School Facility Renovation and Student Achievement

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ABSTRACT

This dissertation examines school renovation and student achievement. The study focuses on the relationship between a complete renovation of a school facility and its influence on student achievement before, during, and after the renovation process. This is a replication study of previous research, Mayo (2012), which focused on middle schools in the Commonwealth of Virginia that were identified as a 'complete' renovation project during the years of 2004-2010. The study utilized the procedures and the descriptive research methodology established in the Mayo (2012) study. This allowed for the same three demographic variables (minority, socioeconomic, and teacher quality) to be addressed. The only modification made was the selection of a new grade level (K-5) focusing on elementary schools. The research question posed in this study, Does the complete renovation process, which includes structural, plumbing, electrical, and heating and air conditioning changes of a school building, influence student achievement?

Out of 514 school construction projects listed by the Virginia Department of Education during 2004-2010, 89 were classified as renovation projects. Out of the 89, only 39 met the criteria of elementary schools servicing fifth grade students. The 39 elementary schools were then further reviewed, and 15 met the criteria of fulfilling the four components of a complete renovation; structural, plumbing, electrical, and heating/air conditioning. The findings of the 15 schools identified as being a complete renovation showed no statistical significance between the variables and were not statistically significant when comparing the fifth grade mathematics and reading student performance to each stage of the renovation process.

Dedication

This dissertation is dedicated to my family. Over the past three years they have understood when I said, “I can’t, I’m writing today,” and they supported me. To my husband, Donnie, I will forever be indebted for his strength, patience, and understanding. Even though I struggled from time to time, there was never any doubt in his mind that I would accomplish this unimaginable goal. He kept me focused and encouraged me every step of the way. Thank you for believing in me and your unconditional love.

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Chapter One

Introduction

The space within becomes the reality of the building. - Frank Lloyd Wright (1957)

Educational space has long been a concern for teachers, students, parents, and administrators. Not only a concern for the learning that takes place in a school building, but the building itself. As famed American architect Frank Lloyd Wright pointed out, the making of a building is more than just constructing the walls; it is what happens within those walls that make it worthwhile (Wright, 1957). Today educators are struggling with critical issues that involve academic achievement, diverse student populations, and economic hardships, all of which impact funding and have links to the school building. The improvement of school facilities is a challenge for local school boards. The decision for most school boards is not in determining if a school facility needs improving, it is whether or not the local school board should build a new school or renovate an existing one.

According to the 2013 Annual Construction Report, total school construction rose from $12.2 billion in 2011 to nearly $13 billion in 2012. However, the spending for new school construction decreased from $6.9 billion to $6.1 billion. This decline is attributed to a major increase in spending for renovations and the upgrading of existing buildings (Abramson, 2013). In the 2012 Annual Construction Report, Abramson projected more than half of the 2012 spending would be used for renovation projects. "It appears that the larger new school projects, many funded four or five years before completion, are not being started as often and that districts are opting for smaller and quicker projects – fixing up deteriorating buildings or small additions to existing ones" (Abramson, 2012, p CR3). The projections were accurate. New school construction lagged behind and school boards moved in the direction of school

renovation projects. While only $6.2 billion was spent nationally on new school construction, $6.8 billion was used for renovations to include retrofit and modernization of existing structures (Abramson, 2012). The state of the economy has forced local school divisions to rethink their planning for capital outlay projects. Many local boards have determined that renovating the existing school facility meets the needs of students and is within the budget of the school board and community.

In accepting the budget constraints and the purpose of the school board to educate all school age children in their community; 'How does this new focus on school renovation relate to student achievement?' Understanding the influence a school renovation project may have on student achievement is important. Various researchers such as Cash (1993), Earthman and Lemaster (1996), Lackney (1999), Earthman (2002), and McGowan (2007) provided vital data that confirmed that building conditions influence student achievement. Elements such as roofing, lighting, plumbing, heating and air systems, and components that produce an energy efficient building have been tied to student achievement. When these elements are being completely or partially renovated during the school year, student learning and achievement is influenced; therefore, additional research could be valuable to educational leaders.

Research that validates a relationship between the renovation of school facilities and student achievement is important. Researchers have an opportunity to move forward and delve deeper into the field of study and determine how much of an influence a renovation project has on student achievement not just before and after the renovation project, but during the renovation. Based on the premise from earlier research that student learning and the physical environment in which they learn are related, additional research of student academic achievement before, during, and after a school renovation project will fill the current gap in

research. The purpose of this study is to replicate the 2012 study by John Mayo who researched the renovation process and student achievement using data from the Virginia Standards of Learning Assessment for Mathematics and Reading at the eighth grade level. For purposes of adding to the field of study, the replication of all components of the Mayo (2012) will be completed for mathematics and reading at the fifth grade level.

Statement of the Problem

In today's climate of educational accountability, student achievement is an obvious variable for researchers to use when studying the possible influence the renovation process has on students. Research has been conducted on building conditions and student achievement, building conditions and school leadership, and teacher attitudes during a renovation project, as well as student behaviors and attitudes during a renovation process; however, few studies have focused on the renovation process and the influence on student achievement before, during, and after a complete school facility renovation. It is important for researchers to investigate, or to study the influence of fully operational schools that are undergoing a complete renovation because disruptions to the educational environment such as noise, air quality, the change of traffic patterns for students, or the entire upheaval and move of students, from one setting to another during the complete renovation may in fact influence student achievement.

Research Questions

The purpose of this research is to investigate the possible relationship between the school facility renovation process and student achievement. Within this context, the overarching question for this study is, "Does the complete renovation process, which includes structural, plumbing, electrical, and heating and air conditioning changes of a

school building, influence student achievement?" Student achievement data for this study is designated as the Virginia Standards of Learning Assessments in Mathematics and Reading at the fifth grade level. The 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 fifth 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 fifth grade level in reading prior to, during, and after the renovation process?

Significance of the Study

The empirical research associated with the renovation process and how it relates to student achievement before, during, and after a complete renovation of a school facility is limited. Even with current studies completed by Maxwell (1999), Tuttle (2002), Duran-Narucki (2008), Earthman and Lemasters (2009), Uline, Tschannen-Moran, and Wolsey (2009), and Mayo (2012), the focus has not been narrowed to show the possible influence of a complete renovation on student achievement at the stages of the process prior to, during, and after the complete renovation. The focus of a complete school renovation and its relationship to student achievement is unexplored.

The practical application of research linking student achievement to the concept of prior to, during, and after the complete renovation process will serve as a stepping stone for others in the field when analyzing the impact of a facility upgrade while maintaining successful student achievement. The goal for any additional research is to identify variables associated

with the renovation process as they relate to student achievement. This focus will not only provide data for school leaders to use in determining if their actions to maintain and improve the facility impact student achievement, but it will potentially have implications for budget funding formulas due to the option of new construction versus renovation, facility projects that have been moved off the school division's priority list due to cost, and implications in how instructional supports for student performance is achieved during a complete renovation. The goal of this study would be to provide additional research that will help determine if the renovation process influences student achievement.

Assumptions

Throughout the course of this research several assumptions are made by the researcher. An assumption will be made that all the completed renovation projects used for this study met industry standards, were completed on time, and were considered successful by the educational leaders. The assumption is made that the data provided by the Virginia Department of Education were accurate. Another assumption made is that the curriculum for both fifth grade mathematics and reading used in each of the schools within the study covered all of the assessed Virginia Standards of Learning. The final assumption is that the composition of the student body of the schools will not measurably change over the course of the study.

Limitations of the Study

The original study conducted by Mayo (2012) had five limitations that were considered to exist based on the relationship between building conditions prior to, during, and after a complete renovation to student achievement. A limitation addressed by Mayo (2012) regarding the actual physical layout of schools is not considered a limitation for this study. Mayo (2012) distinguished the differences between a secondary campus style school compared to one that is

an enclosed structure. Mayo (2012) noted the possibility of a limitation due to the numerous times a student changes classes. Throughout 2004-2010 there were no campus style elementary schools in the state of Virginia.

Limitations from the Mayo (2012) study that are also a factor for this study are that the changes such as wiring, duct work, and piping may not be visible to the occupants of the school; however, cosmetic elements that are visible to the occupants such as new paint, windows, lighting, and fixtures invoke a newer environment and may influence student outcomes. This is based on earlier research from Cash (1993), Duran-Narucki (2008), and Lackney (1999) that the condition of the building impacts student performance. A second limitation for this research is that the study will not be assessing the same group of students over the time of the research. The student population for each assessment year will not be reviewed as a cohort. Only students who were identified as fifth grade students who took the Virginia Standards of Learning assessments in mathematics and reading for that specified year will be reviewed. Students may change depending on the number of years of the renovation project for each school. The third limitation for the study is that no alternative assessment offered by the Virginia Department of Education, such as the Virginia Grade Level Alternate Assessment (VGLA) or the Virginia Alternate Assessment Program (VAAP) will be utilized. Only data provided by the Virginia Department of Education (VDOE) will be utilized. Since neither VGLA nor VAAP data are disseminated by VDOE, results for mean scaled scores will only be collected from online and paper/pencil results. The fourth limitation is that because only fifth grade students' mean scaled scores were analyzed, the mention of these findings as the norm for all renovations within the Commonwealth of Virginia should be taken into consideration and cautioned against. The fifth limitation is that since data were not collected

for any state other than Virginia, the results of this study may only be applied to the Commonwealth of Virginia. The final limitation is noted as the lack of control over the selected teaching staff for each completely renovated school in the study. The Mayo (2012) study addressed teacher quality, but did not address teacher attendance, professionalism, or the influence of teachers to compensate for what they consider to be poor work facilities. This study will follow the methodology used in the Mayo (2012) study and address only the teacher quality aspect since there is no feasible way to quantify the feelings of each teacher regarding the condition of the school building. This researcher affirms that it is impossible to identify all the variables which could influence student achievement and is only providing a description of the data collected for elementary schools in the Commonwealth of Virginia who underwent a complete renovation during the schools years of 2004-2010.

Delimitations of the Study

Even though no delimitations that may have established boundaries for the research were addressed in the Mayo (2012) study, two will be added to this replication study. The first is the delimitation that the schools selected as completely renovated for this study were limited to the Commonwealth of Virginia. The second delimitation is that the only grade level selected for this study was fifth grade.

Definitions of Terms

The following definitions are provided for terms used in the study.

Alternative Assessment: The Commonwealth of Virginia utilizes two alternative methods for students with disabilities. The first is the Virginia Alternate Assessment Program (VAAP), the second is the Virginia Grade Level Alternative (VGLA) in grades 3-8. Each assigned

assessment is dependent upon the nature of the disability. These assessments measure the student with disabilities progress for that grade level (VDOE, 2013).

Capital Outlay: Funds that are intended for purchasing land and/or buildings, repairing or developing architectural structures, and installing various mechanisms such as electricity and gas. Capital outlay is a necessary allocation of funds to ensure that students study in a safe, secure classroom environment.

Complete Renovation: All four elements of renovation are being completed on the renovated school facility. The four components are structural, plumbing, electrical, and heating/air conditioning (Earthman, 1994).

Completion Date: The date in which the contractor has completed the construction/renovation project and the building is approved for occupancy.

Inception Date: The date in which the actual construction/renovation project has begun on-site. It is often confused for the date the contract is awarded by the Virginia Department of Education.

Industry Standards: The elements of building/renovation that are reported as on time and under budget, such as final cost, design features, and completed phases of construction.

Partial Renovation: The upgrade of several, but not all, of the major components for a complete renovation, and no changes would be made to the structure (Earthman, 1994).

Rehabilitation: The completed renovations and/or installation of components of a building which prolongs its life, considered as maintenance items. Examples are replacement of a roof, windows, walls, or of an element of the mechanical systems such as a boiler, temperature controls, water distribution, toilet fixtures, or electrical service.

Remodeling: Work performed to alter, modernize, renovate, or otherwise change a building over in a different way.

Renovation: The process of restoring to a better condition. In reference to school renovation, components would consist of heating, air, and ventilation (HVAC) upgrades, lighting, electrical, structural, and cosmetic improvements.

Scaled score: A scaled score is the conversion of a student's raw score on a standardized test. It may also be a version of the test to a common scale that allows for a numerical comparison between students and schools' assessment results.

Standards of Learning Assessment (SOL): A Virginia assessment that measures how well students have learned the required coursework taught in the Virginia public school system (VDOE, 2013).

Student Achievement: For the purpose of this study, student achievement is restricted to mean the successful mastery of an individual student on the Virginia Standards of Learning Assessments in Mathematics and Reading at the fifth grade level.

