmetic or structural, improved cosmetic conditions were associated with increased mean scale scores on all subtests of TAP ranging in percentile differences of 3.00 – 4.26. The only exception was in the sub-test of *Sources of Information*, wherein no change was noted. When

comparing structural building conditions, student achievement mean scaled scores ranged in percentile differences of 4.72 – 6.27 on all subtests except *Sources*. "All other subtests were higher for schools with upper standard structural building ratings than with lower ratings" (Hines 1996, p. 77). Higher achievement scores were noted with newer buildings, buildings with more windows, and carpeting. The presence of air conditioning and recent exterior painting in school buildings also resulted in higher student scores. Higher achievement was noted at schools with more extracurricular facilities, schools mopped more frequently, wherein graffiti was removed expeditiously, and schools with lockers in good condition than schools that did not have these elements.

When comparing Hines' (1996) study to Cash's (1993) study, it was noted that scale scores and percentile ranks in urban schools were higher than rural schools regardless of the building conditions. Differences ranged from 4.65 to 7 percentile points higher for urban schools than rural schools in science. Standard urban schools scored higher than standard rural schools ranging in from 8.76 scale scores and 15 percentile points higher on mathematics subtest. Similar results were noted with the sources of information subtest (15 percentile points higher) in above standard urban schools and mathematics (19 percentile points higher) when compared to rural schools.

O'Sullivan (2006) compared student achievement scores and school building conditions in Pennsylvania high schools.

> Four hundred twenty-nine (429) high schools were the targeted population for the study with principals from two hundred one (201) schools needing to participate in the study to obtain results reflective of the target population and significant at the .05 level of confidence (O'Sullivan, 2006, p. 45).

The researcher used three years of assessment data based on Pennsylvania's statewide assessment – Pennsylvania System of School Assessment (PSSA) for mathematics, reading, and writing. SES was used as the covariant to account for the differences in student bodies.

The responses from the survey completed by high school principals were identified based on numerical values assigned to each question response. Assessment scores were measured based on a ranking from one of four categories – advanced, proficient, basic, and below basic. A simple mathematical formula of multiplication and division created the scaled score for student achievement. The use of the step-wise multiple regression compared the relationship between the dependent variable, PSSA scores, and the independent variables, overall building conditions, cosmetic and structural conditions.

The findings of the survey indicated that a majority of the schools in the study were at least 49 years old. A majority of the principals, eighty percent, indicated their buildings were satisfactory or outstanding condition.

> As the overall building conditions; the cosmetic building conditions or the structural building conditions in the high schools improved, there was an increase in academic achievement of students of up to 55 points on the PSSA reading assessment and up to 20 points on the PSSA mathematics assessment (O'Sullivan, 2006, p. 117).

Findings from the nine step-wise multiple regression analyses indicated negative and positive predictors of student achievement. "The control variable, the percentage of students participating in the free and reduced lunch program, was the most significant

predictor of student achievement on the PSSA writing, reading and mathematics exams" (O'Sullivan, 2006, p. 111). The socioeconomic status of students accounted for the greatest percentage of variance on test scores for writing, reading, and mathematics. The overall building conditions, cosmetic and structural building conditions attributed to 9.8% of the variance on the writing test, 21.5% on the reading assessment and 20.9% on the mathematics assessment. Facilities adjacent to schools indicated a significant influence on student achievement on the PSSA reading and mathematics exams. Schools adjacent to swimming pools accounted for 2.8% of the variance on the PSSA reading assessment when analyzing the overall building conditions and 4.7% of the variance on the mathematics assessment. Similar results were noted when analyzing structural building conditions with mathematics, 4.7% of the variance on the assessment, and reading, 3.9% of the variance on the assessment. Graffiti on exterior and interior walls was identified as having a relationship with student achievement on the PSSA reading (1.7% to 4.2% of the variance depending on location) and mathematics (1.9% of the variance) assessments when examining the overall and cosmetic building conditions. The interior painting cycle noted a relationship with student achievement on the PSSA writing assessment when overall, cosmetic, and structural conditions were analyzed. Lastly, O'Sullivan noted a relationship between building renovation/addition and student achievement on the PSSA mathematics assessment. The structural building conditions category accounted for 1.6% of the variance on the mathematics assessment.

Crook (2006) researched the relationship between building conditions of high schools in the Commonwealth of Virginia and student achievement on the SOL assessment in reading. Crook replicated the model used by Cash (1993) looking at

various building conditions (standard, and substandard) and student achievement using the CAPE. Crook analyzed the relationships between building conditions and student achievement looking at cosmetic and structural conditions.

One hundred forty-two high schools were indentified for the study and Crook studied 72 high schools based upon feedback from the 142 high schools in the Commonwealth of Virginia selected for the study. The schools were classified as being standard or substandard based on the principals' responses to the survey questions.

An ANCOVA was conducted looking at building conditions and student achievement. The researcher looked at specific cosmetic and structural variables such as wall color, noise, acoustics, lighting, classroom structure, building age, windows, flooring, and heat to see if such variables indicated a relationship between building conditions and student achievement.

The results of the study indicated that building conditions have a positive relationship with student achievement. Results noted significant differences between student scores in schools rated as standard versus substandard. Reading scores for students in standard buildings, 87.7%, was significantly higher than scores of students in substandard buildings, 81.1%. The percentage of students passing the Writing SOL in the standard buildings was 88.9% while 83.3% in substandard buildings. A variance of 6.6% was indicated between building conditions noting a significant effect on reading and writing scores.

When Crook analyzed specific cosmetic and structural variables, reading and writing scores once again were higher in better rated buildings than substandard rated buildings. The percentage of students passing the reading SOL in the standard buildings

was 89.5% and 82.8% in the substandard buildings. The percentage of students passing the Writing SOL was 87.9% in standard buildings whereas 80.9% of the students passed in the substandard buildings.

Bullock (2007) replicated Cash's 1993 study looking at building conditions and student achievement of middle schools in the Commonwealth of Virginia. At the time of the study there were 304 schools classified as middle schools. To focus the study on schools that taught eighth grade, it was determined that 191 schools taught eight grade during the 2005 – 2006 school year, of the school divisions that granted permission to participate in the study. Of the 191 schools eligible, 111, or 58 percent responded. As in Cash's study, the researcher looked specifically at the overall, cosmetic, and structural building conditions and the relationship such conditions influenced student achievement.

Bullock (2007) used an analysis of covariance (ANCOVA) to analyze student achievement, at the eighth grade level, to the various building conditions in the subjects of mathematics, reading, and science. Students scored higher on the mathematics (2.22 percent), reading (3.89 percent), and science (3.86 percent) SOL assessments attending schools rated as being standard versus students in substandard building conditions. Bullock also noted that female students performed better than male students on the mathematics and reading SOL assessments while a greater percentage of males performed better on the science SOL assessment at standard schools in comparison to students in substandard schools. When looking at all three components of the CAPE (overall, cosmetic, and structural), female students outperformed male students on the various assessments.

Cash's (1993) study has been replicated numerous times using the theoretical framework as well as the CAPE. While the theoretical framework and CAPE have been modified over the years, all researchers have indicated a relationship existed between building conditions and student achievement. The cosmetic and structural components studied by Cash and other researchers are generally key components of focus when renovating a school. Components such as building age, windows, flooring, heating, air and ventilation, lighting, paint color, painting cycle, and the condition of floors are all components addressed in total and partial renovation projects. Based on the research on the topic of building conditions and student achievement, an assumption can be made that building condition enhancements can lead to an increase in student achievement.

School Renovation Studies

Maxwell (1999) completed a case study within the Syracuse, New York, City School District (SCSD) on the before, during, and after effects of improving the quality of facilities and how it related to student achievement, at 21 elementary schools in the district. Maxwell evaluated the achievement scores of third and sixth graders in mathematics and reading, to see if any relationship existed between student performance before, during, and after the renovation process on the statewide assessments – Pupil Evaluation Program (PEP) assessments. Maxwell reviewed student assessment data from the PEP assessments five years before the renovation process to five years after the renovation process. Regression analysis in four areas was used to analyze the data: third and sixth grade math and reading PEP scores.

After conducting the analysis, three elementary schools, built around the same time period and covering approximately the same amount of square footage and design,

were studied using regression analysis in the same process as all elementary schools in the district. Assessment results from the PEP were plotted for five years before the renovations to five years after the renovations in the areas of math and reading for students in grades three through six.

The findings of studying all 21 elementary schools indicated that only the math scores showed a statistically significant correlation with the percentage of students attending renovated schools. The reading scores fluctuated from year to year with no apparent trend. The researcher indicated that "a relationship between newer facilities and math scores was established, but causation was not established" (Maxwell, pg. 5). The researcher noted the same results when three elementary schools were studied to get a better understand of the renovation process.

Tuttle (2002) provided a case study of the renovation of a rural middle school in the Commonwealth of Virginia. The case study provided insight on the planning and designing of a school renovation and the decision to renovate a building versus new construction. The researcher noted the cost implications of building new as well as the communities' "attachment" to the current facility. Like most renovations, students attended school during the renovation process, since space was not available within the county to move students during the process. It was noted that all stakeholders assumed student achievement would decline during the renovation process due to the magnitude of distractions such as: noise, debris, classroom movement, and presence of construction workers to name a few.

The findings of the study noted increased student achievement during the renovation process as well as after the renovation when compared to before the

renovation process. SOL scores in all content areas increased, with the exception of history, during the renovation and after the renovation. Writing scores went from 73.9% before the renovation to 75.5% during the renovation and 83.8% after the renovation process. Reading scores increased each year from 64.2% before, 68.3% during, and 87.2% after the renovation process. Mathematics scores increased each year from 67.3% before, 75.7% during, and 79.1% after the renovation process. History scores were 60.1% before, 48% during, and 66.9% after the renovation. Algebra scores increased each year from 85.7% before, 97% during, and 100% after the renovation process. The researcher attributed the increased levels of student achievement to good communication and limiting distracting renovation processes to before and after school hours. Factors such as quality of space, increased safety, increased space, technology enhancements, and increased attendance were noted as variables that could have possibly attributed to increased student achievement.

Berry (2002) conducted a case study on the renovation of Charles Young Elementary School in Washington, D.C. The purpose of the study was to capture the importance of restoring non-performing schools to a healthy state. "This particular study examined the importance of renovating a school to include general sanitation, good air quality, noise control, lighting and glare reduction, soothing color, and general comfort provided by temperature and climate" (Berry, 2002, p. 2). Berry indicated that the 1997 renovation of the elementary school illustrated how an aging city school could be revitalized to an improved school contributing to higher levels of educational performance. Prior to the renovation of Charles Young, the school was in disrepair and

student achievement suffered. The school was selected for renovation based on a 1995 Presidential directive to revitalize urban schools.

> The key objectives of the initiative were: 1. Turn a school building with acute indoor environmental problems into a model school environment; 2. Assess the resources required for such work; 3. Train school staff in the prevention of future indoor environmental quality problems and 4. Provide guidance to assist other schools in evaluating and correcting environmental problems based on the lessons learned in the remediation (Berry, 2002 pp. 9).

The renovation of the school noted gains in student achievement in mathematics and reading scores as measured by the Stanford 9. Each year since the 1997 renovation, standardized test scores indicated an increase in student mathematics and reading scores. The standardized test scores were based on the four *Performance Standards* for the Stanford 9 – advanced, proficient, basic, and below basic. Scores below basic indicated little or no mastery of knowledge and skills; basic, partial mastery; proficient, prepared for the next grade; and advanced, superior performance. Prior to the renovation in 1997, math scores below basic were 49 percentile points compared to 24 percentile points after the renovation process. Math scores basic or above were 51 percentile points prior to the renovation compared to 76 percentile points after the renovation process. Similar results were noted with reading scores prior to and after the renovation. Reading scores below basic prior to the renovation were 41 percentile points compared to 25 percentile points after the renovation whereas, reading scores basic or above prior to the renovation, 59 percentile points and 75 percentile points after the renovation. After the renovation,

Charles Young Elementary School had over half of the poorly performing students performing at the national average attainment levels of basic.