Organization of the Study

This study, focusing on the relationship between a complete school renovation and student achievement, is divided into five chapters. Chapter 1 includes an introduction, a statement of the problem, research questions, the significance of the study, assumptions, limitations and delimitations, as well as definition of terms and the study's organization. Chapter 2 includes a review of the literature related to school renovation and student achievement. Chapter 3 contains a description of the research methodology, the population, data needed, data collection, and the method used for data analysis. Chapter 4 describes the data and the findings of the study and provides an in-depth analysis of the data related to the research questions.

Chapter 5 contains the summary of findings, discussion, conclusion, and recommendations for further study.

Chapter Two: Review of Relevant Literature

Introduction

According to the 21st Century School Fund Report on State Capital Spending on PK-12 School Facilities (Filardo, 2010), more and more school divisions are renovating buildings rather than building new schools. Furthermore, the abundant amount of literature on school building conditions shows that a steady increase of research has been conducted on the impact of public school facilities on educational outcomes (TACIR, 2003). The purpose of this literature review is to investigate research studies that focused on the school renovation process and the influence it may or may not have on student achievement.

Background reading specific to school construction, school renovation, and capital outlay provided a general context for the current research and justified the need for additional research in the area of school renovation related to student achievement. Three main sources were read to gain an overall synopsis of current educational facilities issues. *Planning Educational Facilities* (Earthman, 2009), which outlined the entire process of school construction from its inception of need to its conclusion in orienting staff to the facilities, helped establish the framework for why and when renovation is completed. The *2013 Annual School Construction Report* (Abramson, 2013) provided a detailed analysis of school construction and needed funding. The report was arranged so that the data were disaggregated by new school construction, additions to current buildings, and school renovations. The final source used to gain a better understanding of the renovation process was an article by Chan and Petrie (1998) entitled "The Brain Learns Better in Well-Designed School Environments". The revealing points of the article were that "brain-based research is not a separate movement in education, but an approach from which all education will

ultimately benefit" (Chan & Petrie, 1998, p.1). The article provided analyses in the areas of school facilities specific to light, room temperature, activity areas, and classroom esthetics which provide a more conducive learning environment for students (Chan & Petrie, 1998).

Included in the relevant research for this review are major works in the field of school facilities that consisted of articles and studies confirming significant impact on student achievement and the relationship to the renovation process. The research is comprised of studies that improved upon previous research by utilizing a different methodology, articles that provided an overview of the financial status for American schools, and studies that noted the opposing viewpoint in regards to school facilities and student achievement.

Excluded from the review of literature were renovation projects conducted at private schools, charter schools, pre-K programs, or higher education facilities within the United States. Also excluded were articles, books, and studies that focused on educational facilities outside of the boundaries of the United States. This literature review focused only on public schools within the United States of America.

The first section of the literature review concentrates on the current conditions of public school buildings in America. The second section explains the different building components that influence student achievement, while the third section narrows the scope to review specific school renovation studies. The chapter will close with a summary of the literature review.

Current Condition of America's Public Schools

In the article "Healthy Buildings, Successful Students", Holloway (2000) reported that over 25 million students nationwide attend schools with at least one unsatisfactory environmental condition. Holloway (2000) noted that previous research by Earthman and Lemaster (1996) confirmed the impact of the school building on student achievement. In validating that a large

portion of American students are being educated in substandard buildings, Holloway (2000), along with Earthman and Lemaster (1996), pointed out that the condition of the school facility is "one variable that the school division has direct control over" (Holloway, 2000, p88).

Crampton, Thompson, and Vesely (2004) provided information from a follow-up study that concentrated on the viewpoint of the taxpayer. In an in-depth look at how well school infrastructure is funded in America, Crampton, et.al (2004) affirmed that school finance for facilities has remained the same for over 70 years. Local school districts are responsible for the funding of school facilities. This burden is sustained by way of local property tax revenues and the willingness of voters to approve local bonds. In order to move the educational community forward Crampton, et.al (2004) consistently showed the relationship between school facilities and student achievement and concluded by stating, "With emerging research establishing the critical role of the physical environment of schools in student success, adequate and equitable funding of infrastructure takes on a new urgency" (Crampton, et.al., 2004, p. 45).

The United States Department of Education has not assessed the condition of school facilities across the nation since 1965 when most school systems reported having had at least one building in their system that was considered an inadequate learning environment. The most recent report commissioned by Congress was conducted by the United States General Accounting Office (GAO) in 1995. It confirmed that the nation's schools were in extensive need of repair. Components of the school buildings discussed as unacceptable ranged from plumbing and ventilation to the building structure and cosmetic look. Each building component was examined and in 1995 was found to be substandard (USGAO, 1996).

Affirming this information was a report issued by the American Society of Civil Engineers' (ASCE) which gave school infrastructure a grade of D- on the ASCE 2001 Report

Card on Education (Crampton and Thompson, 2002). It has been 18 years since the GAO report and 12 years since the last national report on school infrastructure was conducted, and the condition of our schools continue to deteriorate while Congress holds states accountable for student performance.

The school buildings of America's public school system have been in the forefront of educational research for more than 30 years, and funding for facilities has been a constant concern. According to the 2009 Research on the Impact of School Facilities on Students and Teachers by the 21st Century School Fund, the report reviewed 19 studies completed on school facilities between 2000 and 2009. Of the 19 studies, 14 focused specifically on the condition of the school building. The 2009 meta-analysis provided basic evidence that the concern for school facilities in America is growing exponentially (21st CSF, 2009).

Building Components that Influence Student Achievement

Two major studies were the foundation for the compilation of research in the field of educational facilities. Weinstein (1979) and McGuffey (1982) provided the first comprehensive look at research findings on the relationship of school facility condition to student achievement and behavior. The review consisted of 238 published studies and 21 papers. The themes that were brought to the forefront of research were facility factors that correlated with positive educational outcomes; (1) age of the facility, (2) condition of the facility, (3) thermal factors, and (4) visual and lighting elements of the facility (TACIR, 2003). In a report prepared for the ACLU Foundation of Maryland, Earthman (2004) indicated that the research is ample enough to state "without equivocation" (Earthman, 2004, p18) that the school building influences student learning. After determining that the age of a school building impacts student achievement,

Earthman (2004) listed in his report seven elements that most impact student achievement in any school facility;

(1) Human Comfort – i.e., temperatures within the human comfort range as regulated by appropriate HVAC systems.

(2) Indoor Air Quality – i.e., appropriate ventilation and filtering systems, also as regulated by appropriate HVAC systems.

(3) Lighting

(4) Acoustical Control

(5) Secondary Science Laboratories

(6) Student Capacity – Elementary

(7) Student Capacity – Secondary (Earthman, 2004, p26).

The first four on the list provided by Earthman (2004) directly influence the occupants of the building. Holmes (2011) found that in order for learning to take place and to be effective, elements of the school facility should first be met: adequate classroom size, clean and comfortable areas, adequate lighting, and a safe and secure environment. In *Planning Educational Facilities: What Educators Need to Know*, Earthman (2009) once again confirmed that air conditioned classrooms with natural lighting and reduction of outside noise allow students to consistently achieve higher mean scores on achievement test than students who do not have the benefit of these building conditions.

Once taking into consideration the health and safety issues, Earthman (2004) established that in order for localities to begin the process of building up school infrastructure, the elements that show a relationship between building condition and student achievement should be funded first.

Review of School Renovation Studies

Supporting the notion that most educators are concerned with the condition of the school facilities around the nation, researchers continue to collect evidence that provides additional support to previous data that the quality of the school building is essential to student achievement. The direct link between student achievement and the condition of the school building has been researched most recently by Maxwell (1999), Tuttle (2002), Duran-Narucki (2008), Shifflett (2010), and Mayo (2012). These five researchers built on the foundational constructs of Cash (1993), Earthman (1994), Lemasters (1997) and Lackney (1999).

Maxwell (1999), in conjunction with the Syracuse, New York, City School District, conducted a case study on the perspective of the facilities planners of the renovation process and how it impacts student learning, performance, attitude, and behavior. The goal of Maxwell (1999) was to research the effects of the facility before and after renovation. Maxwell confirmed in a review of literature that earlier research had only compared student performance in different settings, but not before and after improvement of a facility. Focusing on how the renovation impacted student outcomes, Maxwell (1999) was able to control for the differences in student demographics, as well as teaching styles, which created a new avenue of study for educators and the building industry.

The Syracuse City School District (SCSD) had a dynamic feature in regards to the student population during the years of this study. Since the city borders encompass the actual school boundaries, citizens were allowed to select each year the school that they wished for their children to attend. This created a new student body at each school every year. Prior to the 1999 study, SCSD had at least half of the student body in each school new to the school. Because of this factor, the case study did not focus on comparing school to school, but in looking at

renovation projects and student performance as a whole. The entire SCSD student population of 20,000 during the years of 1983 to 1997 provided the sample population. It was further narrowed to only students during that time frame who participated in the Pupil Evaluation Program (PEP) at grades three and six. This type of sampling, at the district-wide level, provided for an established and stable collection of data. All 21 elementary schools were included in the analysis.

The Pupil Evaluation Program (PEP) was used by SCSD in evaluating third and sixth grade students in mathematics and reading. The assessment was administered every May as a screening tool for identifying students who had fallen below grade level. The selection of utilizing the PEP as the instrument was determined by answering yes to two important questions: Did all the schools in the SCSD participate in the PEP? and, Were the percentages of students who scored at or above the state average reported? The answer to both questions was yes (Maxwell, 1999).

A quantitative method was used to determine whether or not school renovation showed a statistically significant correlation between students who were in learning environments that had been renovated and students who were not. Prior to 1984 none of the schools in SCSD had undergone major renovation projects. However, starting in the summer of 1984 the SCSD began renovation work throughout the entire district. By 1994 over half of the students attending a SCSD school were in renovated buildings. In order to provide a correlation, two measures were selected to analyze: a comparison of the district-wide PEP scores from 1983 until 1997, and the percentage of students in the district attending recently renovated schools and their scores from 1983 to 1997. Maxwell (1999) argued that a positive correlation would mean that the two measures would provide evidence that student performance improved after being in a renovated place.

Maxwell's (1999) initial findings only showed a statistically significant correlation with the PEP mathematics scores of students who attended a renovated school. However, the study did not provide any analysis that determined the degree of significance whether positive or negative. Maxwell (1999) did, however, state that if taken only at face value the findings raised three major questions:

> 1) Why might the quality of facilities affect mathematics learning more than reading? 2) Might there be a difference in the way children learn mathematics skills versus reading skills? 3) Why is the relationship especially strong for older students (sixth grade vs. third grade)? (Maxwell, 1999, p6).

The fact remained that the study confirmed a relation between mathematics scores and a renovated school.

Knowing that further study would be needed, Maxwell (1999) selected three elementary schools (LeMoyne, Meachem, and Elmwood) to gain an in-depth understanding of the scope of the renovation projects. The three schools were selected due to their similarities. All were built within 14 years of each other (1914-1928) and provided similar square footage in floor space (64,200 to 72,666 sq. ft.). Two of the schools, LeMoyne and Meachem, had the same design and were designed by the same architectural firm. The renovation of the three schools had equal increases in square footage and cost on the average of $5 to $6 million each (Maxwell, 1999).

Maxwell (1999) admitted that in using these three schools, the data set was not large enough to show any substantial findings, but a visual look at plotted graphs provided insight into one major trend. The mathematics scores in all three schools showed an upward trend in performance each year, but the reading scores for the same three schools varied year to year with no pattern of improvement. Maxwell (1999) then went beyond the PEP data and looked at

common elements of each school renovation. The following areas were reviewed by Maxwell (1999) for the three selected schools: floors and walkways were refinished, kitchens were gutted and reinstalled, incandescent lighting was replaced by fluorescent lighting, large windows were installed to provide natural lighting, new classrooms were added, and new blackboards were installed in older classrooms. The one element common to all three schools was that community members were included in the planning process and weekly meetings were held so that all stakeholders could participate in the renovation process (Maxwell, 1999).

All three schools in the more focused case study were considered small schools (400 to 600 students). The number of students in a class before, during and after renovation remained the same averaging 18 to 21students; however, the total school enrollment increased due to the fact that parents opted to send their children to a newly renovated school. The student class size stayed the same, but the number of classrooms increased in all three schools. The SCSD made attempts to relocate students at each school during the renovation period. At Meachem and LeMoyne all first grade students were housed in mobile units. The move did not show any impact on the case study due to the fact that first graders did not take the PEP assessment. Therefore, there was no way of knowing if the move benefited student learning by removing them from exposure to dust, noise, machinery, and construction workers.