Shifflett (2010) investigated and reported on teacher perceptions during the renovation process. A study using quantitative data was conducted on two rural high schools in the Commonwealth of Virginia that underwent a complete renovation. Seventy-four teachers responded to survey questions related to school renovation, leadership, student achievement, and morale. A Likert scale that included the choices: strongly agree, agree, neutral, disagree, and strong disagree were used in the study. Data were examined using Pearson's product moment correlation coefficient as well as Cohen's *d*. The researcher used independent sample t-tests and one-way ANOVA to determine differences in teacher satisfaction, schools, or demographic variables.

Findings of the study noted teacher satisfaction was minimally affected by the renovation process, 59.5% neutral and only 4% dissatisfied.

> It was noted that the findings from the study may have been neutral due to the ambivalence by the teachers towards the renovation project, the amount of time between the end of the project and the collection of data, or the fact that the researcher was also the principal at one of the schools (Shifflet, 2010, p. 89).

Both male and female teachers felt satisfied during the renovation process; however, female teachers responded to survey questions with more dissatisfaction regarding safety, cleanliness, job satisfaction, and school rating. A difference in teacher satisfaction was indicated between the two schools studied, School A had 47% of the teachers satisfied during the renovation process compared to 28% at School B satisfied; however, a combined total of three teachers noted the renovation process as being dissatisfied. The

last finding was the satisfaction of teachers within specific age groups. The satisfaction of teachers in the 21 – 25 age group was significantly higher than the 26 – 35 age group. While the results of this particular study did not produce a large number of dissatisfaction responses to survey questions, it provided insight on teachers' perceptions of a school building during the renovation process. The areas of dissatisfaction included cleanliness of the school, teachers seeking a transfer to avoid another renovation project, teachers considering relocation during the project, and room temperatures. Findings were consistent with other research studies in these areas. "Cleanliness and academic achievement and behavior were found to have a relationship in the study by Cash (1993) and the review of research by Earthman and Lemasters (1998)" (Shifflett, 2010, p. 91).

The study by Sifflett (2010) was consistent with the Schneider (2003) study wherein the researcher found a relationship between cleanliness and satisfaction. Teachers expressing an interest in a transfer or relocating during a renovation project were consistent with findings in the Schneider (2003) study of Washington, D.C. and Chicago schools. Room temperature findings were similar to findings in the Cash (1993) study.

## Summary

The purpose of this chapter was to provide an understanding of studies that have noted a relationship between building conditions and student achievement. While the number of renovation studies on this topic is scarce, numerous studies have indicated student achievement increases when building conditions are rated favorably. Many of the studies reviewed noted the use of a building assessment instrument to rate building

conditions. In each case, when buildings were rated average or above average, student achievement scores were noted as being higher.

The purpose of a school renovation is to enhance and/or upgrade current buildings to a level more conducive to learning. The studies researched noted increases in student achievement in all educational settings: rural, urban, and suburban when building conditions were noted as being in good condition. Further research is needed on the relationship between building conditions and student achievement when looking at schools prior to, during, and after the renovation process.

# Chapter 3: Methodology

## Introduction

The purpose of this study was to look at the possible influence the renovation process has on student achievement as measured by student performance on the Standards of Learning (SOL), in the areas of mathematics and reading, at the eighth grade level, in the Commonwealth of Virginia. The scaled scores of mathematics and reading prior to, during, and after a complete renovation were used to make the comparisons.

This chapter explains the methodology of the research; provides a description of the population and the rationale used by the researcher in selecting the population. Data needs are discussed for the research along with a description of the instrument used to collect the data. The researcher also indicates procedures used for gathering and analyzing the data.

## Research Design

In quantitative research the goal is to determine the relationship between an independent variable and a dependent variable in a population. Quantitative research designs are either descriptive or experimental. In a descriptive study, no attempt is made to account for change of behavior or conditions; things are measured as they are. Descriptive research involves gathering data that describe events and then organizes, tabulates, depicts, and describes the data collection (AECT, 2001).

For purposes of this study a descriptive research methodology was used to determine the possible influences the renovation process had on student productivity. To conduct such research, Standards of Learning (SOL) test scores in the areas of

mathematics and reading, at the eighth grade level, from middle schools in the Commonwealth of Virginia for one year prior to the renovation process, during the renovation process, and one year after the renovation process were used depending on the complexity of the renovation, SOL test scores were collected from two to four years during the stages of the renovation process.

Demographic variables were used to ascertain if the composition of the student population in the schools remained the same over the period of time of the study. Variables such as ethnicity, socio-economic factors, and highly qualified teachers served as demographic variables in this study. The assumption was that the composition of the student body would not change over the period of the study; therefore, the students being assessed each year made up a similar composition of student body.

Since this study looked at the student achievement levels, as measured by the scaled scores of SOL assessments, during the stages of the renovation process, a descriptive study would best explain the relationship of this phenomena. Because descriptive research spans both quantitative and qualitative methodologies, it brings the ability to describe events in greater or less depth as needed, to focus on various elements of different research techniques, and to engage quantitative statistics to organize information in meaningful ways (AECT, 2001). The study warrants the ability to conduct further statistical procedures appropriate for the research questions based on the demographic variables analysis and the means of the scaled scores.

## Research Questions

The main research question for this study was: Does the complete renovation process of a school building influence student achievement? This research question was supported by two sub-questions that guided the study.

a. What difference, if any, is there in student scaled scores as measured by the SOL assessment at the eighth grade level in mathematics prior to, during, and after the renovation process?
b. What difference, if any, is there in student scaled scores as measured by the SOL assessment at the eighth grade level in reading prior to, during, and after the renovation process?

## Population

The population for this study was students in eighth grade, at middle schools within the Commonwealth of Virginia that underwent a complete renovation since 2004. Only complete renovation projects were included in the study since it involved a total overhaul of all structural and mechanical systems to the entire building. Complete renovations provide a total overhaul to a building all at one time wherein partial renovations may only include modifications to a portion of a building over a period of time. Such renovations require intensive planning prior to the process to ensure minimal distractions are noted to the learning process, movement of students away from a school location to temporary buildings and/or multiple classrooms during the process, noise distractions, and more accidental incidents of power outages and plumbing problems since it entails the entire building and not a portion of a building.

"A complete renovation is defined as the process of improving every mechanical and structural system and change spaces to accommodate newer educational programs" (Earthman, 1994, p. 10). All schools within the Commonwealth of Virginia are required to send documents, in accordance with the applicable regulations and requirements of the Board of Education and the Virginia Uniform Statewide Building, to the Architectural Consultants working within the Support Services Division of the Virginia Department of Education. School divisions are required to complete the *Energy and Facilities Cost Construction Data* form as well as a detailed description of the scope of the renovation project completed prior to the renovation process. Based on the narrative provided, either by the school division regarding the scope of work or the architectural consultants working for the VDOE, a listing of all middle schools meeting the criteria of having a complete renovation was compiled. For purposes of this study, all school divisions submitting paperwork pertaining to school renovations from 2004 – 2010 were reviewed. The Architectural Consultants track school projects by school plant number; school name; school division name; Literary Loan Number, if applicable; final login date, and control number. Of the 514 school projects logged from 2004 – 2010, 75 schools were middle schools. Of the 75 middle schools, only 10 middle schools met the criteria as being a complete renovation. All other middle schools were noted as partial renovations, the process of improving a structure wherein only portions of the building are improved versus the entire building; therefore, were excluded from this study.

Middle schools were selected since all students are required to take a mathematics and reading SOL assessment at the end of the eighth grade year. High schools would have been more difficult to study since not all students participate in mathematics and

reading each year and/or the varying degrees of mathematics courses and the grouping of students from multiple grade levels to take specific end of course SOL assessments. With students from multiple grade levels having the opportunity to take the assessments more than one time during a school year, based on assessment scores, through the expedited retake process, more extraneous variables may have been prevalent at the high school level.

To be considered for the study, the renovation process needed to have a completion year of Summer 2010. This completion timeframe permitted using data up to the Spring of 2011, one year after the renovation process. The year 2004 was selected since the SOL assessments for mathematics changed in 2001, reflecting new standards being assessed at the eighth grade level and the reading standards changed in 2002.

### Data Needed

To help control for uniformity, student scaled scores were based on the same SOL curriculum framework within a time period. Since this study examined scores over a period of time, a comparison of the same assessment type was essential. Looking at middle schools renovation prior to 2004 would have potentially required analyzing assessment data that tested students on two different versions of the mathematics or reading SOL assessment. The population of middle schools fitting the aforementioned criteria were reviewed by searching the Virginia Department of Education's website, www.doe.virginia.gov.

The demographic data used for this study were the following: percentage of minority students, percentage of socio-economic status, and the percentage of highly qualified teachers. These data consisted of the following:

Minority Students

The percentage of the total number of minority students was determined by the following groups: (1) Hispanic/Latino, (2) American Indian or Alaska Native, (3) Asian, (4) Black or African American, (5) Native Hawaiian or Other Pacific Islander, and (6) Two or More Races, for prior to, during, and after the renovation.

Socio-economic Status

Socio-economic status was determined by the percentage of students participating in the free or reduced meals program, receiving Temporary Assistance for Needy Families (TANF) or receiving Medicaid.

Highly Qualified Teachers

The percentage of highly qualified teachers was identified for each school during the renovation process.

Student Scores

In this particular study the means of the student scores in reading and mathematics for each school Standards of Learning (SOL) assessments were used to measure student achievement. Mathematics and reading scores were used from the 2003 – 2004 to 2010 – 2011 school years.

## Data Gathering

Two types of data were collected: (1) demographic variables (minority students, socio-economic status, and highly qualified teachers) and (2) student scaled scores.

To identify schools having a renovation from 2004 to 2010, the Virginia Department of Education's website, www.doe.virginia.gov, provided the identity of the schools contracted for renovations during a specific year. A listing of all schools

receiving renovations and/or additions was retrieved by clicking on the *Student & School Support* tab from the VDOE website. After clicking on the tab, *Facility Construction & Maintenance* provided a link to the tab *School Construction Projects*. Once on the *School Construction Projects* page, a link to *School Construction Cost Data* provided access to all facility construction costs from the 1999-2000 school year to the 2009-10 school year. From the *School Construction Cost Data* link, the section entitled *Selected Addition and Renovation Projects Under Contract in Fiscal Year 20XX-XX* provided information on the name of the school, school division, contract award date for the renovation, construction cost, total square feet, and the total cost per square foot. Since the table provided a listing of elementary, middle, and high schools, all middle schools were further reviewed by reviewing the contact logs collected by the Architectural Consultants and the scope of work, from the VDOE Department of Support Services, to determine if the renovations were partial or complete based on the definition of a complete renovation.

The researcher reviewed all 75 middle schools noted as having a renovation by visiting the Virginia Department of Education. After reviewing each of the school files, all schools meeting the definition of a complete renovation were further reviewed to ascertain additional information on the project. An email was sent to the school divisions involved in the study asking the following questions (Appendix A):

1. Based on the definition of a complete renovation noted above, please describe the scope of the work for the renovation of School X (Example: replacement of HVAC mechanical system, plumbing system, electrical system, new floor finishes, windows, painting, etc).

2. What was the inception date for the renovation project? End date?

In the event the school divisions did not respond to the email, the researcher contacted the general contractor and/or the architectural firm completing the project. Of the 10 schools meeting the definition of a complete renovation, the researcher received responses for all 10 schools. Once the dates of the actual renovation process were gathered, the demographic variables were collected by visiting the Virginia Department of Education's website. The number of minorities and socio-economic status was gathered from the *Fall Membership Reports*. The researcher used the Fall Membership of each school for information pertaining to the percentage of minorities and the socio-economic status. Once the researcher gathered the number of minorities and the socio-economic status of students, information was converted into a percentage. The percentage of highly qualified teachers was gathered by visiting each school's *Report Card*.