In the Maxwell (1999) case study of SCSD it is important to note that a relationship between the renovation project of an SCSD school building and an improvement in mathematics scores on the PEP were found; however, since the case study was small, there should be no generalization that the renovation caused the scores to increase.

In 1998 another school division, the Clarke County Public School Board (CCPS), began renovation efforts at Johnson-Williams Middle School in Berryville, Virginia. Researcher, Tuttle

(2002), who specifically chose one school to follow throughout the entire renovation process, conducted a case study of the school's renovation process, including the benefits to its users and the influence it had on student learning. In the Johnson-Williams case study, Tuttle (2002) described not only the planning and design of the school renovation project, but presented the projected outcomes and probable benefits of the renovation project to the stakeholders of Johnson-Williams Middle School.

Within the study itself, Tuttle (2002) measured the quality of the school renovation project and discussed specific guiding principles of the project to include the standards of quality for the renovation project in comparison to industry standards. Tuttle (2002) also reviewed the perceptions of teachers about the facility before, during, and after the renovation. Tuttle (2002) tied all of this information to students' social interactions, school relationships, and student achievement.

During the actual construction portion of the renovation process, teacher, student, parent, administrator, and community member interviews were conducted to find out how the project had impacted them within the educational environment. Four students were randomly chosen and provided disposable cameras. These students were asked to take pictures of their favorite and least favorite place in the school before and then again after the renovation project. The assessment data from the Virginia Standards of Learning were collected for one year prior to the start of the renovation project, as well as for the year of the renovation project and the year after the project was completed.

Based on industry standards, the renovation project for Johnson-Williams Middle School was a success. In reviewing items such as budget, design features, and all construction phases, the project came in under budget and on time, which are normally areas of focus for the

construction industry. However, in accordance with the Tuttle (2002) study the emphasis was not on industry standards, but perceptions of the stakeholders before, during, and after the renovation process.

The findings were reported in 10 areas: Improved Quality of Space (IQS); Increased Safety, Security, and Access (ISSA); Increased Space and Flexibility (ISF); Cafeteria, Auditorium, and Circulation Areas (CACA); Temperature and Airflow (TA); Science Laboratories (SL); Technology (T); Changes in Social Interactions (CSI); School Relationships and (SR); and the final area of Student Achievement Outcome (SAO). When the data were analyzed, the review showed increases in all areas of the Standards of Learning (SOL) assessments. This was not considered by Tuttle (2002) as significant since Johnson-Williams students consistently achieved high marks on the SOL assessments each year. The data did not show statistically significant gains throughout the renovation process; however, the largest area of growth in student performance was in the content of English moving from a passing score of 64.2 in the 1998-1999 school year (before renovation) to an 87.2 pass rate in 2000-2001 (after renovation). Tuttle (2002) wrote in his findings, "The most compelling pattern shows that except in history, SOL achievement rose each and every year of the study. This finding documents that, under certain conditions, student achievement can actually rise, even while the school building is undergoing renovation" (Tuttle, 2002, p. 30). The reliability in the comparison of the pass rate was noted by Tuttle (2002) as skewed. The pass rate for the year of 1998-1999 was assessing a different group of students than those assessed for the 2000-2001 pass rates. Tuttle (2002) determined that no clear relationship between educational facilities and student achievement can be identified due to the fact that the populations of the actual students tested were different.

Six years later, the research of Duran-Narucki (2008) investigated how the condition of school facilities affected student attendance and student academic achievement. Only a few unpublished studies had attempted to connect deficient facilities to low student attendance and achievement. The 2008 study attempted to clarify the role the condition of school facilities played in educational outcomes for students. Duran-Narucki (2008) included 95 elementary schools in New York City in the study which was later narrowed to specifically select elementary schools located in the borough of Manhattan.

Duran-Narucki (2008) used the NY Building Condition Survey (NYSED, 2008) as the instrument for building evaluation and accessed the data through the New York City Board of Education's website. The survey used a five point Likert scale to rate a total of 20 items related to building conditions. The Building Condition Survey was completed by architects and engineers who were not employees of New York City schools. By using non-public school employees, Duran-Narucki (2008) attempted to control confounding variables. Additionally, Duran-Narucki (2008) attempted to control for additional confounding variables by selecting items that were present in all 95 elementary schools such as boiler systems, column bearing walls, floor finish, stairs, temperature control thermostats, stalls in toilet areas, and windows. Using Cronbach's alpha, the reliability of the items used in the assessment was determined to be satisfactory with an alpha of .8709.

Duran-Narucki (2008) completed the study by using a four step process for testing mediation hypothesis. The first step involved the independent variable (school building condition) being related to the dependent variable (academic achievement). Second, the independent variable (school building condition) must be related to the potential mediator (attendance). The third step stated the mediator (attendance) must be related to the dependent

variable (academic achievement) after controlling for the independent variable (school building condition). The fourth step involved determining if there was a significant relationship between school building conditions and academic achievement.

Attendance was viewed by Duran-Narucki (2008) as a dynamic of education. If students do not attend school they cannot engage in the learning environment, which limits their academic success. To incorporate attendance as a mediator, Duran-Narucki (2008) built on previous research from Branham (2004) that showed the conditions of a school influences whether or not a student is more likely to be absent from school. Academic achievement was measured in the study by student scores on the New York City and New York state tests on mathematics and English language arts (p. 281). Duran-Narucki (2008) used a multiple regression analyses used by Baron and Kenny (1986) for testing a mediator hypothesis.

The multiple regression analyses showed that school building conditions were significantly related to scores on standardized tests in mathematics and English language arts. The study also found the conditions of school buildings predicted both attendance and academic achievement after controlling for other possible predictors such as socioeconomic status, ethnicity, school size, and teacher quality (p. 283). Overall, the study concluded students in deficient buildings attended fewer days in percentage and experienced poorer performance on mathematics and English language arts standardized tests. Additionally, Duran-Narucki (2008) stated functional, clean, and attractive school buildings have a positive impact on education and ultimately on student achievement and attendance (p. 285).

In 2010 researcher Shifflett completed a phenomenological study that investigated teacher perceptions during a renovation project. The compelling feature of this study was that it contributed to the collection of data for more than just teacher perceptions. It also provided

additional examination of school renovations based on the foundations of the Tuttle (2002) research. The Tuttle (2002) study suggested further exploration be completed in an effort to reinforce the findings that the renovation process impacts student performance based on the conditions of the learning environment of teachers and students.

For the research study Shifflett (2010) chose to include only two high schools from Augusta County Public Schools (ACPS) in Fishersville, Virginia. Wilson Memorial High School (WMHS) and Stuarts Draft High School (SDHS) underwent renovation projects starting in 2006 and culminating in 2008 which allowed for commonalities to be examined. As principal of Wilson Memorial High School, Shifflett had a first-hand view of the decisions made during a renovation process and how they impacted student performance. The study compared the perceptions of his teachers during the renovation process to those of a sister school in the ACPS division. Looking for patterns and themes between the two schools allowed Shifflett (2010) to determine common perceptions of satisfaction as well as dissatisfaction with all stakeholders, specifically teachers. In determining teacher perceptions, Shifflett (2010) hoped to gain enough knowledge to develop a plan that would assist administrators in generating teacher and student success. The methodology used in this study was a mixed-methods approach combining both quantitative and qualitative methods, one of a handful of studies that has taken this approach.

A 24 question survey was created by Shifflett (2010) in order to target specific areas of concerns compiled during the review of literature. The focus included items that addressed school renovation issues such as noise, distraction, odor, safety, climate conditions, construction workers, time, and morale. Of the 24 questions, Shifflett (2010) provided a variety of forms to assist in narrowing the teachers' perceptions. This forethought in design allowed for an easier recognition of patterns and themes within the context of the study.

The questions were written using the following format: two questions checked for overall satisfaction, two questions were open-ended responses, 10 questions were written with negative verbiage, while the remaining 10 were written with positive verbiage. The respondents answered the 20 questions using a numerical scale scoring points from one to five and had the option to provide verbal information on the two questions that were open-ended responses. Of the 76 potential participants, 74 completed the survey (Shifflett, 2010).

In reviewing the data for each research question Shifflett (2010) determined that research question one and two, which focused on common perceptions of teachers, indicated that 36.5% of the population was satisfied with the renovation project and 4% was dissatisfied with the renovation project. Of the 74 surveys, a total of only 27 had the required calculated score between 1 and 2.49 for satisfied and 3.50 to 5 for dissatisfied. All other survey results aligned with the neutral category of 2.50 to 3.49.

Research question three, "Were there any differences in teacher perceptions in the two schools?" provided more insight into the two different schools selected. The research concluded that 47% of the teachers from SDHS were coded as satisfied, while only 28% from WMHS were so coded. Shifflett (2010) further explained that the coding for this research question also showed that only 4% from SDHS and 2% from WMHS were coded as dissatisfied, leaving the majority of participants at WMHS in the neutral category.

The fourth and final research question, "Were there any relationships between teacher perceptions and the specific demographics?" used the demographic of gender. The research showed that for a total of eight survey questions a significant difference between male and female response was seen. The specific content of these questions dealt with safety, cleanliness,

completion, good work environment, and difficulties associated with construction workers (Shifflett, 2010).

The final analysis conducted by Shifflett (2010) was a review of the main themes associated with the two open-ended questions on the survey. Out of the 74 participants, 26 responded "none" to the questions asking for participants to describe any difficult experiences that occurred during the renovation project. The remaining respondents cited either in written or verbal response that their highest concern was communication. Temperature, cleanliness, lack of space, and odor followed in that order as difficulties with the renovation project.

One of the major accomplishments of this research was that Shifflett (2010) was able to create a survey producing questions that aligned with major concepts and findings from previous studies and build his research upon those studies. In the area of safety during a renovation project Shifflett (2010) revealed findings that were consistent with studies by Tuttle (2002) and Young (2003). The finding that the perception of feeling safe is related to the condition of the building was based on and confirmed by Earthman and Draeger (2000) in *Experiencing A Renovation: A Practical Guide for Principals*. Neither of the previous studies or the guide book presented data on teacher satisfaction, just on the perceptions of the building condition and safety.

One of the major drawbacks to this study is the placement of Shifflett (2010) as acting principal of WMHS during the renovation project. Could this be the reason that a majority of the WMHS participants responded as neutral to many of the questions? The fact that Shifflett (2010) noted this in the conclusion is admirable. Shifflett (2010) was accurate in the assessment that a larger study including more participants from other geographical areas would allow for deeper analysis into teachers' satisfaction of a renovation project. Shifflett's analysis aligns with

multiple research studies that confirm teacher satisfaction plays a role in a teachers attendance, which in turn impacts student achievement.

During the years of 2004-2010 a research study was conducted by Mayo (2012). The inquiry examined the relationship between the renovation process and student achievement. The goal of the study was to answer the question, "Does the renovation process of a school building influence student achievement?" (Mayo, 2012, p.ii). The study posed two sub-questions specific to performance of eighth grade students on the Virginia Standards of Learning mathematics and reading assessments. These two sub-questions examined the differences in student mathematics and reading scores prior to, during, and after the renovation process.

The population of the Mayo (2012) study was considerably defined. After extensive review of the Virginia Department of Education Energy and Facilities Cost Construction Data, Mayo (2012) determined 514 school projects were logged with the state from 2004-2010. Seventy-five were characterized as middle school level. Of the 75, only 10 middle schools were identified as a complete renovation site. The 10 identified middle schools were included in the study. All students enrolled in each of the 10 identified schools participated in the Virginia Standards of Learning assessments for mathematics and reading at the eighth grade level and were included as the population sample for the study.

Mayo (2012) used the data from the Virginia Department of Education to determine if school renovation influenced student achievement. The mean scaled scores of each state assessment prior to, during, and after a complete renovation were used to make comparisons. The collection of data was from 2004-2010 to ensure that the data collected would allow for a comparison of the same student assessment type. To remain consistent, the data used in this

study were the assessments that continually aligned to the same set of standards in both mathematics and reading at the eighth grade level.

A descriptive research methodology was used by the researcher in order to ascertain whether or not the renovation process influenced student achievement. Mayo (2012) determined that by using only quantitative data the research does not prove a relationship existed between the independent variable (renovation) and the dependent variable (achievement) within the population. By opening the research up to a descriptive method, Mayo (2012) was able to describe the events of the renovation process in greater depth, then organize and focus on different quantitative statistical techniques of the data to present information in a meaningful way.

To control for uniformity of the sample population, all schools were required to meet the following criteria: a) the renovation process for their school had been completed before the summer of 2010, b) the percentages of minority and socioeconomic status students were of similar composition each year, and c) teachers were classified highly qualified based on criteria from the Commonwealth of Virginia.

The collection of the data was completed not only by the use of scores from the Virginia Department of Education (VDOE) website, but with email responses from each of the 10 school division Director of Facilities. The correspondence, via email, was a request to have the Director of Facilities complete a survey answering two questions on the scope of the work and the start and end date of the renovation project (Mayo, 2012).

Demographic variables such as minority, socioeconomic status, and highly qualified teacher percentages were compiled in order to determine any changes in the student composition during the study. Changes were not expected for any of the demographic variables during the

time of the study. To determine if the expectations were correct, an Analysis of Variance (ANOVA) was conducted to compare any possible differences in the demographics during the three specific times of the renovation process: pre, during, and post (Mayo, 2012).

In order to define the variance, Mayo (2012) pointed out that the total variance due to error and the variances due to the differences between the means were analyzed. He completed this task by using the means of the scaled scores for renovation years and compared that score to both the pre-renovation and post-renovation years. This analysis was used in order to see if there was a significant difference between students achievement scores pre-and post-renovation (Mayo, 2012). Additional testing for the mathematics and reading mean scaled scores was completed using a *t*-test. The end result to accept or reject the null hypothesis for student achievement during the time of the study showed no statistical difference. To ensure that building conditions actually did play a role in student achievement scores, the renovation stages were not used in the *t*-test. This allowed for a clear distinction to be set between student performance before renovating the building, which had poor conditions, and student achievement after the renovation, which had improved conditions. The study revealed no statistical significance in the relationship between demographic variables when compared to the three specific phases of the renovation process (before, during, and after). This meant that there were no significant changes in student composition during the period of the study.

The means scores used in this study were from the Virginia Standards of Learning Assessments in mathematics and reading for students in grade eight of the 10 middle schools that met the criteria of having a complete renovation. The hypothesis designed by the researcher indicated the demographic variables would only vary slightly during the renovation process (Mayo, 2012). The researcher explained in the findings that the 10 middle schools participating

in the study allowed for a diverse group of students around the regions from the state of Virginia. To investigate the differences between means scores of mathematics and reading and the three demographic variables, the researcher chose to conduct a 1 x 3 ANOVA. Demographic variables were used to determine if there were any differences in student composition and achievement throughout the period of the study. The analysis indicated there was basically no change in the composition of the student bodies in the schools over the renovation period of time.

The 1 x 3 ANOVA revealed the percentage change of minorities was not statistically significant over the renovation stages, the percentage change of socio-economic status was not statistically significant over the renovation stages, and the percentage change of highly qualified teachers was not statistically significant over the renovation stages. Since the data did not show any differences among the demographic variables between the specific stages of the renovation process, Mayo (2012) concluded that the variables did not have any influence upon the means of the scaled scores in mathematics and reading on the Virginia Standards of Learning Grade 8 Assessments.

After conducting the 1 x 3 ANOVA, Mayo (2012) conducted a *t*-test using the means scaled scores to show whether or not there was an impact on mathematics and reading mean scaled scores when comparing pre-renovation to post-renovation scores. The *t*-test, which assesses whether the means of two groups are statistically different from each other, did not reveal a statistically significant difference between student achievement scores in mathematics when comparing pre-renovation to post-renovation. However, the *t*-test conducted on the reading mean scaled scores revealed a statistically significant impact on student achievement when comparing pre-renovation to post-renovation stages of the process when $p > .05$. A *p* value is understood in research to be the probability of obtaining results. A *p* value of 0.05 is understood

to mean that there is a 5% probability that the results are due to chance. The larger the *p* value, the greater the results are due to chance. Therefore, in the context of the stages of renovation vs. reading scaled scores, the study indicated $t(18)=2.4093$, $p=0.027$ (Mayo, 2012) which revealed that student achievement, in the area of reading, showed a statistical difference across the 10 schools at different stages of the renovation process due to the low *p* value of 0.027.

The analysis targeted on the specific means and standard deviation scores for pre-renovation, renovation, and post-renovation phases for schools identified as A – J. The findings provided foundational evidence that in the area of reading, when comparing pre-renovation and post-renovation means scaled scores to the three demographic variables of minority, socio-economic status, and highly-qualified teachers there was a statistically significant relationship between renovation and student achievement. Mayo (2012) confirmed that this was only in the area of reading, and mathematics did not show any significant relationship (Mayo, 2012).

Summary of Literature Review

The evolving research conducted over the past thirty years has pointed to the notion that school facilities must be user friendly considering the fact that the needs of its occupants continue to change (Uline, Tschannen-Moran, & Wolsey, 2009). Remaining as the focus for many researchers is the idea that a wide range of variables impact student achievement, especially when considering school facilities and their direct impact on students (Uline et.al,2009). It can be determined that constant exchanges between the original school buildings' design, the day-to-day operations of the school buildings environment, and the occupants (students and teachers) are defining characteristics of the learning climate of schools and are factors that can be used to predict high or low performing schools.

As it has been shown throughout this analysis and review of relevant literature, the condition of the school environment may play a role in the overall attendance and engagement of students, but not necessarily a role in their academic achievement. Even though the review of each research study focused on how the building aspects of a school may or may not have an impact on student achievement, the findings were varied and inconclusive. Maxwell (1999) showed an improvement in mathematics scores on the PEP, but not with any other content area; Tuttle (2002) did not show any statistical significant gains through the renovation process, even though the SOL scores in each content rose every year; Duran-Narucki (2008) confirmed that building conditions were significantly related to attendance and scores on the standardized test; Shifflet (2010) provided findings that focused on the perceptions of teachers on the condition of a building and that it played a role in a teachers' attendance, which impacted student achievement; and finally, Mayo (2012) found a statistical difference in the influence of the renovation process on student performance in the area of reading. Aside from the inconsistent findings, some overarching and common themes were revealed such as the community and school connection, a safe and orderly environment, student demographics, varied grade levels, and the evidence of minimal impact from the renovation process on student achievement.

The challenges of a renovation project for schools in session are vast. They range from planning the design of the building to including all stakeholders in the decision making process. But, most importantly, it includes coordinating the renovation process so that student achievement is not impacted. Research that is conducted simultaneously with the construction project allows for real-time interviews, surveys, and photographing of all stages before, during, and after the renovation comparing the perceptions of the process to the student achievement data collected before, during, and after the renovation.

The four most recent studies provided a more diverse view than previous research. The combination of involving stakeholders, recognizing industry standards, and the specific building conditions analyzed allowed different variables to be used when determining student achievement and the influence of the renovation process. The blend of these research studies was effective in understanding which had the most measureable impact on student achievement determining the educational benefit of a school renovation project.

The conclusion can be drawn that even though each study encompassed a different focus on how student achievement is impacted when focusing on the condition of the school building, the renovation of the school building and its importance in the education process and student achievement is uncertain. Students and teachers will attend school if the school has an appearance of a clean and safe environment. Research from Duran-Narucki (2008) confirmed that the absenteeism of both teachers and students increase when these two occupants are forced to work and learn in a substandard building. Therefore, the connection leans stronger to student attendance and its impact on student achievement rather than the renovation process due to the condition of the building.

Fixing schools in disrepair sends a direct message to students and teachers that education is important. Research has documented that poor, minority students are more likely to be enrolled in a school that is in disrepair, and therefore one way to support academic achievement for these students is to repair those schools (Duran-Narucki, 2008). Researchers in the field of education should continue to focus on the relationship between school condition and student achievement in an effort to close the achievement gap. When confronted with the decision of whether or not to renovate a dilapidated school building, school planners, educators, and taxpayers should rely on research-based practices in order to have a successful building project

by both industry standards and student performance standards. As has been shown, there are research studies that show no significant influence on student achievement during a renovation process. However, the overwhelming majority of research by Cash (1993), Earthman and Lemaster (1996), Lackney (1999), Earthman (2002), and McGowan (2007) has provided a distinct understanding that student performance whether in mathematics, reading, attendance, or behavior is influenced by the condition of the school facility. The question that can be pursued by researchers is a more in-depth approach as to whether or not a complete renovation process influences student achievement.

Chapter Three: Methodology

Introduction

The proposed study replicated a 2012 study on the relationship between a complete renovation of a school facility and its influence on student achievement before, during, and after the renovation process. The former study focused on middle schools in the Commonwealth of Virginia that were identified as a 'complete' renovation project during the years of 2004-2010. One of the recommendations for further study emanating from the Mayo (2012) study was that the research should be replicated on both the elementary and the high school levels. This study utilized the procedures established in the Mayo (2012) study with the modification of a new grade level (K-5) focusing on elementary schools in the Commonwealth of Virginia that were identified as a complete renovation project during the years of 2004-2010. The purpose was to look at the possible influence the renovation process had on student achievement as measured by student performance on the Virginia Standards of Learning (SOL) assessment in the areas of mathematics and reading at the fifth grade level.

The theoretical model used to examine the influence between completely renovated schools in Virginia and student achievement before, during, and after the renovation was the model developed in 1993 by Cash. In her study, Cash (1993) designed a framework that explained the roles leadership and financial ability have on the efforts of the custodial staff in maintaining building conditions of a school and the impact on student achievement. Cash's Theoretical Model (1993) shown in Figure 1 was used in the Mayo (2012) study as the framework for analyzing the difference in student achievement throughout the renovation process.

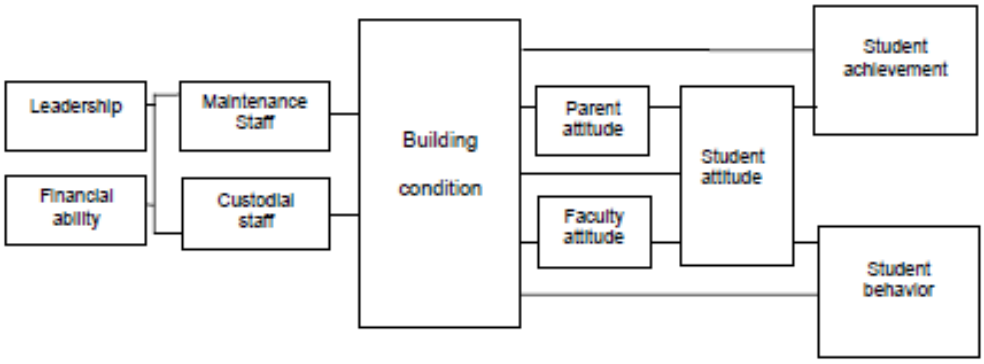

Figure 1: Cash's Theoretical Model (1993) illustrates the relationship between the physical and structural environment of the school building and their combined impact on student achievement. From *Building Condition and Student Achievement and Behavior*, by C.S. Cash, 1993. (UMI No. 9319761). Copyright 1993 by the American Psychological Association.

The proposed study concentrated on the portion of the model that focused on the possible relationship between building condition and student achievement in an effort to determine if the change of the building condition (before, during, and after a complete renovation) may or may not influence student achievement.

A quantitative research methodology was used in conducting this study. The quantitative approach allowed the researcher to seek facts and causes of human behavior so that differences among the variables were identified. In quantitative studies, as in this one, data collected were numerical and descriptive. The study made no attempt to account for or show cause for the change in condition, only in gathering data. This study described the event of completed renovations and the data connected to student achievement before, during, and after the renovation process.

Population

The population for this study was students in the fifth grade at Virginia elementary schools (or middle schools that house the fifth grade) that meet the criteria of having a complete

renovation from 2004 to 2010. Complete renovations include four components that receive upgrades all at one time, rather than partial building upgrades over a period of time. The four components are structural, plumbing, electrical, and heating and air conditioning (Earthman, 1994). Due to the fact that the renovation process may take longer than a single year, data were collected for the entire timespan of the renovation process for each school building.

The pool of participants was identified using the Virginia Department of Education Public School Facilities Cost Data Report. The report provided a detailed description of the scope of the renovation projects, and from this information a detailed list of all elementary schools meeting the criteria of having a complete renovation was assembled. Of the 514 school projects that were reported to the Virginia Department of Education Support Services Division during the 2004-2010 school years, 89 schools conducted a renovation with 39 of them meeting the criteria of an elementary school servicing fifth grade students. All high school and middle schools were excluded from the study. The 39 elementary schools were narrowed further to determine the exact number of schools that received a complete renovation during 2004-2010.