Mean scaled scores for eighth grade students in Mathematics 8 and Reading 8 for each school identified for the study were requested from the VDOE. The VDOE compiled the mean scaled scores for each school during the renovation process as well as the state averages. For purposes of this study, only eighth graders taking the Mathematics 8 or Reading 8 SOL assessment were included; therefore, eighth graders taking advanced mathematics courses such as Algebra I or Geometry as well as sixth or seventh graders taking Mathematics 8 were excluded.

Information collected for demographic variables and the scaled scores was keyed into an Excel document. Once all information was keyed into an Excel document, the

researcher transferred these data into Statistical Package for Social Sciences (SPSS) software application for data disaggregation.

## Data Analysis

To analyze the data, the demographic variables (percentage of socio-economic status, percentage of minority students, and the percentage of highly qualified teachers) and the results of school means of the scaled student scores on the SOL assessments in mathematics and reading were used one year prior to, during, and one year after the renovation process.

In order to conduct this particular study, the demographic variables were compiled in table format combining all schools and each school separately to identify any changes during the study. The assumption was that minimal change, if any, would be noted in the demographic variables. The schools identified for the study would presumably be located in stable communities in various geographic regions of the Commonwealth of Virginia resulting in assumed minimal deviation of change in the variable of minority groups, socio-economic status, and the highly qualified status of teachers. For each demographic variable, specific variables were compared at the pre-renovation years to the renovation years and the renovation years to the post-renovation years to determine if there was a significant difference between the environments.

After finding the mean amount of the demographic variables, an Analysis of Variance (ANOVA) was conducted to compare the stages of the renovation to the demographic variables. The purpose of the ANOVA was to determine if the demographic variables had any statistical significance between the three stages of the

renovation. As indicated, the assumption was that a difference would not be noted over the course of the renovation process.

To analyze the means of the scaled scores for each school, an ANOVA was performed and compared for the stages of the renovation process. An ANOVA was used to test the differences in means for statistical significance for each stage of the renovation process. To analyze the variance, the total variance due to error and the variance due to the differences between the means were analyzed. The means of the renovation years were compared to both the pre-renovation and post-renovation years to see if there was a significant difference.

Additional testing was conducted on the pre-renovation stage and the post-renovation stage using a *t* test. The *t* test was conducted on the mean scaled scores for mathematics and reading for only the pre and post stages of the renovation process. The results of the *t* test were used to assess whether the means of pre and post-renovation stages were statistically different from each other.

Statistical Package for Social Sciences (SPSS) software was used to conduct the statistical analysis for this study. Analyses were conducted to accept or reject the null hypothesis. The null hypothesis in this study would indicate that no statistical differences would be noted regarding student achievement prior to, during, or after the renovation process. In the event the data (prior to, during, and after) are not of statistical significance, the alternative hypothesis that the various renovation factors do indeed play a role in student achievement will be rejected.

The 1 x 3 ANOVA was run to test whether the means of the scaled scores prior to, during, and after the renovation process were equal. Using SPSS, the F ratio assisted in

determining if one should accept or reject the null hypothesis. Using the F ratio, the variance between subjects was divided by the variance expected due to chance. The outcome of the analysis resulted in two possible explanations for the differences that occur between groups, if statistically significant: (1) differences due to the treatment effect (stage in the renovation process) or (2) the differences will be due to chance. An alpha level of .05 was used for all statistical tests and the effect size was calculated by using *r*. If alpha was less than .05, there would be a statistical significance of the various stages of the renovation process on student achievement. If alpha was greater than .05, there would not be a statistical significance of the various stages of the renovation process on student achievement.

After running the 1 x 3 ANOVA, a *t* test was run on the pre-renovation stage and the post-renovation stage to determine if the building condition played a role in student achievement. The renovation stages of the stages of the renovation process were not tested using the *t* test. The *t* test was run to determine if any statistical significant relationship existed between the building conditions and student achievement.

## Summary

The purpose of this chapter was to identify the methodology for the study. The chapter provided a description of the population and the rationale for the selection of the proposed schools. Additionally, the research design, data needed, and data analysis procedures were identified.

# Chapter 4: Findings

## Introduction

This study looked at the possible influence the renovation of a school building had upon student productivity at middle schools within the Commonwealth of Virginia. Student achievement in the areas of mathematics and reading were examined prior to the renovation, during the renovation, and after the renovation process. Data from this study will serve as a valuable resource for school divisions in determining the impact of the renovation process on student achievement.

## Procedures

After receiving IRB approval, information was gathered on the 75 middle schools identified as being renovated, 10 middle schools were identified as being complete renovations (Appendix C). An email was sent December 7, 2011, to the facilities contact person for each of the school divisions with schools identified to study. The main purpose of the email was to determine the time period of the renovation process. Information gathered from the emails allowed the collection of data one year prior to the renovation, during the renovation, and one year after the renovation process. To ensure a 100% response rate, data from general contractors and/or architectural firms were gathered in the event the school division did not respond to the questions outlined in the email, to receive the substantial completion date of the project.

A request was made to the VDOE for the mean scaled scores for the 10 schools identified as having complete renovations from the 2003 – 2004 to 2010 – 2011 school years (Appendix B). Data on the demographic variables were gathered by navigating the

Virginia Department of Education's website. On January 12, 2012, the means of the scaled scores for Mathematics 8 and Reading 8 SOL assessments were provided from the VDOE.

Data were organized in an Excel document and then imported into SPSS for statistical analysis to determine the means and standard deviations of the demographic variables for the three stages of the renovation process: (1) pre, (2) during, (3) post. After finding the descriptive statistics for the renovation stages, the 1 x 3 ANOVA was conducted to determine the statistical difference, if any, between the variables and the renovation stages. The same procedures were followed relating to the means of the scaled scores in mathematics and reading during the renovation stages. The means of the scaled scores for the renovation stages were also compared to the state averages during the same time period. A *t* test was conducted on the pre-renovation and post-renovation stages to determine the statistical difference, if any between the two stages and student achievement.

While only 10 schools were studied, the *n* value for the renovation included the number of schools plus the number of years. Of the 10 schools studied, two schools had a renovation period of four years, one school had a renovation period of three years, six schools had a renovation period of two years, and one school had a renovation period of one year. Based on the multiple years to renovate each school, the means of the scaled scores in mathematics and reading were used to calculate the means during the renovation years. In most cases, each school had renovation periods that occurred over a period of multiple years. Based on the renovation period encompassing multiple years, the sample size for the renovation period was larger than the pre-renovation and post-

renovation periods since the study reviewed the mean scaled scores one year prior and one year after the renovation process. Table 4.1 illustrates how the sample sizes were generated when analyzing the sample sizes for the renovation stages for the 10 schools.

Table 4.1 *Summary of Schools and Renovation Stages by Year*

| School | 2003-04 | 2004-05 | 2005-06 | 2006-07 | 2007-08 | 2008-09 | 2009-10 | 2010-11 |
|---|---|---|---|---|---|---|---|---|
| A | Pre-Renovation | Renovation | Renovation | Post-Renovation | | | | |
| B | | Pre-Renovation | Renovation | Renovation | Renovation | Post-Renovation | | |
| C | Pre-Renovation | Renovation | Renovation | Post-Renovation | | | | |
| D | | Pre-Renovation | Renovation | Renovation | Post-Renovation | | | |
| E | | Pre-Renovation | Renovation | Renovation | Post-Renovation | | | |
| F | | Pre-Renovation | Renovation | Renovation | Post-Renovation | | | |
| G | | Pre-Renovation | Renovation | Renovation | Post-Renovation | | | |
| H | | Pre-Renovation | Renovation | Renovation | Renovation | Renovation | Post-Renovation | |
| I | | | | Pre-Renovation | Renovation | Post-Renovation | | |
| J | | | | | Pre-Renovation | Renovation | Renovation | Post-Renovation |

## Demographic Variables

In order to see if key demographic variables changed during the renovation process, the means of selected demographic variables were analyzed for each stage of the renovation process. Of the 10 middle schools that met the criteria of being a complete renovation, two schools had a pre-renovation school year of 2003 – 2004, six schools had a pre-renovation school year of 2004 – 2005, one school had a pre-renovation school year of 2006 – 2007 and one school had a pre-renovation school year of 2007 – 2008 respectively.

As for the renovation years, a total of two schools were under renovation during the 2004 – 2005 school year, eight schools during the 2005 – 2006 school year, seven schools during the 2006 – 2007 school year, four schools during the 2007 – 2008 school year, two schools during the 2008 – 2009 school year, and one school during the 2009 – 2010 school year. The post-renovation included one school for the 2006 – 2007 school year, four schools for the 2007 – 2008 school year, three schools for the 2008 – 2009 school year, and one school for the 2009 – 2010 and 2010 2011 school years.

It was hypothesized that the demographic variables would only vary slightly during the renovation process; therefore, the population studied would be made of a similar composition of student body each year. From looking at the means of the key demographic variables, only minimal changes were noted in the pre-renovation, renovation, and post-renovation time period. Table 4.2 illustrates the means and standard deviations of the demographic variables and the renovation stages. The mean of the percentage of minorities was 48.31% during the pre-renovation with a standard deviation

of 30.34 ($M$ = 48.31, $SD$ = 30.34), 52.70% during the renovation, with a standard deviation of 27.45 ($M$ = 52.70, $SD$ = 27.45) and 50.75% during the post-renovation with a standard deviation of 29.56 ($M$ = 50.75, $SD$ = 29.56). The mean of the percentage of socio-economic status of students was 38.54% during the pre-renovation with a standard deviation of 14.51 ($M$ = 38.54, $SD$ = 14.51), 41.27% during the renovation with a standard deviation of 13.50 ($M$ = 41.27, $SD$ = 13.50), and 43.84% during the post-renovation with a standard deviation of 12.73 ($M$ = 43.84, $SD$ = 12.73). The mean of the percentage of highly qualified teachers was 93.3% during the pre-renovation with a standard deviation of 7.48 ($M$ = 93.3, $SD$ = 7.48), 97.21% during the renovation with a standard deviation of 4.52 ($M$ = 97.21, $SD$ = 4.52), and 97.9% during the post-renovation with a standard deviation of 4.04 ($M$ = 97.9, $SD$ = 4.04).

Table 4.2

*Mean Amount of Demographic Variables by Renovation Stage (N=10 schools)*

| | Pre-renovation (n=10) | | Renovation (n=24)* | | Post-Renovation (n=10) | |
|---|---|---|---|---|---|---|
| Measure | *M* | *SD* | *M* | *SD* | *M* | *SD* |
| 1. % of Minorities | 48.31 | 30.34 | 52.70 | 27.45 | 50.75 | 29.56 |
| 2. % SES | 38.54 | 14.51 | 41.27 | 13.50 | 43.84 | 12.73 |
| 3. % Highly Qualified | 93.30 | 7.48 | 97.21 | 4.52 | 97.90 | 4.04 |

**Renovation N = 24 instead of 10 because renovation = # schools plus # years.*

A further review of the demographic variables by year indicated the same results from the stages of the renovation process. Table 4.3 illustrates the means of the demographic variables by the renovation stages for 2003 – 2005 school years. During the

2003 – 2004 school year, two schools were analyzed and the mean of the percentage of minorities was 47.1%, percentage of socio-economic status of students was 42.75%, and the percentage of highly qualified teachers was 94.5%. During the 2004 – 2005 school year, eight schools were analyzed and the mean of the percentage of minorities was 38.94%, socio-economic status of students was 35.05%, and highly qualified teachers was 97%. During the 2005 – 2006 school year, eight schools were analyzed and the mean of the percentage of minorities was 40%, socio-economic status of students was 37.39%, and highly qualified teachers was 96.38%.

Table 4.3

*Mean Amount of Demographic Variables by Year (2003-2006)*

| | 2003-04 (n=2) | | 2004-05 (n = 8) | | 2005-06 (n=8) | |
|---|---|---|---|---|---|---|
| Measure | *M* | *SD* | *M* | *SD* | *M* | *SD* |
| 1. % of Minorities | 47.10 | 25.55 | 38.94 | 24.67 | 40.00 | 24.72 |
| 2. % SES | 42.75 | 6.22 | 35.05 | 13.00 | 37.39 | 14.38 |
| 3. % Highly Qualified | 94.50 | 7.78 | 97.00 | 2.83 | 96.38 | 3.54 |

Table 4.4 illustrates the means of the demographic variables by the renovation stages for the 2006 – 2008 school years. During the 2006 – 2007 school year, nine schools were analyzed and the percentage of minorities was 45.67%, socio-economic status of students was 41.86%, and highly qualified teachers was 96.33%. During the 2007 – 2008 school year, nine schools were analyzed and the percentage of minorities was 53.20%, socio-economic status of students was 42.89%, and highly qualified

teachers was 95.44%. During the 2008 – 2009 school year, five schools were analyzed and the percentage of minorities was 75.07%, socio-economic status of students was 46.12%, and highly qualified teachers was 96.6%.

Table 4.4

*Mean Amount of Demographic Variables by Year (2006-2009)*

| | 2006-07 (n=9) | | 2007-08 (n=9) | | 2008-09 (n=5) | |
|---|---|---|---|---|---|---|
| Measure | *M* | *SD* | *M* | *SD* | *M* | *SD* |
| 1. % of Minorities | 45.67 | 26.65 | 53.20 | 32.06 | 75.07 | 13.68 |
| 2. % SES | 41.86 | 14.54 | 42.89 | 14.10 | 46.12 | 13.51 |
| 3. % Highly Qualified | 96.33 | 7.73 | 95.44 | 6.97 | 96.60 | 5.64 |

Table 4.5 illustrates the means of the demographic variables by the renovation stages for the 2009 – 2010 school years. During the 2009 – 2010 school year, two schools were analyzed and the percentage of minorities was 85.19%, socio-economic status of students was 49.62%, and highly qualified teachers was 100%. During the 2010 – 2011 school year, one school was analyzed and the percentage of minorities was 94.12%, socio-economic status of students was 56.62%, and highly qualified teachers was 100%. The school analyzed for the 2010 – 2011school year did not have a standard deviation since the sample size only included one school. In order to generate a standard deviation, the sample size must be greater than one since the definition of a standard deviation involves dividing by the degree of freedom, which is equal to the number of

entries minus one. During school year 2010 – 2011, the number of entries minus one would equal zero; therefore, a sample size of one cannot generate a standard deviation.

Table 4.5

*Mean Amount of Demographic Variables by Year (2009-2011)*

| | 2009-10 (n=2) | | 2010-11 (n=1) | |
|---|---|---|---|---|
| Measure | *M* | *SD* | *M* | *SD** |
| 1. % of Minorities | 85.19 | 15.08 | 94.12 | . |
| 2. % SES | 49.62 | 7.21 | 56.62 | . |
| 3. % Highly Qualified | 100.00 | 0.00 | 100.00 | . |

**No standard deviation because N=1.*

Tables 4.2 – 4.5 showed only the means and standard deviations of the demographic variables for all schools identified for the study by the renovation stages. During school years 2003 – 2004, 2009 – 2010, and 2010 – 2011, the sample sizes ranged from one to two schools. As a result of the small sample size, the demographic variables indicated a range of means when compared to years wherein the sample size was larger. The smaller sample sizes were more of a representation of specific schools rather than a composite means of all schools studied. When looking at the 2009 – 2010 and 2010 – 2011 school years, it was evident that the schools had a greater percentage of minorities as well as socio-economic status of students.

The 10 schools studied captured a diverse group of schools within a majority of the geographic regions of the Commonwealth of Virginia. In order to see the difference between means against the variability within the sample, the 1 x 3 ANOVA was

conducted to see if changes in demographic variables occurred during stages of the renovation. Each demographic variable was compared to the pre-renovation, renovation, and post-renovation. There was not a significant difference between the demographic variables and the renovation stages at the $p < .05$ level for the three conditions.

Table 4.6 illustrates a summary of the 1 x 3 ANOVA for the stages of renovation and demographic variables. The percentage of minorities were not statistically significant over the renovation stages at the $p < .05$ level for the three conditions $F(2,41) = 0.085$, $p = 0.918$. The percentage of socio-economic status of students were not statistically significant over the renovation stages at the $p < .05$ level for the three conditions $F(2,41) = 0.382$, $p = 0.685$. The percentage of highly qualified teachers were not statistically significant over the renovation stages at the $p < .05$ level for the three conditions $F(2,41) = 2.451$, $p = 0.099$.

Table 4.6

*Summary of 1 x 3 ANOVA for Stages of Renovation vs. Demographic Variables*

| Source | Sum of Squares | df | Mean Square | F |
|---|---|---|---|---|
| % Minorities | | | | |
| Factor | 139.312 | 2 | 69.656 | .085 |
| Within Groups (Error) | 33,483.772 | 41 | 816.677 | |
| Total | 33,623.084 | 43 | | |
| % SES | | | | |
| Factor | 140.744 | 2 | 70.372 | .382 |
| Within Groups (Error) | 7,545.626 | 41 | 184.040 | |
| Total | 7,686.370 | 43 | | |
| % Highly Qualified | | | | |
| Factor | 134.019 | 2 | 67.009 | 2.451 |
| Within Groups (Error) | 1,120.958 | 41 | 27.340 | |
| Total | 1,254.977 | 43 | | |

*p < 0.05

Because there were no statistically significant differences among the demographic variables between the three stages of the renovation, the demographic variables did not have any influence upon the means of the scaled scores in mathematics or reading. The assumption that the demographic variables would remain relatively stable during the renovation stages was validated with the results of the 1 x 3 ANOVA.

### Means of Scaled Scores

The same procedures used to calculate the means, standard deviations, and the 1 x 3 ANOVA for the demographic variables were used to analyze the means of the scaled scores for the renovation stages. The results of the analysis of the means of the scaled scores were used to answer the two sub-research questions of the study:

a. What difference, if any, is there in student scaled scores as measured by the SOL assessment at the eighth grade level in mathematics prior to, during, and after the renovation process?
b. What difference, if any, is there in student scaled scores as measured by the SOL assessment at the eighth grade level in reading prior to, during, and after the renovation process?

The means of the scaled scores for each of the renovation stages were generated by taking the mean scaled scores in mathematics and reading separately for each stage of the renovation process and calculating the average. As indicated in the Table 4.1, the means of mathematics and reading were calculated by adding all of the mean scaled scores for mathematics and reading separately for each of the renovation stages and dividing by the sample size for the renovation stage. For the pre-renovation stage, the sample size included the total number of schools in the study, 10 schools, the renovation

stage included a sample size of 24 since each school had a different number of total renovation years, and the post-renovation stage included a sample size of 10 schools.

Sub-research Question 1: What difference, if any, is there in student scaled scores as measured by the SOL assessment at the eighth grade level in mathematics prior to, during, and after the renovation process?

Table 4.7 illustrates the mean scaled scores for the renovation stages for the 10 schools. The pre-renovation stage included a sample size of 10, the renovation stage included a sample size of 24, and the post-renovation stage included a sample size of 10. The mean score of the mathematics scores during the pre-renovation was 451.12 with a standard deviation of 23.56 ($M = 451.12$, $SD = 23.56$). The mean score during the renovation was 451.82 with a standard deviation of 24.84 ($M = 451.82$, $SD = 24.84$). The post-renovation mean score was 458.05 with a standard deviation of 47.03 ($M = 458.05$, $SD = 47.03$).

Table 4.7

*Mean Amount of Math Scaled Scores by Renovation Stage (N = 10 schools)*

| | Pre-renovation (n=10) | | Renovation (n=24)* | | Post-Renovation (n=10) | |
|---|---|---|---|---|---|---|
| Measure | *M* | *SD* | *M* | *SD* | *M* | *SD* |
| 1. Math Scaled Score | 451.12 | 23.56 | 451.82 | 24.84 | 458.05 | 47.03 |

The 1 x 3 ANOVA was conducted to see if the stages of the renovation process impacted student achievement on the Mathematics 8 SOL assessment administered to eighth grade students. Based on the results of the analysis, no statistically significant

difference was noted between the renovation stages on math scaled scores $F(2,41) = .169$, $p = 0.845$. Table 4.8 illustrates the results of the ANOVA indicating that student achievement in the area of mathematics, as measured by scaled scores, is not different across schools at different stages of renovation process.

Table 4.8

*Summary of 1 x 3 ANOVA for Stages of Renovation vs. Math Scaled Scores*

| Source | Sum of Squares | df | Mean Square | F |
|---|---|---|---|---|
| Factor | 323.014 | 2 | 161.507 | .169 |
| Within Groups (Error) | 39,092.350 | 41 | 953.472 | |
| Total | 39,415.364 | 43 | | |

Sub-research Question 2: What difference, if any, is there in student scaled scores as measured by the SOL assessment at the eighth grade level in reading prior to, during, and after the renovation process?

Table 4.9 illustrates the mean scaled scores for the renovation stages for the 10 schools. The pre-renovation stage included a sample size of 10, the renovation stage included a sample size of 24, and the post-renovation stage included a sample size of 10. The mean score of the reading scores during the pre-renovation was 446.14 with a standard deviation of 17.45 ($M = 446.14$, $SD = 17.45$). The mean score during the renovation was 457.85 with a standard deviation of 18.37 ($M = 457.85$, $SD = 18.37$). The post-renovation mean score was 466.46 with a standard deviation of 20.17 ($M = 466.46$, $SD = 20.17$).

Table 4.9

*Mean Amount of Reading Scaled Scores by Renovation Stage (N = 10 schools)*

| | Pre-renovation (n=10) | | Renovation (n=24)* | | Post-Renovation (n=10) | |
|---|---|---|---|---|---|---|
| Measure | *M* | *SD* | *M* | *SD* | *M* | *SD* |
| 1. Reading Scaled Score | 446.14 | 17.45 | 457.85 | 18.37 | 466.46 | 20.17 |

The 1 x 3 ANOVA was conducted to see if the stages of the renovation process impacted student achievement on the Reading 8 SOL assessment administered to eighth grade students. Based on the results of the analysis, no statistically significant difference was noted between the renovation stages on reading scaled scores $F(2,41) = 3.028$, $p = 0.059$. Although results did not indicated a statistically significant difference between the renovation stages on reading scores, $p = 0.059$ indicates some significance between the variables. When looking at the pre-renovation years and the post-renovation years the difference between the mean scaled scores was 20.32 points; however, when looking at the pre-renovation years and renovation years the difference was only 11.71 points. The difference between the renovation and post-renovation years was 8.61 points, indicating a greater increase in student achievement when comparing the pre-renovation years to the post-renovation years. Based on the sample size of the population studied, standards of error will be larger, as indicated in this study. With a larger sample size, a difference may have been noted between the renovation stages on the reading scores when looking at the pre-renovation years and post renovation years. Table 4.10 illustrates the results of

the ANOVA indicating that student achievement in the area of reading, as measured by scaled scores, is not different across schools at different stages of the renovation process.

Table 4.10

*Summary of 1 x 3 ANOVA for Stages of Renovation vs. Reading Scaled Scores*

| Source | Sum of Squares | df | Mean Square | F |
|---|---|---|---|---|
| Factor | 2,091.281 | 2 | 1,045.640 | 3.028 |
| Within Groups (Error) | 14,158.380 | 41 | 345.326 | |
| Total | 16,249.661 | 43 | | |

Based on the results of the ANOVA for the mathematics and reading scaled scores, the null hypothesis that the renovation process has no impact on student achievement cannot be rejected when $p > .05$.

After running the ANOVA on the renovation stages to determine if an impacted existed with mathematics and reading mean scaled scores, a *t* test was run on the pre-renovation and post-renovation stages for the mean scaled scores for mathematics and reading. The results of the *t* test on the mathematics mean scaled scores did not indicate a statistically significant impact on student achievement when comparing the pre-renovation stages to the post-renovation stages $t(18) = 0.4166$, $p = 0.682$. The results of the *t* test on the reading mean scaled scores did indicate a statistically significant impact on student achievement when comparing the pre-renovation stages to the post-renovation stages $t(18) = 2.4093$, $p = 0.027$. Table 4.11 illustrates the results of the *t* test for pre-renovation and post-renovation stages for the mathematics and reading mean scaled scores.