The fifth grade elementary level was selected due to the fact that the Virginia Standards of Learning Assessment for both mathematics and reading changed before the 2004 school year and again after the 2010 school year. In order to keep the data comparing the same assessment criteria, the years, as well as the grade level, allowed for continuity with the data. This range also mirrored the selection of Mayo (2012) in choosing the middle school eighth grade level for similar reasons.

The final component of the population consideration was the demographic variables used to determine if the composition of the student body in the 39 possible schools remained the same

over the period of time of the study. The variables that may have influence on student performance that were reviewed are socioeconomics, ethnicity, and highly qualified teachers.

Data Needed

The importance of comparing similar data across the time span of the renovation process is essential for this study. Selecting the school years 2004-2010 allowed for both the Standards of Learning (SOL) mathematics and reading assessments to be consistent because each were based on the same curriculum frameworks established by the Virginia Department of Education. If additional years prior to 2004 or after 2010 were utilized, the data would have been from two different versions of the mathematics and reading SOL assessments and uniformity within the data would have failed to exist. In order to align with the Mayo (2012) study, mathematics and reading scores were used from the 2004-2005 to 2010-2011 school years.

Demographic data needed for this study were the following: percentage of minority students, percentage of students on free/reduced lunch, and the percentage of highly qualified teachers. The following criteria/definitions were used in selecting these demographic data:

(1) The percentage of minority students within the total student population was the combined sum of Hispanic/Latino, American Indian or Alaska Native, Asian, Black or African American, Native Hawaiian or Other Pacific Islander, and students identified as two or more races for the years of 2004-2010 prior to, during, and after the complete renovation.

(2) The socio-economic status was determined by the percentage of students from the total student population who received free and reduced meals, students who received Temporary Assistance for Needy Families (TANF), or those students who received Medicaid.

(3) The percentage of highly qualified teachers was determined for each school of complete renovation utilizing the Virginia Department of Education School Report Card calculations.

(4) The study utilized the means of the student scores in mathematics and reading for each school Standards of Learning (SOL) assessment scaled scores to measure student achievement.

Data Collection

All data were collected from the Virginia Department of Education (VDOE) either by using the VDOE website, www.doe.virginia.gov, or by phone or face-to-face meetings with members of the Virginia Department of Education Support Services. Two forms of data was collected: (1) demographic data which consisted of minority students, socioeconomic student status, and highly qualified teachers and (2) students' scaled scores on the mathematics and reading Standards of Learning (SOL) assessments for the years 2004-2005 through 2010-2011. A scaled score is the conversion of a student's raw score on a standardized test which allowed a comparison of student performance data.

The researcher retrieved a list of all the schools having some form of renovation, either partial or complete, by accessing the Student and School Support link on the left hand side of the VDOE home page. Selecting the Facility Construction and Maintenance link on the right hand side of the VDOE Student and School Support page revealed the School Construction Projects link, also on the right hand side of the webpage. By accessing this, the researcher found the Project Cost link midway down the middle of the webpage. Selecting the School Construction Data Cost link and the reports for the cost of all Virginia schools construction were listed dating back to the 1999-2000 school year.

The Construction Cost Data Report provided information on the name of the school, school division, contract award data, construction cost, total square feet, and the total cost per square foot for the renovation. The VDOE report did not list in any priority order the schools who received renovations based on funding, scope of the renovation project, or whether designated as elementary or secondary schools. It was necessary to identify only the elementary schools on the list and complete a review of the submitted Construction Contract Logs on file with the VDOE Department of Support Services. The reports, which were provided to VDOE by each division, detailed the scope of the work noting if the renovation was a partial or complete renovation.

Once all 39 elementary project reports were reviewed and a final list of elementary schools having complete renovations during the 2004-2005 through 2010-2011 school years was compiled, an e-mail was sent to each Director of Facilities/Director of Maintenance & Operations of the school divisions that meet the set criteria, asking two questions:

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 (official start date of contractor) for the renovation project? What was the completion date (official end date the school division reported work ceased)?

If the school division chooses not to answer the two questions by e-mail, the researcher contacted, by phone, the school division human resource department to request the contact information for the Director of Facilities or Director of Maintenance & Operations, as well as the

Director of Finance for that specific school division. The researcher called the Director and gathered the needed information. If there was still no response from the identified school division, then the general contractor and/or architectural firm that completed the renovation project was contacted. After the dates for each completed renovation project were determined, all demographic variables were assembled by utilizing two reports housed on the VDOE website under the Assessment and Achievement Data link: (1) Fall Membership Report, which is a representation of the number of K-12 students enrolled on the first school day in October each year, and (2) Report Card (for each identified school) which provided information about student achievement, accountability ratings, attendance, program completion, school safety, teacher quality, and other topics.

The final data collected were the mean scaled score for fifth grade students in mathematics and reading for each of the identified elementary schools during the years of the study. To collect this information, the researcher sent a formal written request to the VDOE Office of School Improvement requesting the release of said data.

Data Analysis

In order to determine if the completed renovation had any influence on student achievement on the mathematics and reading Standards of Learning (SOL) assessment at the fifth grade level, an analysis of the data one year prior to, during, and one year after the renovation project was completed. All data were gathered and the researcher entered the data into an Excel document, transferred the data into the software program, Statistical Package for Social Sciences (SPSS) and ran three specific analyses: a descriptive statistics, a 1 x 3 Analysis of Variance (ANOVA), and a *t*-test. See Table 3.1 for a detailed summary of the three statistical analyses that were completed.

With the demographic variables assembled individually and collectively, a descriptive statistic was the first analysis completed in order to compare and determine if there was a significant difference between the demographics of the schools. The second analysis completed was an Analysis of Variance (ANOVA) which compared the stages of renovation (prior to, during, and after) to the demographic variables. The purpose of this analysis was to determine if there was any statistical significance between the three stages of the renovation process. Another ANOVA test was conducted to establish the difference in means for statistical significance by each stage of the renovation. This analysis revealed the total variance due to error and the variance due to the differences between the means. The final review of the ANOVA conveyed if there was a significant difference when comparing the means of the renovation years to both the pre-renovation and post-renovation years. The breakdown of the student achievement data analysis compared pre-renovation and post-renovation, pre-renovation and renovation – year 1, pre-renovation and renovation – year 2, pre-renovation and renovation – year 3 if necessary, and renovation and post-renovation.

Since additional tests were completed in the Mayo (2012) study, this study replicated the final analysis using the *t*-test on the mean scaled scores for mathematics and reading for only the pre and post stages of the renovation process. The outcome of the *t*-test was used to determine if there were any statistically significant differences in the pre and post stages of renovation on student achievement.

The analysis was conducted using the Statistical Package for Social Sciences (SPSS) software in order to accept or reject the null hypothesis established in the Mayo (2012) study: that no statistical difference would be noted regarding student achievement prior to, during, or after the complete renovation process. An alpha level of .05 was used for all statistical tests, and

the effect size was calculated by using *r*. If alpha is less than .05, then it was considered a statistical significance with the stages of the renovation process on student achievement; if alpha was greater than .05 then it was not be considered a statistical significance.

For the purposes of this study, only the fifth grade mathematics and reading Standards of Learning assessment data was included. These data were targeted for a comparison of the elementary schools meeting the criteria of a complete renovation. The data were collected and analyzed for school years 2004-2005 through 2010-2011 comparing student achievement before, during, and after the completed renovation.

Table 3.1 *Summary of Data Analysis Test and Comparisons*

Test Completed	Comparisons	Dates Used	Grade & Content
Descriptive Statistics	Variables between demographics of schools. a. % of minority b. % of free/reduced lunch status c. % of highly qualified teachers	School year 2004/05 through 2010/11	Grade 5 Mathematics Grade 5 Reading
ANOVA #1	Stages of renovation (prior to, during, and post) to demographic variables (described above).	School year 2004/05 through 2010/11	Grade 5 Mathematics Grade 5 Reading
ANOVA #2	Difference in means for statistical significance among each stage of renovation. a. Reveals the total variance of error and the variance due to the differences between the means. b. Delineates the significance in comparing the means of the renovation.	School year 2004/05 through 2010/11	Grade 5 Mathematics Grade 5 Reading
t-Test	Determine if there is a statistical significance. a. Difference in pre and post stages of renovation on student achievement.	School year 2004/05 through 2010/11	Grade 5 Mathematics Grade 5 Reading

Summary

The intent of this chapter was to describe the methodology that was used in this study. The chapter described in detail the selection of the population and how each school was vetted in order to determine if the school met the identified criteria. The chapter also listed the data needed based on the specifications from the Mayo (2012) study. The data collection and methods that were used in analyzing the data collected followed the Mayo (2012) study exactly in order to maintain the guidelines within research for conducting a replication study.

Chapter Four: Presentation of Findings

Introduction

The compilation of data from 15 elementary/middle schools in the Commonwealth of Virginia was completed for this study. According to the Virginia Department of Education fifth grade is considered an elementary level. However, some school divisions in the Commonwealth of Virginia house their fifth grade students in the middle school. Fifth graders in this situation are still considered by the state as elementary. Findings from this study add to the research of the possible influences a complete renovation of a school building may or may not have on student achievement. An examination of student performance in the areas of mathematics and reading on the Standards of Learning Assessment prior to the renovation, during the renovation, and after the renovation process for the 15 schools was completed. The findings from this study may serve as one data point for school divisions in the Commonwealth of Virginia when the school division is contemplating a complete renovation of an existing facility.

Procedures

IRB Approval was given on October 23, 2013, (Appendix A) which allowed the researcher to begin making initial contact to staff members at Virginia Department of Education (VDOE). Of the 514 school projects that were reported to VDOE Support Services Division during the 2004-2010 school years, 89 schools conducted a renovation with 39 of them meeting the criteria of an elementary school servicing fifth grade students. On October 31, 2013, all 39 elementary school facility construction files were reviewed on site at the VDOE offices in Richmond. Fifteen (15) of the 39 schools met the additional requirement of being a school that had been completely renovated.

On November 9, 2013, an e-mail correspondence was sent to each of the 15 school division's Directors of Facilities and Maintenance (Appendix B) which confirmed the inception

and end dates of the completed renovations. That same date a request was made to the VDOE Office of School Improvement. The e-mail to VDOE requested the mean scaled scores for the 15 schools identified as having complete renovations from the 2004-2005 to 2010-2011 school years (Appendix C). On November 10, 2013, the Director of the VDOE Office of School Improvement sent a secured site link that allowed the researcher to access all of the mean scale scores for mathematics and reading from 2004-2005 to 2010-2011 school years. By November 23, 2013 emails from the Directors of Facilities and Maintenance and/or Division Superintendents of all the schools verifying the inception and end date of the renovation projects in their division had been received.

Demographic data were comprised of the (1) percentage of minority students, (2) percentage of students on free/reduced lunch, and the (3) percentage of highly qualified teachers were collected from the Fall Membership Report on the VDOE website. All data were organized in an Excel document and imported into SPSS for analysis. Descriptive statistics were run for the three stages of the renovation process in order to determine the means and standard deviations of the three demographic variables selected. An ANOVA analysis was conducted to determine the statistical difference, if any, between the three variables and the different stages of the renovation process: pre, during, and post. Two additional ANOVA analyses were conducted in order to compare the means scaled scores in mathematics and reading along with the three stages of the renovation process: pre, during, and post. The final test completed was a *t*-test conducted to show any statistical difference between the pre-and post-renovation stages and student performance on the mathematics and reading standards of learning assessments.

It is important to note that while only 15 schools (five more than the original study) were studied, the *n* value (the *n*umber of samples) included not only the number of schools in the

study (15 pre, 15 post), but the number of years for each school's renovation (18) for a total *n* value of 48. One school had a renovation period of two years, one school had a renovation period of three years, and 13 schools had a renovation period of only one year each. With two schools having multiple years for renovation, the scaled scores for mathematics and reading during the years of the renovation were averaged together to calculate the means during the renovation. Table 4.1 displays the designation for the 15 schools for each year of the renovation process.