Table 4.11

*Group Differences between Renovation Stages on the Math and Reading Scaled Scores*

| Measure | Pre-renovation *M* | Pre-renovation *SD* | Post-renovation *M* | Post-renovation *SD* | *df* | *t* |
|---|---|---|---|---|---|---|
| 1. Math Scaled Score | 451.12 | 23.56 | 458.05 | 47.03 | 18 | 0.42 |
| 2. Reading Scaled Score | 446.14 | 17.45 | 466.46 | 20.17 | 18 | 2.41* |

* $p < 0.05$

## Comparison of Mean Scaled Scores in Mathematics and Reading versus the State

In order to compare the means of the scaled scores in mathematics and reading to the state, scores from each school had to be analyzed separately since schools studied had different pre-renovation, during, and post-renovation years. Tables 4.12 and 4.13 illustrate the comparison of the 10 schools separately with the state averages for each school year of the renovation process. There were no standard deviations for the pre and post renovation years because it only encompassed one school year.

When comparing mathematic scores, School A had a mean scaled score of 463.51 during the pre-renovation and the mean scaled score for the state was 448.11. During the renovation years, the mean score was 437 with a standard deviation of 18.95 ($M = 437$, $SD = 18.95$) and the state mean score was 447.93 with a standard deviation of 10.00 ($M = 447.93$, $SD = 10.00$). The mean score during the post-renovation were 418.50 and 469.16 respectively.

School B had a mean scaled score of 487.87 during the pre-renovation and the mean scaled score of the state was 442.27. During the renovation years, the mean score was 470.02 with a standard deviation of 5.62 ($M = 470.02$, $SD = 5.62$) and the state mean score was 449.82 with a standard deviation of 11.34 ($M = 449.82$, $SD = 11.34$). The mean scores during the post-renovation were 505.72 and 469.16 respectively.

School C had a mean scaled score of 449.82 during the pre-renovation and the mean scaled score of the state was 448.11. During the renovation years, the mean score was 430.58 with a standard deviation of 21.61 ($M = 430.58$, $SD = 21.61$) and the state mean score was 441.13 with a standard deviation of 1.62 ($M = 441.13$, $SD = 1.62$). The mean scores during the post-renovation were 409.67 and 447.26 respectively.

School D had a mean scaled score of 438.13 during the pre-renovation and the mean scaled score of the state was 442.27. During the renovation years, the mean score was 446.31 with a standard deviation of 2.14 ($M = 446.31$, $SD = 2.14$) and the state mean score was 443.62 with a standard deviation of 5.15 ($M = 443.62$, $SD = 5.15$). The means during the post-renovation were 480.98 and 462.22 respectively.

School E had a mean scaled score of 454.47 during the pre-renovation and the mean scaled score of the state was 442.27. During the renovation years, the mean score was 486.14 with a standard deviation of 3.91 ($M = 486.14$, $SD = 3.91$) and the state mean score was 443.62 with a standard deviation of 5.15 ($M = 443.62$, $SD = 5.15$). The mean scores during the post-renovation were 519.12 and 462.22 respectively.

School F had a mean scaled score of 467.40 during the pre-renovation and the mean scaled score of the state was 442.27. During the renovation years, the mean score was 491.41 with a standard deviation of 2.89 ($M = 491.41$ $SD = 2.89$) and the state mean score was 443.62 with a standard deviation of 5.15 ($M = 443.62$, $SD = 5.15$). The mean scores during the post-renovation were 497.29 and 462.22 respectively.

School G had a mean scaled score of 436.84 during the pre-renovation and the mean scaled score of the state was 442.27. During the renovation years, the mean score was 417.92 with a standard deviation of 33.39 ($M = 417.92$, $SD = 33.39$) and the state

mean score was 443.62 with a standard deviation of 5.15 ($M$ = 443.62, $SD$ = 5.15). The mean scores during the post-renovation were 415.11 and 462.22 respectively.

School H had a mean scaled score of 471.75 during the pre-renovation and the mean scaled score of the state was 442.27. During the renovation years, the mean score was 448.11 with a standard deviation of 14.95 ($M$ = 448.11, $SD$ = 14.95) and the state mean score was 454.66 with a standard deviation of 13.39 ($M$ = 454.66, $SD$ = 13.39). The mean scores during the post-renovation were 493.11 and 470.36 respectively.

School I had a mean scaled score of 403.88 during the pre-renovation and the mean scaled score of the state was 447.26. During the renovation year, the mean was 444.50 and the state mean was 462.22. The mean scores during the post-renovation were 452.44 and 469.16 respectively.

School J had a mean scaled score of 437.58 during the pre-renovation and the mean scaled score of the state was 462.22. During the renovation years, the mean score was 452.00 with a standard deviation of 5.82 ($M$ = 452.00, $SD$ = 5.82) and the state mean score was 469.76 with a standard deviation of 0.85 ($M$ = 469.76, $SD$ = 0.85). The mean scores during the post-renovation were 388.53 and 458.89 respectively.

When comparing reading scores, School A had a mean scaled score of 460.34 during the pre-renovation and the mean scaled score for the state was 442.55. During the renovation years, the mean score was 449.54 with a standard deviation of 11.10 ($M$ = 449.54, $SD$ = 11.10) and the state mean score was 459.05 with a standard deviation of 9.48 ($M$ = 459.05, $SD$ = 9.48). The mean scores during the post-renovation were 457.33 and 482.25 respectively.

School B had a mean scaled score of 478.46 during the pre-renovation and the mean scaled score of the state was 450.28. During the renovation years, the mean score was 483.29 with a standard deviation of 19.25 ($M = 483.29$, $SD = 19.25$) and the state mean score was 461.98 with a standard deviation of 9.14 ($M = 461.98$, $SD = 9.14$). The means during the post-renovation were 507.70 and 482.25 respectively.

School C had a mean scaled score of 424.75 during the pre-renovation and the mean scaled score of the state was 442.55. During the renovation years, the mean score was 441.92 with a standard deviation of 0.95 ($M = 441.92$, $SD = 0.95$) and the state mean score was 451.95 with a standard deviation of 2.36 ($M = 451.95$, $SD = 2.36$). The mean scores during the post-renovation were 447.09 and 460.57 respectively.

School D had a mean scaled score of 437.62 during the pre-renovation and the mean scaled score of the state was 450.28. During the renovation years, the mean score was 443.73 with a standard deviation of 1.69 ($M = 443.73$, $SD = 1.69$) and the state mean score was 457.09 with a standard deviation of 4.92 ($M = 457.09$, $SD = 4.92$). The mean scores during the post-renovation were 471.86 and 471.74 respectively.

School E had a mean scaled score of 440.65 during the pre-renovation and the mean scaled score of the state was 450.28. During the renovation years, the mean score was 467.45 with a standard deviation of 2.63 ($M = 467.45$, $SD = 2.63$) and the state mean score was 457.09 with a standard deviation of 4.92 ($M = 457.09$, $SD = 4.92$). The mean scores during the post-renovation were 462.60 and 471.74 respectively.

School F had a mean scaled score of 456.64 during the pre-renovation and the mean scaled score of the state was 450.28. During the renovation years, the mean score was 462.64 with a standard deviation of 1.06 ($M = 462.64$, $SD = 1.06$) and the state mean

score was 457.09 with a standard deviation of 4.92 ($M = 457.09$, $SD = 4.92$). The mean scores during the post-renovation were 458.05 and 471.74 respectively.

School G had a mean scaled score of 427.72 during the pre-renovation and the mean scaled score of the state was 450.28. During the renovation years, the mean score was 433.35 with a standard deviation of 4.73 ($M = 433.35$, $SD = 4.73$) and the state mean score was 457.09 with a standard deviation of 4.92 ($M = 457.09$, $SD = 4.92$). The mean scores during the post-renovation were 444.12 and 471.74 respectively.

School H had a mean scaled score of 462.95 during the pre-renovation and the mean scaled score of the state was 450.28. During the renovation years, the mean score was 462.81 with a standard deviation of 22.54 ($M = 462.81$, $SD = 22.54$) and the state mean score was 467.04 with a standard deviation of 12.59 ($M = 467.04$, $SD = 12.59$). The mean scores during the post-renovation were 494.54 and 485.04 respectively.

School I had a mean scaled score of 436.56 during the pre-renovation and the mean scaled score of the state was 460.57. During the renovation year, the mean was 445.25 and the state mean was 471.74. The mean scores during the post-renovation were 464.63 and 482.25 respectively.

School J had a mean scaled score of 435.69 during the pre-renovation and the mean scaled score of the state was 471.74. During the renovation years, the mean score was 467.81 with a standard deviation of 6.35 ($M = 467.81$, $SD = 6.35$) and the state mean score was 482.25 with a standard deviation of 1.98 ($M = 482.25$, $SD = 1.98$). The mean scores during the post-renovation were 456.70 and 489.12 respectively.

Table 4.12

*Comparison of Mean Amount of Math Scaled Score by School vs. State*

| | School | | State | |
|---|---|---|---|---|
| Measure | *M* | *SD* | *M* | *SD* |
| School A | | | | |
| 1. Pre-renovation (2003-2004) | 463.51 | . | 448.11 | . |
| 2. Renovation (2004-2008) | 437.00 | 18.95 | 447.93 | 10.00 |
| 3. Post-renovation (2008-2009) | 418.50 | . | 469.16 | . |
| School B | | | | |
| 1. Pre-renovation (2004-2005) | 487.87 | . | 442.27 | . |
| 2. Renovation (2005-2008) | 470.02 | 5.62 | 449.82 | 11.34 |
| 3. Post-renovation (2008-2009) | 505.72 | . | 469.16 | . |
| School C | | | | |
| 1. Pre-renovation (2003-2004) | 449.82 | . | 448.11 | . |
| 2. Renovation (2004-2006) | 430.58 | 21.61 | 441.13 | 1.62 |
| 3. Post-renovation (2006-2007) | 409.67 | . | 447.26 | . |
| School D | | | | |
| 1. Pre-renovation (2004-2005) | 438.13 | . | 442.27 | . |
| 2. Renovation (2005-2007) | 446.31 | 2.14 | 443.62 | 5.15 |
| 3. Post-renovation (2007-2008) | 480.98 | . | 462.22 | . |
| School E | | | | |
| 1. Pre-renovation (2004-2005) | 454.47 | . | 442.27 | . |

| Measure | School | | State | |
|---|---|---|---|---|
| | *M* | *SD* | *M* | *SD* |
| 2. Renovation (2005-2007) | 486.14 | 3.91 | 443.62 | 5.15 |
| 3. Post-renovation (2007-2008) | 519.12 | . | 462.22 | . |
| School F | | | | |
| 1. Pre-renovation (2004-2005) | 467.40 | . | 442.27 | . |
| 2. Renovation (2005-2007) | 491.41 | 2.89 | 443.62 | 5.15 |
| 3. Post-renovation (2007-2008) | 497.29 | . | 462.22 | . |
| School G | | | | |
| 1. Pre-renovation (2004-2005) | 436.84 | . | 442.27 | . |
| 2. Renovation (2005-2007) | 417.92 | 33.39 | 443.62 | 5.15 |
| 3. Post-renovation (2007-2008) | 415.11 | . | 462.22 | . |
| School H | | | | |
| 1. Pre-renovation (2004-2005) | 471.75 | . | 442.27 | . |
| 2. Renovation (2005-2009) | 448.11 | 14.95 | 454.66 | 13.39 |
| 3. Post-renovation (2009-2010) | 493.11 | . | 470.36 | . |
| School I | | | | |
| 1. Pre-renovation (2006-2007) | 403.88 | . | 447.26 | . |
| 2. Renovation (2007-2008) | 444.50 | . | 462.22 | . |
| 3. Post-renovation (2008-2009) | 452.44 | . | 469.16 | . |
| School J | | | | |
| 1. Pre-renovation (2007-2008) | 437.58 | . | 462.22 | . |
| 2. Renovation (2008-2010) | 452.00 | 5.82 | 469.76 | 0.85 |

| Measure | School | | State | |
|---|---|---|---|---|
| | *M* | *SD* | *M* | *SD* |
| 3. Post-renovation (2010-2011) | 388.53 | . | 458.89 | . |

Table 4.13

*Comparison of Mean Amount of Reading Scaled Score by School vs. State*

| Measure | School | | State | |
|---|---|---|---|---|
| | *M* | *SD* | *M* | *SD* |
| School A | | | | |
| 4. Pre-renovation (2003-2004) | 460.34 | . | 442.55 | . |
| 5. Renovation (2004-2008) | 449.54 | 11.10 | 459.05 | 9.48 |
| 6. Post-renovation (2008-2009) | 457.33 | . | 482.25 | . |
| School B | | | | |
| 1. Pre-renovation (2004-2005) | 478.46 | . | 450.28 | . |
| 2. Renovation (2005-2008) | 483.29 | 19.25 | 461.98 | 9.14 |
| 3. Post-renovation (2008-2009) | 507.70 | . | 482.25 | . |
| School C | | | | |
| 1. Pre-renovation (2003-2004) | 424.75 | . | 442.55 | . |
| 2. Renovation (2004-2006) | 441.92 | 0.95 | 451.95 | 2.36 |
| 3. Post-renovation (2006-2007) | 447.09 | . | 460.57 | . |
| School D | | | | |
| 1. Pre-renovation (2004-2005) | 437.62 | . | 450.28 | . |
| 2. Renovation (2005-2007) | 444.73 | 1.69 | 457.09 | 4.92 |

| Measure | School | | State | |
|---|---|---|---|---|
| | *M* | *SD* | *M* | *SD* |
| 3. Post-renovation (2007-2008) | 471.86 | . | 471.74 | . |
| School E | | | | |
| 1. Pre-renovation (2004-2005) | 440.65 | . | 450.28 | . |
| 2. Renovation (2005-2007) | 467.45 | 2.63 | 457.09 | 4.92 |
| 3. Post-renovation (2007-2008) | 462.60 | . | 471.74 | . |
| School F | | | | |
| 1. Pre-renovation (2004-2005) | 456.64 | . | 450.28 | . |
| 2. Renovation (2005-2007) | 462.64 | 1.06 | 457.09 | 4.92 |
| 3. Post-renovation (2007-2008) | 458.05 | . | 471.74 | . |
| School G | | | | |
| 1. Pre-renovation (2004-2005) | 427.72 | . | 450.28 | . |
| 2. Renovation (2005-2007) | 433.35 | 4.73 | 457.09 | 4.92 |
| 3. Post-renovation (2007-2008) | 444.12 | . | 471.74 | . |
| School H | | | | |
| 1. Pre-renovation (2004-2005) | 462.95 | . | 450.28 | . |
| 2. Renovation (2005-2009) | 464.81 | 22.54 | 467.04 | 12.59 |
| 3. Post-renovation (2009-2010) | 494.54 | . | 485.04 | . |
| School I | | | | |
| 1. Pre-renovation (2006-2007) | 436.56 | . | 460.57 | . |
| 2. Renovation (2007-2008) | 445.25 | . | 471.74 | . |
| 3. Post-renovation (2008-2009) | 464.63 | . | 482.25 | . |

| Measure | School | | State | |
|---|---|---|---|---|
| | *M* | *SD* | *M* | *SD* |
| School J | | | | |
| 1. Pre-renovation (2007-2008) | 435.69 | . | 471.74 | . |
| 2. Renovation (2008-2010) | 467.81 | 6.35 | 483.64 | 1.98 |
| 3. Post-renovation (2010-2011) | 456.70 | . | 489.12 | . |

## Summary

The findings of the 10 schools indentified as being complete renovations were summarized by a descriptive statistical analysis. The 1 x 3 ANOVA of renovation stages and demographic variables indicated no statistical significance between the variables; however, statistical significance was indicated when examining the pre-renovation and the post-renovation stages in the area of reading. The assumption that the composition of the student body would not change over the period of the study was of importance, for the students being assessed each year made up a similar composition of student body.

The 1 x 3 ANOVA of the renovation stages and student achievement in mathematics and reading indicated no statistical significance between the variables. Although mathematics and reading achievement was not statistically significant when compare to the renovation stages, the reading $p$ value of $p = 0.059$ more closely identifies a relationship between the renovation stages and student achievement when examining the pre-renovation years to the post-renovation years. The $t$ test indicated a statistically significant relationship between the two stages and student achievement in the area of reading with $p = 0.027$.

# Chapter 5: Discussion, Conclusion, Implications for Practice and Recommendation for Future Studies

## Introduction

Chapter five addresses the main research question, "Does the complete renovation process of a school building influence student achievement?" and the sub-research questions, "What difference, if any, is there in student scaled scores as measured by the SOL assessment at the eighth grade level in mathematics prior to, during, and after the renovation process?" and "What differences, if any, is there in student scaled scores as measured by the SOL assessment at the eighth grade level in reading prior to, during, and after the renovation process?" This chapter also examines the findings, offer a discussion of the findings, and a conclusion based on those findings. The chapter concludes with some recommendations for further study.

## Summary

The means of the scaled scores for all students that participated in the Virginia Standards of Learning assessments for mathematics and reading at the eighth grade level were used to examine the relationship between the renovation process and student achievement. In order to examine the relationship between the renovation process and student achievement, all schools within the Commonwealth of Virginia that had a complete renovation were further studied between the time periods of 2003 – 2010. The years 2003 – 2010 were highlighted because of statewide changes to the standards in mathematics during 2001 wherein students were assessed on the standards in 2002 and 2002 for reading wherein the students were assessed on the standards in 2003. As for

2010, in order to have data for one year after the renovation process the renovation process had to have a substantial completion date of the summer of 2010.

Out of the 75 schools studied during the 2003 – 2010 time period, only 10 schools met the criteria for a complete renovation. Before analyzing the means of the scaled scores in mathematics and reading for the 10 schools in the study, demographic variables (percentage of minority students, percentage of socio-economic status, and percentage of highly qualified teachers) were analyzed, to determine if the schools studied were located in stable communities, resulting in minimal deviation of change in the variable of minority groups, socio-economic status, and the highly qualified status of teachers. In order to analyze, the total percentage of minorities, percentage of socio-economic status, and the percentage of highly qualified teachers were calculated for each stage of the renovation process: pre-renovation, renovation, and post-renovation. The sample size of schools for the pre-renovation, renovation and post-renovation process included 10 schools. Because the renovation process extended over several years for each school, there were several data points of student scaled scores covering those years. The data points for the 10 schools totaled 24 separate scaled scores. These means of student scores for each year for each school were used to develop a mean of the total student scores for the renovation period.

After analyzing the demographic variable data, the means of the scaled scores in mathematics and reading at the eighth grade level were analyzed for the 10 schools one year prior to the renovation process, during the renovation process, and one year after the renovation process. The means of the scaled scores in mathematics and reading of each school's pre-renovation years, renovation years, and post-renovation years were further

analyzed to gather a mean scaled score for the total number of schools for the pre-renovation, renovation, and post-renovation for mathematics and reading. The 1 x 3 ANOVA was conducted to determine the statistical significance of the stages of the renovation process on student achievement. After running the ANOVA, a *t* test was conducted to determine the statistical significance of the pre-renovation stage and the post-renovation stage on student achievement.

## Findings

The means of the scaled scores of eighth grade students administered the mathematics and reading Virginia Standards of Learning assessments for grade 8 were used in this study. The mean scaled scores in mathematics and reading were analyzed during the stages of the renovation process, which included pre-renovation, renovation, and post-renovation. This information was used to determine if there was a relationship between the stages of the renovation process and student achievement. This researcher did not find a statistically significant relationship between the three stages of the renovation process and student achievement.

The demographic variables were analyzed prior to looking at the means of the scaled scores on the mathematics and reading assessments. The purpose of reviewing the demographic variables was to ascertain if the composition of the student population in the schools remained the same over the period of time of the renovation process. Each demographic variable was compared at the pre-renovation years to the renovation years and the renovation years to the post-renovation years.

When comparing the percentage of minorities during the pre-renovation to the renovation, there was an increase of 4.39 percentage points from the pre-renovation to the

renovation and a decrease of 1.95 percentage points from the renovation to the post-renovation. The percentage of socio-economic students increased 2.73 percentage points from the pre-renovation to the renovation and indicated an increase of 2.57 percentage points from renovation to post-renovation. The percentage of highly qualified teachers noted the greatest increase from the pre-renovation to the renovation stage with an increase of 3.91 percentage points and an increase of 0.69 percentage points from the renovation stage to the post-renovation stage.

### Finding One

The findings indicated no statistically significant relationship between the renovation process and the demographic variables, when the 1 x 3 ANOVA was conducted on the renovation stages and the demographic variables. For purposes of this study, no statistically significant relationship indicated the composition of the student population in the schools remained the same during the renovation process.

### Finding Two

To determine the statistical significance of the mean scaled scores in the areas of mathematics and reading on the renovation process, the means of the scaled scores during the pre-renovation, renovation, and post-renovation were compared. In mathematics, mean scores only increased 0.7 points from the pre-renovation stage to the renovation stage. The mean scores increased 6.23 points from the renovation stage to the post-renovation stage. When looking at the pre-renovation to the post-renovation stages, an increase of 6.93 points was noted. The 1 x 3 ANOVA did not note a statistical significance with $p = 0.845$.

Reading mean scores increased 11.71 points from the pre-renovation stage to the renovation stage. The renovation stage to the post-renovation stage indicated an increase of 8.61 points. When comparing the pre-renovation mean scores to the post-renovation mean scores an increase of 20.32 points was noted. The 1 x 3 ANOVA did not note a statistical significance with $p = 0.059$.

### Finding Three

When comparing individual schools to the state averages in mathematics, three schools scored higher than the state average during all stages of the renovation process, three school scored lower than the state average during all stages of the renovation process, and four schools noted a combination of higher and lower mean scaled scores during the stages of the renovation process when compared to the state average.

School A had a mean scaled score 15.4 points higher during the pre-renovation stage when compared to the state average. During the renovation stage School A had a mean scaled score 10.93 points lower than the state average. The post-renovation mean score of School A had a scaled score 50.66 points lower than the state average. School A scored higher than the state average during the pre-renovation years however, lower during the renovation and post-renovation years.

School B noted a mean scaled score 45.6 points higher than the state average during the pre-renovation stage and 20.2 points higher than the state during the renovation stage. The post-renovation mean score had a scaled score 36.56 points higher than the state average. School B scored higher than the state averages during all stages of the renovation process.

School C had a mean scaled score 1.71 points higher than the state average during the pre-renovation stage and 10.55 points lower than the state during the renovation stage. The post-renovation mean score had a scaled score 37.59 points lower than the state average. School C scored higher than the state average during the pre-renovation year; however, lower during and post-renovation years.

School D had a mean scaled score 4.14 points lower than the state average during the pre-renovation stage and 2.69 points higher during the renovation stage. The post-renovation mean score had a scaled score 18.76 higher than the state average. School D scored higher than the state average during the renovation and post-renovation years; however, lower during the pre-renovation year.

School E represented a mean scaled score 12.2 points higher than the state average during the pre-renovation stage and 42.52 points higher than the state average during the renovation stage. The post-renovation mean score noted a scaled score 56.9 points higher than the state average. School E scored higher than the state averages during all stages of the renovation process.

School F noted a mean scaled score 25.13 points higher than the state average during the pre-renovation stage and 47.79 points higher during the renovation stage. The post-renovation mean score resulted in a scaled score 35.07 points higher than the state average. School F scored higher than the state averages during all stages of the renovation process.

School G had a mean scaled score 5.34 points lower than the state average during the pre-renovation stage and 25.7 points lower than the state during the renovation stage. The post-renovation mean score indicated a scaled score 47.11 points lower than the state

average. School G scored lower than the state average during the stages of the renovation process.