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

School	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	Post-Renovation			
D		Pre-Renovation	Renovation	Post-Renovation			
E					Pre-Renovation	Renovation	Post-Renovation
F			Pre-Renovation	Renovation	Post-Renovation		
G				Pre-Renovation	Renovation	Post-Renovation	
H		Pre-Renovation	Renovation	Post-Renovation			
I		Pre-Renovation	Renovation	Post-Renovation			
J					Pre-Renovation	Renovation	Post-Renovation
K		Pre-Renovation	Renovation	Post-Renovation			
L		Pre-Renovation	Renovation	Post-Renovation			
M		Pre-Renovation	Renovation	Post-Renovation			
N		Pre-Renovation	Renovation	Post-Renovation			
O		Pre-Renovation	Renovation	Post-Renovation			

Demographic Variables

The main reason for selecting the three specific variables was to determine whether or not the demographics for each of the elementary schools stayed similar across all stages of the renovation process. In running a descriptive analysis, the three variables; minority, socioeconomic, and highly qualified teachers, were analyzed to determine if the school had a similar composition from the pre-renovation, during the years of renovation, all the way to post-renovation. The 15 elementary schools that met the criteria of a complete renovation had nine schools in the pre-renovation process in the 2005-2006 school year. Three schools were considered in pre-renovation stage in 2006-2007 with only one school having established pre-renovation stage in 2007-2008. Closing out the pre-renovation stage were two schools in 2008-2009. The actual years of renovation for the 15 schools varied slightly with nine schools in the renovation stage in 2006-2007, three in 2007-2008, and the remaining three in the renovation stage during the 2008-2009 school year. The post-renovation stage included nine schools for the 2007-2008 school year, one for the 2008-2009 school year, two for the 2009-2010 school year, and three schools for the 2010-2011 school year (Table 4.1).

The theory that the demographics of each school would have minimal change throughout all three stages of the renovation process was made in accordance with the hypothesis derived from the Mayo (2012) study. Mayo (2012) hypothesized that if there were no statistically significant changes in the demographic variables, then the student body for each school would consist of a similar composition for each year of the study. Table 4.2 displays the means and standard deviations of the demographic variables through each stage of the renovation process. The mean of the percentage of minorities was 20.50% for the pre-renovation stage with a standard deviation of 20.40% (M = 20.50, SD = 20.40), 22.50% during renovation, with a

standard deviation of 20.20% (*M* = 22.50, *SD* = 20.20), and 20.30% post-renovation with a standard deviations of 20.10% (*M* = 20.30, *SD* = 20.10). Data for the variable of socio-economic status of students reveals the mean of the percentage was 37.32% for the pre-renovation stage with a standard deviation of 20.90%, (*M* = 37.32, *SD* = 20.90), 40.03% during renovation, with a standard deviation of 23.63% (*M* = 40.03, *SD* = 23.63), and 39.10% post-renovation with a standard deviation of 24.25% (*M* = 39.10, *SD* = 24.25). The final demographic variable data found the mean of the percentage of highly qualified teachers was 98.54% for the pre-renovation stage with a standard deviation of 2.17 (*M* = 98.54, *SD* = 2.17), 99.11% during renovation with a standard deviation of 1.72% (*M* = 99.11, *SD* = 1.72), and 99.81% post-renovation with a standard deviation of .717% (*M* = 99.81, *SD* = .717).

Table 4.2 *Mean Amount of Demographic Variables by Renovation Stage (N=15 schools)*

		Pre-Renovation (n=15)		Renovation *(n=18)		Post-Renovation (n=15)	
	Measure	M	SD	M	SD	M	SD
1.	% of Minorities	20.50	20.40	22.50	20.20	20.30	20.10
2.	% SES	37.32	20.90	40.03	23.63	39.10	24.25
3.	% Highly Qualified	98.54	2.17	99.11	1.72	99.81	0.71

**Renovation N = 18 instead of 15 because renovation = # schools plus # years. Total N=48*

An extended review of the three demographic variables by year revealed similar outcomes as to those in Table 4.2 which was presented by the stages of renovation. Table 4.3 displays the means and standard deviation of the three demographic variables by year, 2005-2008. During the year 2005-2006 nine schools were analyzed, 2006-2007 a total of 12 schools, and in 2007-2008 the school sample was 13. The mean of the percentage of minorities in 2005-

2006 was 17.00%, with a standard deviation of 23.60% (*M* = 17.00, *SD* = 23.60), a 25.00% mean in 2006-2007 with a standard deviation of 13.30% (*M* = 25.00, *SD* = 13.30), and a mean of 14.30% in 2007-2008 with a standard deviation of 01.50% (*M* = 14.30, *SD* = 01.50). Data for the variable of socio-economic status of students indicated the mean of the percentage was 36.09% for the year 2005-2006 with a standard deviation of 23.46%, (*M* = 36.09, *SD* = 23.46), 37.60% in 2006-2007, with a standard deviation of 21.01% (*M* = 37.60, *SD* = 21.01), and 21.49% in 2007-2008, with a standard deviation of 2.23% (*M* = 21.49, *SD* = 2.23). The final demographic variable data indicated the mean of the percentage of highly qualified teachers was 98.96% for the years of 2005-2006 with a standard deviation of 1.81% (*M* = 98.96, *SD* = 1.81), 98.95% in 2006-2007 with a standard deviation of 1.97% (*M* = 98.95, *SD* = 1.97), and 100% in 2007-2008 with a standard deviation of .000% (*M* = 100.00, *SD* = .000).

Table 4.3 *Mean Amount of Demographic Variables by Year (2005-2008)*

		2005-2006 *(n=9)		2006-2007 *(n=12)		2007-2008 *(n=13)	
	Measure	M	SD	M	SD	M	SD
1.	% of Minorities	17.00	23.60	25.00	13.30	14.30	1.50
2.	% SES	36.09	23.46	37.60	21.01	21.49	2.23
3.	% Highly Qualified	98.96	1.81	98.95	1.97	100.00	.000

**n= number of schools in any stage of renovation.*

During the year 2008-2009 six schools were analyzed, 2009-2010 a total of five schools, and in 2010-2011 the school sample was three. Table 4.4 (Years 2008-2011) indicates the mean of the percentage of minorities was 35.80% for the year 2008-2009 with a standard deviation of 3.30% (*M* = 35.80, *SD* = 3.30), a means of 11.40% in 2009-2010, with a standard deviation of

3.10% (*M* = 11.40, *SD* = 3.10), and a mean of 36.80% in 2010-2011 with a standard deviation of 2.80% (*M* = 36.80, *SD* = 2.80). Data for the variable of socio-economic status of students reveals the mean of the percentage was 62.83% for the year 2008-2009 with a standard deviation of 5.33%, (*M* = 62.83, *SD* = 5.33), 19.99% in 2009-2010, with a standard deviation of 2.36% (*M* = 19.99, *SD* = 2.36), and 61.88% in 2010-2011, with a standard deviation of 6.01% (*M* = 61.88, *SD* = 6.01). The final demographic variable data indicated the mean of the percentage of highly qualified teachers was 100% for the years of 2008-2009 with a standard deviation of .000% (*M* = 100.00, *SD* = .000), 99.02% in 2009-2010 with a standard deviation of 1.66% (*M* = 99.02, *SD* = 1.66), and 99.48% in 2010-2011 with a standard deviation of 1.72% (*M* = 99.48, *SD* = 1.72).

Table 4.4 *Mean Amount of Demographic Variables by Year (2008-2011)*

		2008-2009 *(n=6)		2009-2010 *(n=5)		2010-2011 *(n=3)	
	Measure	M	SD	M	SD	M	SD
1.	% of Minorities	35.80	3.30	11.40	3.10	36.80	2.80
2.	% SES	62.83	5.33	19.99	2.36	61.88	6.01
3.	% Highly Qualified	100.00	.000	99.02	1.66	99.48	1.72

**n= number of schools in any stage of renovation.*

Both Tables 4.3 and 4.4 illustrate the range of means when comparing the three demographic variables across the time span of 2004-2011 with all schools in any stage of the renovation process. This led to smaller sample sizes at the end of the timeframe due to the fact that all schools had different completion dates. Only three schools were in the sample population for the final year of the study (2010-2011).

The 15 schools studied also varied in geographic locations within the Commonwealth of Virginia. Therefore, in order to analyze the difference between the means of each school against the variables within the sample an Analysis of Variance (ANOVA) was completed. The ANOVA illustrated whether or not changes in the demographic variables occurred during the stages of the renovation. Table 4.5 displays a summary of the demographic variables when compared within the factors of pre, during, and post renovation stages. The categories listed in Table 4.5 provide a specific purpose in the statistical analysis of the demographic variables. The Sum of Squares illustrates the total variance between the demographic variables and the stages of renovation, df references the degree of freedom (overlap) between the demographic variables and the stages of renovation, Mean Square denotes how similar the groups are, and F is the ratio of variance. This aspect of Table 4.5 designates whether or not the factors of the demographic variables are equal across the stages of renovation. When the F-ratio and the *p*-value (the probability that a hypothesis is wrong) is statistically significant at a .05 level or below, then the ANOVA illustrated in Table 4.5 confirms that the student population within the schools is not similar throughout the time span of the pre-, during, and post-renovation stages.

Table 4.5 *Summary of ANOVA for Demographic Variables vs. Stages of Renovation*

Source	Sum of Squares	df	Mean Square	F	Sig.
% of Minorities					
Factor	.005	2	.002	.059	.943
Within Groups (Error)	1.853	45	.041		
Total	1.858	47			
% SES					
Factor	61.014	2	30.507	.058	.944
Within Groups (Error)	23,848.538	45	529.968		
Total	23,909.552	47			
% Highly Qualified					
Factor	12.107	2	6.054	2.194	.123
Within Groups (Error)	124.151	45	2.759		
Total	136.258	47			

$p<0.05$

Table 4.5 illustrated that no significant difference occurred within the stages of renovation and the demographic variables did not significantly influence the means of the scaled scores in mathematics or reading. To verify, an analysis was conducted of the mean scaled scores in both mathematics and reading at the fifth grade level on the Virginia Standards of Learning.

Means of Scaled Scores

The mathematics and reading Standards of Learning (SOL) assessment scores are reported by the VDOE as a means of a scaled score. Students who take an SOL receive a raw score based on the total number correct out of the number of questions on the assessment. The raw score is then converted into a scale based on the percentage of students taking the

assessment and their range in answering questions correct or incorrect. Once the scale is determined, the state issues for each school, by grade and student, the scaled score received to determine if the student passed or failed the SOL assessment. For this study the means (average) of the scaled scores were collected from the VDOE in order to analyze whether or not a complete renovation influenced student achievement.

Procedures that were used for the demographic variables in order to calculate the means, standard deviations, and the ANOVA analysis of the renovation stages were also used to analyze the means of the scaled scores to answer the two sub-research questions regarding student achievement in the area of mathematics and reading. The two sub-questions are as follows:

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

The mathematics and reading scaled scores were reported and calculated separately for each stage of the renovation process: pre, during, and post. Due to multiple years it may have taken for some schools to renovate, the ‘during’ stage of the renovation process included an average which combined the scaled score of all the years during renovation. The total sample size for the ‘during’ renovation stage was 18 years of school data. The pre-renovation and post-renovation both consisted of only the total number of schools in the study, which was 15. The sample size totaled 48 years of school data. This consisted of 15 years for pre-renovation, 18 years for during renovation, and 15 years for post-renovation.

Sub-research Question 1:

What is the difference, if any, in student scaled scores as measured by the Standards of Learning Assessment at the fifth grade level in mathematics prior to, during, and after the renovation process?

Illustrated in Table 4.6 are the Math Mean Scaled Scores for the three renovation stages of the combined 15 schools in the study. The pre-renovation stage revealed a mean mathematics scaled score of 499.42 with a standard deviation of 31.93 (M = 499.42, SD = 31.93). The mean score during renovation was 506.39 with a standard deviation of 29.51 (M = 506.39, SD = 29.51). The post-renovation mean mathematics scaled score was 504.59 with a standard deviation of 25.60 (M = 504.59, SD = 29.51).

Table 4.6 *Mean Amount of Math Scaled Scores by Renovation Stage (N=15 schools)*

	Pre-Renovation (n=15)		Renovation *(n=18)		Post-Renovation (n=15)	
Measure	M	SD	M	SD	M	SD
1. Math Mean Scaled Scores	499.42	31.93	506.39	29.51	504.59	25.60

**Renovation N = 18 instead of 15 because renovation = # schools plus # years. Total N is 48.*

In order to see if the stages of the renovation process showed any differences on student achievement in the area of mathematics on the fifth Grade SOL assessment, an ANOVA was conducted. Table 4.7 illustrates the results of the ANOVA indicating that in the area of mathematics, as measured by a means of scaled scores, student achievement is not different among schools when targeting different stages of the renovation process. The F-ratio and Significance is higher than the statistical *p*-value (the *p*robability that a hypothesis is wrong) of

.05 indicating that the influence of any particular stage of the renovation process had no bearing on student achievement.