School H had a mean scaled score 29.48 points higher than the state average during the pre-renovation stage and 6.55 points lower than the state during the renovation years. The post-renovation mean scaled score was 22.75 points higher than the state average. School H scored higher than the state average during the pre and post-renovation years, but not during the renovation years.

The mean scaled score for School I was 43.38 points lower than the state average during the pre-renovation stage and 17.72 points lower than the state during the renovation stage. The post-renovation mean score was 16.72 points lower than the state average. School I scored below the state average during each of the stages of the renovation process.

School J had a mean scaled score 24.64 points lower than the state average during the pre-renovation stage and 17.76 points lower during the renovation stage. The post-renovation mean score was 70.36 points lower than the state average. School J scored below the state average during each of the stages of the renovation process.

### Finding Four

When comparing individual schools to the state averages in reading, four schools scored lower than the state average during all stages of the renovation process, one school scored higher than the state average during all stages of the renovation process, and five schools noted a combination of higher and lower mean scaled scores during the stages of the renovation process when compared to the state average.

The mean scaled score for School A was 17.79 points higher during the pre-renovation stage when compared to the state average. During the renovation stage School A noted a mean scaled score 9.51 points lower than the state average. The post-renovation mean scaled score was 24.92 points lower than the state average. School A scored higher than the state average during the pre-renovation year; however, lower during the renovation and post-renovation years.

School B had a mean scaled score 28.18 points higher than the state average during the pre-renovation stage and 21.31 points higher than the state during the renovation stage. The post-renovation mean scaled score was 25.45 points higher than the state average. School B scored higher than the state averages during all stages of the renovation process.

School C indicated a mean scaled score 17.8 points lower than the state average during the pre-renovation stage and 10.03 points lower than the state during the renovation stage. The post-renovation mean scaled score was13.48 points lower than the state average. School C scored lower than the state average during all stages of the renovation process.

School D had a mean scaled score 12.66 points lower than the state average during the pre-renovation stage and 13.36 points lower than the state during the renovation stage. The post-renovation stage indicated a mean scaled score 0.12 points higher than the state average. School D scored lower than the state average during the pre-renovation and renovation stages; however, higher during and post-renovation stage.

The mean scaled score for School E was 9.63 points lower than the state average during the pre-renovation stage and 10.36 points higher than the state average during the

renovation stage. The post-renovation mean scaled score was 9.14 points lower than the state average. School E scored lower than the state averages during the pre and post-renovation years and higher during the renovation years.

School F had a mean scaled score 6.36 points higher than the state average during the pre-renovation stage and 5.55 points higher during the renovation stage. The post-renovation stage indicated a mean scaled score 13.69 points lower than the state average. School F scored higher than the state averages during the pre and renovation stages; however lower during the post-renovation stage.

School G resulted in a mean scaled score 22.56 points lower than the state average during the pre-renovation stage and 23.74 points lower than the state during the renovation stage. The post-renovation mean scaled score was 27.62 points lower than the state average. School G scored lower than the state average during the stages of the renovation process.

School H noted a mean scaled score 12.67 points higher than the state average during the pre-renovation stage and 2.23 points lower than the state during the renovation stage. The post-renovation stage had a mean scaled score 9.5 points higher than the state average. School H scored higher than the state average during the pre and post-renovation stages, but not during the renovation stages.

School I had a mean scaled score 24.01 points lower than the state average during the pre-renovation stage and 26.49 points lower than the state during the renovation stage. The post-renovation means had a scaled score 17.62 points lower than the state average. School I scored below the state average during each of the stages of the renovation process.

School J indicated a mean scaled score 36.05 points lower than the state average during the pre-renovation stage and 15.83 points lower during the renovation stage. The post-renovation mean scaled score was 32.45 points lower than the state average. School J scored below the state average during each of the stages of the renovation process.

### Finding Five

When comparing the findings of individual schools with the state averages in mathematics and reading, seven of the schools noted the same trends for both subjects. One could assume that schools with higher scaled scores in mathematics and reading than the state averages would indicate higher performing schools versus schools that scored lower than the state averages in mathematics and reading would indicate lower performing schools. While the assumption may be true, further research would need to be conducted to determine if schools outperforming the state averages in mathematics and reading are higher performing schools versus schools that performed lower than the state average.

## Conclusion

The main research question for this study was: Does the complete renovation process of a school building influence student achievement? The findings of this study did not indicate a statistically significant relationship between the means of student scores when compared over the three stages of renovation process. A statistically significant relationship, however, was found when comparing the mean student scores in reading before and after the renovation process.

Analyses of the sub research questions did not result in a statistically significant relationship in the areas of mathematics or reading when studying all stages of the

renovation process. The statistical analyses conducted on the mean scaled scores on the mathematics SOL assessments only indicated minimal increases between the renovation stages; however the increases in the mean scaled scores over the renovation stages for reading were greater.

## Discussion

The data in this study indicates that there is not a statistically significant relationship between the stages of the renovation process and student achievement. When examining the mathematics scaled scores no statistical significance is noted with $p = 0.845$; however the reading scaled scores noted a $p$ value of $p = 0.059$, indicating an alpha close to being significant when $p = .05$. Since a significance level of 0.05 is generally used in research studies, this study noted a level of significance when $p < .05$. In the event the significance level had been set at 0.10, a level of significance would have been noted between the renovation process and reading scaled scores.

In research studies, the significance level indicates the probability of obtaining results. When using a $p$ value of 0.05, it is understood that there is a 5% probability that the results are due to chance. Looking at a $p$ value of 0.10 would indicate a 10% probability that the results are due to chance. The larger the $p$ value the greater the results are due to chance; therefore, it is better to use lower significance levels. Although smaller $p$ values are preferred over larger $p$ values, smaller sample sizes will generally not indicate a level of significance when $p = 0.05$ or 0.01. Smaller sample sizes will sometimes note a level of significance when $p = 0.1$ whereas very large sample sizes generally generate better statistical significance results when $p = 0.01$.

Looking further at the reading scaled scores indicated a larger difference between the pre-renovation stage and the post-renovation stage. A *t*-test of the pre-renovation ($M$ = 446.14, $SD$ = 17.45) and post-renovation indicates ($M$ = 466.46, $SD$ = 20.17); $t(18)$ = 2.4093, p = 0.027 a level of significance when $p < .05$. The research suggests that the performance of students increases in the area of reading when comparing student achievement prior to the renovation process to after the renovation process. While it has been clearly indicated that no statistically significant findings were noted when comparing all stages of the renovation process, analyzing reading in the fashion noted above clearly resembles the results of studies conducted by Edwards (1992), Cash (1993), Earthman, et al (1995), Hines (1996), O'Sullivan (2006), Crook (2006), Bullock (2007), Tuttle (2002), and Berry (2002), wherein a relationship between the building condition and student achievement was evident in the area of reading.

When comparing the results of this study to other studies noting a relationship between building conditions and student achievement, the findings indicate differences from previous research on the topic of building conditions and student achievement, when comparing all stages of the renovation process. While the study did not indicate a statistical significant relationship between the renovation process and student achievement, the level of significance in the area of reading was close. Studies by Cash (1993), Earthman et al (1995), Hines (1996), and Berry (2002) while norm-referenced assessments noted similarities with reading assessment scores increasing based on the condition of the building.

A level of significance was indicated when the means of the scaled scores for the pre-renovation process and post-renovation process were compared, indicating a change

in the building condition. Although, one cannot assume the schools being renovated were deteriorating prior to the renovation process, the school building itself was in need of a complete overhaul to every mechanical and structural system; therefore the conditions of the building improved with the renovation. Cash (1993) indicated student achievement was higher in buildings with above standard ratings versus substandard school buildings on every subtest of the Test of Academic Proficiency (TAP). Earthman, et al (1995) indicated schools rated as having above standard building conditions scored one to nine percentile points higher on the Comprehensive Test of Basic Skills (CTBS). Hines (1996) noted differences on the TAP when standard building conditions were compared to substandard building conditions. Percentile scores were higher in schools rated as standard. Berry (2002) noted that below basic reading scores decreased 16 percentile points when reading scores on the Stanford 9 were comparing the pre-renovation process to the post-renovation process. Basic or above reading scores increased 16 percentile points when comparing the pre-renovation process to the post-renovation process on the Stanford 9.

When comparing the results of this study to studies that were done on criterion-referenced assessments, such as, the Standards of Learning (SOL), reading scores increased in buildings rated as being standard or above standard when comparing to sub-standard building conditions. O'Sullivan (2006) noted an increase in academic achievement when the overall building conditions improved at high schools in Pennsylvania, as measured on the Pennsylvania System of School Assessment (PSSA), the criterion-referenced assessment for the state of Pennsylvania. O'Sullivan also mentioned that a relationship existed between building renovation and student

achievement on the PSSA mathematics assessment, a relationship that was not evident in this particular study. Crook (2006) indicated that reading scores of students in schools rated as being in standard condition were 6.6 percentage points higher when comparing standard to sub-standard building conditions on the SOL at the high school level. Bullock's (2007) study noted a reading gain of 3.89 percent when comparing middle schools rated as standard to sub-standard at the middle school level. Tuttle (2002) indicated that reading scores on the reading SOL, at the middle school level, increased 23 percentage points during the renovation process when looking at the pre-renovation scores of students to the post-renovation scores of students.

Based on the results of the study, other assumptions can be made resulting in the lack of statistical significance. When assessments are administered, scores are expected to be more similar for a specific school year versus looking at various assessments over multiple school years. While the mathematics and reading SOL assessments tested students' understanding of the curriculum framework based on standards adopted in 2001, for mathematics and 2002, for reading, assessments may vary slightly from year to year resulting in higher or lower raw scores. Based on this phenomenon, the means of the scaled scores may vary slightly from year to year based on the level of difficulty of the assessments. Because this study looked at stages of the renovation process over a range of years, more variance can be expected in the findings; however, looking specifically at one year and comparing three schools at different stages of the renovation process, one school at the pre-renovation stage, one school during renovation, and one school at the post-renovation stage may alleviate the amount of variance in the study.

## Implications for Practice

### Implication One

Administrators that work closely with construction managers and architectural firms on the planning of renovation projects can assist with limiting renovation factors that may be exacerbated during various phases of the renovation process such as demolition periods wherein increased noise and debris may be prevalent, classroom movement, and the timing of renovating the gymnasium and cafeteria/commons area.

### Implication Two

Renovating a school is sometimes the only viable option in some localities based on the land that may be available for purchase. Although new construction of the actual building may sometimes cost less to build, land to build the new facility may not be readily available and/or be deemed financially possible for some localities.

### Implication Three

Renovations can occur without removing the total student population to another facility during the renovation process. In some localities, portable classroom space and/or additional instructional space away from the renovation site are not readily available. Renovating a school building and occupying at the same time requires developing a phased construction schedule.

### Implication Four

With some schools displaying architectural character and generally unique to a specific neighborhood, renovations are viable options. In many cases the citizens in the neighborhood prefer and/or have various covenants in place to ensure the historical presence remains in specific neighborhoods housing schools built in the early 1900s.

## Recommendations for Further Study

The following recommendations for further studies are offered.

1. Conduct a study at the middle school level on two schools, of similar demographic representation, that had a complete renovation during the time period of 2004 – 2010. The study would include a mixed method approach wherein the researcher would talk to teachers and administrators about the changes in instruction during the stages of the renovation process. Parents and students could be interviewed to discuss perceptions of the renovation process and student achievement.
2. Conduct a study at the elementary school level of the renovation process and student achievement. The study could look at the renovation process and student achievement at the fifth grade level in the areas of mathematics and reading, as measured on the Standards of Learning (SOL). The number of elementary schools in the Commonwealth of Virginia meeting the definition of a complete renovation may produce a larger sample size to study.
3. Conduct a study looking at a cohort of students and conducting a longitudinal study of the scaled scores of students over a period of time, such as, sixth grade, seventh grade, and eighth grade during the stages of the renovation process. The study could determine the impact on the renovation process on a select group of students during the stages of the renovation process.
4. Conduct a study of all elementary, middle, and high schools of the renovation process and student achievement. The study could look at the renovation process and student achievement of specific tested grades at the elementary, middle and

high school levels within the Commonwealth of Virginia, as measured on the SOL. Looking at all three levels may help increase the sample size since there are limited numbers of complete renovations.

5. Conduct a study looking at the building level leadership during the stages of the renovation process to determine the impact leadership may pose on student achievement. Doing such a study would require a mixed method approach by interviewing various stakeholders and determining the impact leadership may have on the renovation process with the student achievement results.

## References


Association for Educational Communications and Technology (2001). *What is descriptive research?* Retrieved from www.aect.org/edtech/ed1/41/41-01.html.

Berry, M. A. (January, 2002). *Healthy school environment and enhanced educational performance: The case of charles young elementary school Washington, D.C.,* Carpet and Rug Institute (CRI).

Bullock, C. C. (2007). *The relationship between school building conditions and student achievement at the middle school level in the commonwealth of virginia*. (Unpublished doctoral dissertation). Virginia Polytechnic Institute and State University, Blacksburg, VA

Cash, C.S. (1993). *Building condition and student achievement and behavior*. (Unpublished doctoral dissertation). Virginia Polytechnic Institute and State University, Blacksburg, VA

Crook, J.R. (2006). The relationship between the percentage of students passing the standards of learning examination and the condition of the educational facilities in the high schools of the state of Virginia. *Dissertation Abstracts International*. (UMI No. 3231036).

Earthman, G. I. (1994). Problems of Maintenance and Renovation. *School renovation handbook investing in education* (pp. 1-12). Lancaster, PA: Technomic Publishing Co., Inc.

Earthman, G., Cash C.S., & Van Berkum, D. (1995). *A statewide study of student achievement and behavior and school building condition.* Paper session presented at the meeting of Council of Educational Facility Planners, International, Dallas,

TX.

Earthman, G. and Lemasters, L. (1998). *Where children learn: A discussion of how a facility affects learning.* Retrieved from http://www.eric.ed.gov/ERICWebPortal/contentdelivery/servlet/ERICServlet?accno=419368

Edwards, M. (1992). *Building conditions, parental involvement and student achievement in the D.C. public school system* (Unpublished master's thesis). Georgetown University, Washington, D.C.

Hines, E. (1996). Building condition and student achievement behavior. (Unpublished Doctoral dissertation). Virginia Polytechnic Institute and State University, Blacksburg, VA

Hoffman, L. (2010). *Numbers and types of public elementary and secondary schools from the common core of data: school year 2007-08* (NCES 2010-305). National Center for Education Statistics, Institute of Education Sciences, U.S. Department of Education. Washington, D.C. Retrieved April 20, 2011 from http://nces.ed.gov/pubsearch/pubsinfo.asp?pubid=2010-305.

Jago, E. and Tanner, K. (1999). *Influence of the school facility on student achievement: lighting and color*. Athens, GA: Department of Educational Leadership; University of GA. Retrieved from http://www.coe.uga.edu/sdpl/researcherabstracts/visual.html

King J. & Marans, R.W. (1979). *The physical environment and learning process*. (Report No. 320-ST2). Ann Arbor: Univerisity of Michigan Architectural Research Laboratory.

Lyons, J.B. (2001, November). *Do school facilities really impact a child's education*.

Council of Educational Facility Planners International, Scottsdale, AZ. Retrieved from http://cashnet.org/resource-center/resourcefiles/142.pdf.

McGuffey, C. (1982). Facilities. In improving educational standards and productivity: The research basis for policy. H. Walberg. Berkeley, CA: McCutchan Pub. Corp.

Maxwell, L. (1999). *School building renovation and student performance: One district's experience*. Paper session presented at the meeting of Council of Educational Facility Planners, International, Scottsdale, AZ.

National Center for Educational Statistics (1999). *How old are America's public schools?* Retrieved from http://nces.ed.gov/surveys/frss/publications/1999048/

Ornstein, A. (1994). School finance and the condition of schools. *Theory Into Practice* (pp.118-125). Abingdon, Oxford, UK: Taylor and Francis, Ltd. doi: 10.1080/00405849409543618

O'Sullivan, S. (2006). *A study of the relationship between building conditions and student academic achievement in Pennsylvania's high schools* (Unpublished doctoral dissertation). Virginia Polytechnic Institute and State University, Blacksburg, VA.

Schneider, M. (2003). *Linking school facility conditions to teacher satisfaction and success.* Retriieved from http://www.21csf.org/csfhome/Documents/Teacher_Survey/SCHOOL_FACS_AND_TEACHING.pdf

Shifflett, D. W. (2010). *A study of teacher experiences during a renovation project* (Unpublished doctoral dissertation). Virginia Polytechnic Institute and State University, Blacksburg VA.

Tuttle, J. (2002). *Reconstructing school renovation: A study of the renovation*

*of Johnson-Williams Middle School, Berryville, Virginia*. Retrieved from http://www.eric.ed.gov/ERICDocs/data/ericdocs2sql/content_storage_01/0000019b/80/1a/45/62.pdf

Twenty First Century School Fund (February 2011). *PK-12 public school facility infrastructure fact sheet*. Retrieved from www.bestfacilities.org/best-home/docuploads/pub/236_PK-12PublicSchoolInfrastructureFactSheetFinal4.pdf

United States General Accounting Office (1995, February). *School facilities: condition of america's school*. (GAO/HEHS Publication No. 95-61).

Virginia Department of Education (2010). Retrieved from http://www.doe.virginia.gov/support/facility_construction/school_construction/costs/index.shtml.

Virginia Department of Education (2011). www.doe.virginia.gov

# Appendix A

## Email to the School Division Director of Facilities

Good afternoon,

I am a doctoral student at Virginia Polytechnic Institute and State University. I am currently working on a dissertation that focuses on the possible influence the renovation process has on student achievement, in the areas of mathematics and reading, at the eighth grade level.

The purpose of my study follows:

The goal of the research is to see if there is a relationship between the renovation process and student achievement. The scaled scores of the mathematics and reading SOL assessments, at the eighth grade level will be reviewed one year prior to, during, and one year after a complete renovation process.

I have had an opportunity to review all middle school renovations since 2004 in the Commonwealth of Virginia and I wanted to find out additional information on the renovation of _____ Middle School. With my study, I am reviewing schools that had a complete renovation, the process of improving the mechanical, structural, and the possible addition of educational space within a specific building. Key components would improve every mechanical and structural system, wherein students were moved within the same building during the renovation process.

If you would take the time to answer the following questions, it would be greatly appreciated as I narrow down the number of schools that will fit the criteria of the study.

1. Based on the definition of a complete renovation noted above, please describe the scope of the work for the renovation of _____ Middle School (i.e. replacement of HVAC mechanical system, plumbing system, electrical system, new floor finishes, windows, painting, etc).

2. What was the inception date for the renovation project? End date?

Thanks again for assisting in the aforementioned questions.

## Appendix B

### Letter to the Virginia Department of Education

December 14, 2011

Dr. Kathleen Smith
Director of School Improvement
Virginia Department of Education
101 North 14th Street
P.O. Box 2120
Richmond, Virginia 23218-2120

Dear Dr. Smith:

I am a doctoral student at Virginia Tech in the School of Education. I am currently working on a dissertation that focuses on the possible influence the renovation process has on student achievement, in the areas of mathematics and reading, at the eighth grade level. Reviewing scaled scores on the mathematics and reading Standards of Learning (SOL) assessments will measure student achievement.

The purpose of my study follows:

The goal of the research is to see if there is a relationship between the renovation process and student achievement. The scaled scores of the mathematics and reading SOL assessments, at the eighth grade level will be reviewed one year prior to, during, and one year after a complete renovation process. Data from this study will serve as a valuable resource for school divisions in determining the impact of the renovation process on student achievement. This information could lead the school divisions to consider ways to minimize the effect of the renovation process on student achievement.

After reviewing all middle schools renovated since 2004 wherein improvements were made to every mechanical and structural system, and in some cases the addition of educational space, I have narrowed the study down to twelve schools. For the schools selected to study, access will be needed to scaled SOL assessment scores in mathematics and reading at the eighth grade level for the specified time periods of the renovation process. The means of the scaled scores for the state will be needed for each of the specified time periods in the areas of mathematics and reading at the eighth grade level. Information on demographic variables (minority percentile, socio economic status percentile, pupil teacher ratios, and highly qualified teacher percentile) will also be needed for each school noted below during the specified time periods.

| School Name | SOL Assessment Data – School Years |
|---|---|
| School A | 03-04, 04-05, 05-06, 06-07, 07-08, 08-09 |
| School B | 04-05, 05-06, 06-07, 07-08, 08-09 |

| | |
|---|---|
| School C | 03-04, 04-05, 05-06, 06-07 |
| School D | 04-05, 05-06, 06-07, 07-08 |
| School E | 04-05, 05-06, 06-07, 07-08 |
| School F | 04-05, 05-06, 06-07, 07-08 |
| School G | 04-05, 05-06, 06-07, 07-08 |
| School H | 04-05, 05-06, 06-07, 07-08, 08-09, 09-10 |
| School I | 06-07, 07-08, 08-09 |
| School J | 07-08, 08-09, 09-10, 10-11 |

Note: Means of the scaled scores in mathematics and reading at the state level for the following years: 2003-04, 2004-05, 2005-06, 2006-07, 2007-08, 2008-09, 2009-10, 2010-11

Understanding how valuable your time is, I appreciate your consideration in assisting with this study. If additional information is needed, please do not hesitate to contact me via email at jlmayo@vt.edu.

Sincerely,

John L. Mayo
Virginia Tech Doctoral Student

# Appendix C

VirginiaTech

**Office of Research Compliance**
Institutional Review Board
2000 Kraft Drive, Suite 2000 (0497)
Blacksburg, Virginia 24060
540/231-4606 Fax 540/231-0959
e-mail irb@vt.edu
Website: www.irb.vt.edu

**MEMORANDUM**

**DATE:** November 22, 2011

**TO:** Glen Earthman

**FROM:** Virginia Tech Institutional Review Board (FWA00000572, expires May 31, 2014)

**PROTOCOL TITLE:** The Renovation Process and Student Achievement

**IRB NUMBER: 11-1013**

Effective November 22, 2011, the Virginia Tech IRB Protocol Reviewer, Brandi Evans, approved the new protocol for the above-mentioned research protocol.

This approval provides permission to begin the human subject activities outlined in the IRB-approved protocol and supporting documents.

Plans to deviate from the approved protocol and/or supporting documents must be submitted to the IRB as an amendment request and approved by the IRB prior to the implementation of any changes, regardless of how minor, except where necessary to eliminate apparent immediate hazards to the subjects. Report promptly to the IRB any injuries or other unanticipated or adverse events involving risks or harms to human research subjects or others.

All investigators (listed above) are required to comply with the researcher requirements outlined at http://www.irb.vt.edu/pages/responsibilities.htm (please review before the commencement of your research).

**PROTOCOL INFORMATION:**
Approved as: **Exempt, under 45 CFR 46.101(b) category(ies) 4**
Protocol Approval Date: **11/22/2011**
Protocol Expiration Date: **NA**
Continuing Review Due Date*: **NA**
*Date a Continuing Review application is due to the IRB office if human subject activities covered under this protocol, including data analysis, are to continue beyond the Protocol Expiration Date.

**FEDERALLY FUNDED RESEARCH REQUIREMENTS:**
Per federally regulations, 45 CFR 46.103(f), the IRB is required to compare all federally funded grant proposals / work statements to the IRB protocol(s) which cover the human research activities included in the proposal / work statement before funds are released. Note that this requirement does not apply to Exempt and Interim IRB protocols, or grants for which VT is not the primary awardee.

The table on the following page indicates whether grant proposals are related to this IRB protocol, and which of the listed proposals, if any, have been compared to this IRB protocol, if required.