Table 4.7 *Summary of ANOVA for Math Mean Scaled Scores vs. Stages of Renovation*

Source	Sum of Squares	df	Mean Square	F	Sig.
Math Mean Scaled Scores					
Factor	416.734	2	208.367	.245	.784
Within Groups (Error)	38,266.582	45	850.368		
Total	38,683.316	47			

$p<0.05$

Sub-research Question 2:

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

Illustrated in Table 4.8 are the Reading Mean Scaled Scores for the three renovation stages of the combined 15 schools in the study. Each stage of the renovation process had a different sample size due to the multiple years of renovations per school. The pre-renovation and post-renovation sample sizes were the total number of schools in the study, 15 for each stage. The during renovation stages sample size grew due to multiple years of renovation per school and increased to a sample size of 18, for a total sample size of 48. The pre-renovation stage revealed a mean reading scaled score of 489.25 with a standard deviation of 27.06 (M = 489.25, SD = 27.06). The mean score during renovation was 478.89 with a standard deviation of 26.75 (M = 478.89, SD = 26.75). The post-renovation mean reading scaled score was 483.52 with a standard deviation of 25.45 (M = 483.89, SD = 25.45).

Table 4.8 *Mean Amount of Reading Scaled Scores by Renovation Stage(N=15Schools)*

	Pre-Renovation (n=15)		Renovation *(n=18)		Post-Renovation (n=15)	
Measure	M	SD	M	SD	M	SD
1. Reading Mean Scaled Scores	489.25	27.06	478.89	26.75	483.52	25.45

**Renovation N = 18 instead of 15 because renovation = # schools plus # years. Total N is 48.*

Once again an ANOVA was conducted in order to see if the stages of the renovation process showed any differences on student achievement in the area of reading on the fifth grade SOL assessment. Table 4.9 illustrates the results of the ANOVA indicating that in the area of reading, as measured by a means of scaled scores, student achievement is not different among schools when targeting different stages of the renovation process. The F-ratio and Significance is higher than the statistical *p*-value (the probability that a hypothesis is wrong) of .05 indicating that the influence of any particular stage of the renovation process once again had no bearing on student achievement.

Table 4.9 *Summary of ANOVA for Reading Mean Scaled Scores vs. Stages of Renovation*

Source	Sum of Squares	df	Mean Square	F	Sig.
Reading Mean Scaled Scores					
Factor	878.546	2	439.273	.628	.538
Within Groups (Error)	31,495.009	45	699.889		
Total	32,373.554	47			

$p<0.05$

The final combined school analysis was conducted by running a *t*-test on the pre-renovation stage and the post-renovation stage for the mean scaled scores for mathematics and

reading in order to determine if an influence existed from pre to post stages. The *t*-test did not indicate any statistically significant influence on student achievement in mathematics or reading when comparing the pre-renovation stage to the post-renovation stage. Table 4.10 illustrates that mathematics revealed no significance as $p<0.05$; $t(28) = -0.489$, $p = 0.467$. Reading also revealed no significance as $p<0.05$; $t(28) = 0.598$, $p = 0.883$.

Table 4.10 *Group Differences Between Renovation Stages on Math and Reading Scaled Scores*

		Pre-Renovation (n=15)		Post-Renovation (n=15)				
	Measure	M	SD	M	SD	*df*	*t*	Sig.
1.	Math Mean Scaled Scores	499.42	31.93	504.59	25.60	28	-.489	.467
2.	Reading Mean Scaled Scores	489.25	27.06	483.52	25.45	28	.598	.883

$p<0.05$

Comparison of Mean Scaled Scores in Mathematics and Reading vs the State

To align with the methodology used by Mayo (2012), an analysis of each school's means scaled scores in mathematics and reading was conducted and compared to the state means scaled scores. All schools' analyses were completed independently due to the various years of inception and completion dates for the school's renovation project. To illustrate the comparison, Tables 4.11 and 4.12 display the 15 schools separately with the state averages for each school year of the renovation process.

Table 4.11 compares the mathematics scaled scores of all schools in the study to the mathematics scaled scores of the state. The mean scaled score for School A was 510.25 in pre-renovation stage and the mean scaled score for the state was 447.26. During the renovation years, the mean score was 528.82 with a standard deviation of 22.93 (M = 528.82, SD = 22.93) while

the state compared with a mean score of 494.78 and standard deviation of 17.04 (M = 494.78, SD = 17.04). The mean scores during the post-renovation stage were 547.23 for School A and 470.36 for the state.

School B had a mean scaled score of 483.41 for the stage of pre-renovation and the mean scaled score for the state was 447.26. The years of renovation illustrated the mean scaled score was 509.38 with a standard deviation of 35.45 (M = 509.38, SD = 35.45) and the state mean score during renovation was 476.64 with a standard deviation of 32.37 (M = 476.64, SD = 32.37). The mean scores of the post-renovation stage were 500.91 and 458.89 respectively.

School C had a mean scaled score of 535.49 in the pre-renovation stage and the mean scaled score of the state was 489.97. During the renovation year, the mean scaled score was 556.00, while the state compared at 447.26. The mean scaled scores of the post-renovation stage were 510.10 for School C and 462.22 for the state.

School D posted a 534.23 as a mean scaled score in the pre-renovation stage and the state compared at 489.97. The one year during renovation listed the mean scaled score as 526.91 with the mean scaled score for the state at 447.26. The post-renovation stage for School D illustrated a mean scaled score as 541.07 and the state's mean scaled score as 462.22.

School E had a mean scaled score of 490.57 during the pre-renovation and the mean scaled score of the state was 469.16. During the renovation year, the mean score was 512.28 and the state was 470.36. The mean scores during the post-renovation were 522.67 and 458.89 corresponding with the school and state respectively.

School F had a mean scaled score of 488.60 in the pre-renovation stage and the mean scaled score of the state was 447.26. During the renovation year, the mean scaled score was

472.09, while the state compared at 462.22. The mean scaled scores of the post-renovation stages were 500.25 for School F and 469.16 for the state.

School G posted a 508.15 as a mean scaled score in the pre-renovation stage and the state compared at 462.22. The one year during renovation listed the mean scaled score as 535.23 with the mean scaled score for the state at 469.16. The post-renovation stage for School D illustrated a mean scaled score as 496.60 and the state's mean scaled score as 470.36.

School H had a mean scaled score of 548.03 during the pre-renovation and the mean scaled score of the state was 489.97. During the renovation year, the mean score was 523.20 and the state was 447.26. The mean scores during the post-renovation were 520.36 and 462.22 corresponding with the school and state respectively.

School I had a mean scaled score of 474.06 in the pre-renovation stage and the mean scaled score of the state was 489.97. During the renovation year, the mean scaled score was 465.01, while the state compared at 447.26. The mean scaled scores of the post-renovation stages were 441.99 for School I and 462.22 for the state.

School J posted a 493.80 as a mean scaled score in the pre-renovation stage and the state compared at 469.16. The one year during renovation listed the mean scaled score as 466.60 with the mean scaled score for the state at 470.36. The post renovation stage for School J illustrated a mean scaled score as 491.56 and the state's mean scaled score as 458.89.

School K had a mean scaled score of 491.22 during the pre-renovation and the mean scaled score of the state was 489.97. During the renovation year, the mean score was 505.78 and the state was 447.26. The mean scores during the post-renovation were 514.64 and 462.22 corresponding with the school and state respectively.

School L had a mean scaled score of 520.29 in the pre-renovation stage and the mean scaled score of the state was 489.97. During the renovation year, the mean scaled score was 503.86, while the state compared at 447.26. The mean scaled scores of the post-renovation stages were 511.20 for School L and 462.22 for the state.

School M posted a 514.74 as a mean scaled score in the pre-renovation stage and the state compared at 489.97. The one year during renovation listed the mean scaled score as 475.92 with the mean scaled score for the state at 447.26. The post renovation stage for School M illustrated a mean scaled score as 488.96 and the state's mean scaled score as 462.22.

School N had a mean scaled score of 483.21 during the pre-renovation and the mean scaled score of the state was 489.97. During the renovation year, the mean score was 514.95 and the state was 447.26. The mean scores during the post-renovation were 505.94 and 462.22 corresponding with the school and state respectively.

School O had a mean scaled score of 415.28 for the stage of pre-renovation and the mean scaled score for the state was 489.97. The year of renovation illustrated the mean scaled score was 471.40 and the state mean score during renovation was 447.26. The mean scaled score of the post-renovation stage for School O was 475.42 and the state had a mean scaled score of 462.22.

Table 4.11 *Comparison of Math Mean Scaled Scores by School vs. State*

	School		State	
Measure	M	SD	M	SD
School A				
1. Pre-renovation (2006-2007)	510.25	.	447.26	.
2. Renovation (2007-2009)	528.82	22.93	494.78	17.04
3. Post-renovation (2009-2010)	547.23	.	470.36	.
School B				
1. Pre-renovation (2006-2007)	483.41	.	447.26	.

2. Renovation (2007-2010)	509.38	35.45	476.64	32.37
3. Post-renovation (2010-2011)	500.91	.	458.89	.
School C				
1. Pre-renovation (2005-2006)	535.49	.	489.97	.
2. Renovation (2006-2007)	556.00	.	447.26	.
3. Post-renovation (2007-2008)	510.10	.	462.22	.
School D				
1. Pre-renovation (2005-2006)	534.23	.	489.97	.
2. Renovation (2006-2007)	526.91	.	447.26	.
3. Post-renovation (2007-2008)	541.07	.	462.22	.
School E				
1. Pre-renovation (2008-2009)	490.57	.	469.16	.
2. Renovation (2009-2010)	512.28	.	470.36	.
3. Post-renovation (2010-2011)	522.67	.	458.89	.
School F				
1. Pre-renovation (2006-2007)	488.60	.	447.26	.
2. Renovation (2007-2008)	472.09	.	462.22	.
3. Post-renovation (2008-2009)	500.25	.	469.16	.
School G				
1. Pre-renovation (2007-2008)	508.15	.	462.22	.
2. Renovation (2008-2009)	535.23	.	469.16	.
3. Post-renovation (2009-2010)	496.60	.	470.36	.
School H				
1. Pre-renovation (2005-2006)	548.03	.	489.97	.
2. Renovation (2006-2007)	523.20	.	447.26	.
3. Post-renovation (2007-2008)	520.36	.	462.22	.
School I				
1. Pre-renovation (2005-2006)	474.06	.	489.97	.
2. Renovation (2006-2007)	465.01	.	447.26	.

3. Post-renovation (2007-2008)	441.99	.	462.22	.
School J				
1. Pre-renovation (2008-2009)	493.80	.	469.16	.
2. Renovation (2009-2010)	466.60	.	470.36	.
3. Post-renovation (2010-2011)	491.56	.	458.89	.
School K				
1. Pre-renovation (2005-2006)	491.22	.	489.97	.
2. Renovation (2006-2007)	505.78	.	447.26	.
3. Post-renovation (2007-2008)	514.64	.	462.22	.
School L				
1. Pre-renovation (2005-2006)	520.29	.	489.97	.
2. Renovation (2006-2007)	503.86	.	447.26	.
3. Post-renovation (2007-2008)	511.20	.	462.22	.
School M				
1. Pre-renovation (2005-2006)	514.74	.	489.97	.
2. Renovation (2006-2007)	475.92	.	447.26	.
3. Post-renovation (2007-2008)	488.96	.	462.22	.
School N				
1. Pre-renovation (2005-2006)	483.21	.	489.97	.
2. Renovation (2006-2007)	514.95	.	447.26	.
3. Post-renovation (2007-2008)	505.94	.	462.22	.
School O				
1. Pre-renovation (2005-2006)	415.28	.	489.97	.
2. Renovation (2006-2007)	471.40	.	447.26	.
3. Post-renovation (2007-2008)	475.42	.	462.22	.

Table 4.12 compares the reading scaled scores of all schools in the study to the reading scaled scores of the state. The mean scaled score for School A was 502.79 in pre-renovation stage and the mean scaled score for the state was 460.57. During the renovation years, the mean

score was 516.06 with a standard deviation of 10.19 (M = 516.06, SD = 10.19) while the state compared with a mean score of 485.38 and standard deviation of 4.32 (M = 485.38, SD = 4.32). The mean scores during the post-renovation stage were 511.50 for School A and 485.04 for the state.

School B had a mean scaled score of 541.04 for the stage of pre-renovation and the mean scaled score for the state was 460.57. The years of renovation illustrated the mean scaled score was 466.46 with a standard deviation of 9.66 (M = 466.46, SD = 9.66) and the state mean score during renovation was 484.53 with a standard deviation of 2.08 (M = 484.53, SD = 2.08). The mean scores of the post-renovation stage were 471.55 and 489.12 respectively.

School C had a mean scaled score of 524.52 in the pre-renovation stage and the mean scaled score of the state was 470.28. During the renovation year, the mean scaled score was 526.66, while the state compared at 460.57. The mean scaled scores of the post-renovation stages were 516.38 for School C and 471.74 for the state.

School D posted a 512.93 as a mean scaled score in the pre-renovation stage and the state compared at 470.28. The one year during renovation listed the mean scaled score as 503.95 with the mean scaled score for the state at 460.57. The post renovation stage for School D illustrated a mean scaled score as 517.14 and the state's mean scaled score as 471.74.

School E had a mean scaled score of 481.22 during the pre-renovation and the mean scaled score of the state was 482.25. During the renovation year, the mean score was 471.07 and the state was 485.04. The mean scores during the post-renovation were 478.22 and 489.12 corresponding with the school and state respectively.

School F had a mean scaled score of 476.65 in the pre-renovation stage and the mean scaled score of the state was 460.57. During the renovation year, the mean scaled score was

480.91, while the state compared at 471.74. The mean scaled scores of the post renovation stages were 496.43 for School F and 482.25 for the state.

School G posted a 477.92 as a mean scaled score in the pre-renovation stage and the state compared at 471.74. The one year during renovation listed the mean scaled score as 488.46 with the mean scaled score for the state at 482.25. The post-renovation stage for School D illustrated a mean scaled score as 476.77 and the state's mean scaled score as 485.04.

School H had a mean scaled score of 509.03 during the pre-renovation and the mean scaled score of the state was 470.28. During the renovation year, the mean score was 480.50 and the state was 460.57. The mean scores during the post-renovation were 495.37 and 471.74 corresponding with the school and state respectively.

School I had a mean scaled score of 444.39 in the pre-renovation stage and the mean scaled score of the state was 470.28. During the renovation year, the mean scaled score was 460.73, while the state compared at 460.57. The mean scaled scores of the post-renovation stages were 440.00 for School I and 471.74 for the state.

School J posted a 485.47 as a mean scaled score in the pre-renovation stage and the state compared at 482.25. The one year during renovation listed the mean scaled score as 439.11 with the mean scaled score for the state at 485.04. The post-renovation stage for School J illustrated a mean scaled score as 459.12 and the state's mean scaled score as 489.12.

School K had a mean scaled score of 480.66 during the pre-renovation and the mean scaled score of the state was 470.28. During the renovation year, the mean score was 500.78 and the state was 460.57. The mean scores during the post-renovation were 496.94 and 471.74 corresponding with the school and state respectively.

School L had a mean scaled score of 483.60 in the pre-renovation stage and the mean scaled score of the state was 470.28. During the renovation year, the mean scaled score was 460.64, while the state compared at 460.57. The mean scaled scores of the post-renovation stages were 468.15 for School L and 471.74 for the state.

School M posted a 473.25 as a mean scaled score in the pre-renovation stage and the state compared at 470.28. The one year during renovation listed the mean scaled score as 434.26 with the mean scaled score for the state at 460.57. The post-renovation stage for School M illustrated a mean scaled score as 460.58 and the state's mean scaled score as 471.74.

School N had a mean scaled score of 503.54 during the pre-renovation and the mean scaled score of the state was 470.28. During the renovation year, the mean score was 489.98 and the state was 460.57. The mean scores during the post-renovation were 514.89 and 471.74 corresponding with the school and state respectively.

School O had a mean scaled score of 441.86 for the stage of pre-renovation and the mean scaled score for the state was 470.28. The year of renovation illustrated the mean scaled score was 451.58 and the state mean score during renovation was 460.57. The mean scaled score of the post-renovation stage for School O was 449.78 and the state was 471.74.

Table 4.12 *Comparison of Reading Mean Scaled Scores by School vs. State*

	School		State	
Measure	M	SD	M	SD
School A				
1. Pre-renovation (2006-2007)	502.79	.	460.57	.
2. Renovation (2007-2009)	516.06	10.19	485.38	4.32
3. Post-renovation (2009-2010)	511.50	.	485.04	.
School B				
1. Pre-renovation (2006-2007)	541.04	.	460.57	.

2. Renovation (2007-2010)	466.46	9.66	484.53	2.08
3. Post-renovation (2010-2011)	471.55	.	489.12	.
School C				
1. Pre-renovation (2005-2006)	524.52	.	470.28	.
2. Renovation (2006-2007)	526.66	.	460.57	.
3. Post-renovation (2007-2008)	516.38	.	471.74	.
School D				
1. Pre-renovation (2005-2006)	512.93	.	470.28	.
2. Renovation (2006-2007)	503.95	.	460.57	.
3. Post-renovation (2007-2008)	517.14	.	471.74	.
School E				
1. Pre-renovation (2008-2009)	481.22	.	482.25	.
2. Renovation (2009-2010)	471.07	.	485.04	.
3. Post-renovation (2010-2011)	478.22	.	489.12	.
School F				
1. Pre-renovation (2006-2007)	476.65	.	460.57	.
2. Renovation (2007-2008)	480.91	.	471.74	.
3. Post-renovation (2008-2009)	496.43	.	482.25	.
School G				
1. Pre-renovation (2007-2008)	477.92	.	471.74	.
2. Renovation (2008-2009)	488.46	.	482.25	.
3. Post-renovation (2009-2010)	476.77	.	485.04	.
School H				
1. Pre-renovation (2005-2006)	509.03	.	470.28	.
2. Renovation (2006-2007)	480.50	.	460.57	.
3. Post-renovation (2007-2008)	495.37	.	471.74	.
School I				
1. Pre-renovation (2005-2006)	444.39	.	470.28	.
2. Renovation (2006-2007)	460.73	.	460.57	.

3. Post-renovation (2007-2008)	440.00	.	471.74	.
School J				
1. Pre-renovation (2008-2009)	485.47	.	482.25	.
2. Renovation (2009-2010)	439.11	.	485.04	.
3. Post-renovation (2010-2011)	459.12	.	489.12	.
School K				
1. Pre-renovation (2005-2006)	480.66	.	470.28	.
2. Renovation (2006-2007)	500.78	.	460.57	.
3. Post-renovation (2007-2008	496.94	.	471.74	.
School L				
1. Pre-renovation (2005-2006)	483.60	.	470.28	.
2. Renovation (2006-2007)	460.64	.	460.57	.
3. Post-renovation (2007-2008	468.15	.	471.74	.
School M				
1. Pre-renovation (2005-2006)	473.25	.	470.28	.
2. Renovation (2006-2007)	434.26	.	460.57	.
3. Post-renovation (2007-2008	460.58	.	471.74	.
School N				
1. Pre-renovation (2005-2006)	503.54	.	470.28	.
2. Renovation (2006-2007)	489.98	.	460.57	.
3. Post-renovation (2007-2008	514.89	.	471.74	.
School O				
1. Pre-renovation (2005-2006)	441.86	.	470.28	.
2. Renovation (2006-2007)	451.58	.	460.57	.
3. Post-renovation (2007-2008	449.78	.	471.74	.

Summary

Data were collected and analyzed from 15 elementary schools in the Commonwealth of Virginia in order to build on the previous research of Mayo (2012) regarding the relationship

between a complete renovation of a school and student achievement. The study looked at the areas of mathematics and reading, examining performance on the Standards of Learning Assessment prior to the renovation, during the renovation, and after the renovation process. Throughout this chapter a review of the procedures used in collecting and analyzing data was recorded.

The study utilized student academic and demographic data from the period of 2004-2005 through 2010-2011 school years. Student demographic data were used to demonstrate that the student population for each school stayed similar throughout the renovation process. Student achievement data consisted of mean scaled scores from the VDOE and were used to examine the trends in academic performance throughout the stages of renovation. A breakdown of the descriptive statistics completed for three demographic variables, the ANOVA, and the *t*-test was provided in order to explore the overarching question, "Does the complete renovation process of a school building influence student achievement?"

Chapter Five: Analysis of Findings, Conclusions, Discussion, and Recommendations

Introduction

The purpose of this study was to examine the relationship between the complete renovation of a school facility and student achievement. This chapter contains the analysis of the finding of the two research sub-questions which focus specifically on the mathematics and reading scaled scores for students in the Commonwealth of Virginia who took the Standards of Learning Assessments during the years of 2004-2010. Conclusions, discussion, and recommendations for further study will also be addressed.

Upon selecting the option to continue with a replication of previous research from the Mayo (2012) study, it was hoped that this one would lead to defining the relationship between a school renovation project and student performance. Out of 514 school construction projects listed by the Virginia Department of Education during 2004 to 2010, 89 were classified as renovation projects. Out of the 89, only 39 met the criteria of elementary schools servicing fifth grade students. The 39 elementary schools were then further reviewed and 15 met the criteria of fulfilling the four components of a complete renovation: structural, plumbing, electrical, and heating and air conditioning.

Analysis of Findings

The findings of the 15 schools identified as being a complete renovation generally showed no statistical significance between the variables and were not statistically significant when comparing student performance to each stage of the renovation process. With this new information it is important to provide a breakdown of the four analyses completed in this study in order to present any statistical significance or the lack thereof within the demographic variables,

mean scaled score for mathematics and reading analysis, or from a comparison of mean scaled scores for each school against the state average.

Demographic Variables: Finding One

Of the 48 sample years of demographic assessment data used during the renovation stages, no significant change was found in any of the three demographic variables. The percent of minorities fluctuated by two-one-thousands of a point showing little difference in the number of minority students served at each school across the three stages of the renovation project. The percent of socioeconomic status students showed only a slight gain of 2.71% during the renovation stage, then dropping back down .93% at post renovation. And lastly, the percent of highly qualified teachers only increased by 1.27% from pre- to post-renovation stage showing no statistical difference in this category. This is noted in Table 4.5 illustrating that no significant difference occurred within the stages of renovation, which means that the demographic variables did not significantly influence the means of the scaled scores in mathematics or reading.

Means of Scaled Scores for Mathematics and Reading: Finding Two

After analyzing the demographic variables, the means of the scaled scores in mathematics and reading at the fifth grade level were then analyzed for the 15 schools. The analysis consisted of one year prior to the renovation, the years during the renovation period averaged together, and one year post-renovation. In order to examine the relationship between the student achievement and each stage of the renovation process, this study only targeted completed renovations from the time period of 2004-2010. These years were selected based on the statewide changes to the standards in mathematics during 2001 and reading during 2002. As for the ending date of the study, 2010 was selected in order to have data for one year after the renovation process was completed. There was no statistical significance found in the relationship between the three

stages of the renovation process and student achievement. Table 4.7 illustrated the results of the ANOVA indicating that in the area of mathematics, as measured by a means of scaled scores, student achievement is not different among schools when different stages of the renovation process were targeted. In Table 4.7 the significance level of .784 (*p*-value of .05) indicated that the influence of any particular stage of the renovation process had no bearing on student achievement. Table 4.8 illustrated the results of the ANOVA indicating that in the area of reading, as measured by a means of scaled scores, student achievement is not different (before, during, or after) when different stages of the renovation process were targeted. In Table 4.9 the significance level of .538 (*p*-value of .05) indicated that the influence of any particular stage of the renovation process once again had no bearing on student achievement.

One of the most revealing aspects of the study was the difference among mathematics in comparison to the content of reading. Table 4.10 illustrated the *t*-test analysis, and even though neither mathematics nor reading showed any significant difference, mathematics *p*=value was half the amount of reading: math mean scaled score .467 and reading mean scaled score .883. This was an interesting outcome since the mathematics scores pre- to post-renovation increased by 5.17%, while reading decreased 5.73% which leads this researcher to believe that other variables dealing with the specific instruction of the mathematics content were involved. Variables such as the use of research based instructional strategies, backwards planning and quality lesson design, and the nurturing environment of school.

Comparison of Mean Scaled Scores in Mathematics and Reading vs. the State

A comparison of each school's means scaled student scores in mathematics and reading was made to the state mean scaled score revealed no momentous results. In the area of mathematics, 11 of the schools showed higher mean scaled scores in all three stages of the

renovation process in comparison to the state, four schools showed a combination of higher and lower scores within the renovation process in comparison to the state, and not a single school in the study showed lower mean scaled scores in the area of mathematics in all three stages of the renovation process in comparison to the state mean scaled scores. In the area of reading this was a little different in that only seven schools showed higher mean scaled scores in all three stages of the renovation process in comparison to the state, five schools showed a combination of higher and lower scores within the renovation process in comparison to the state, and two actually scored lower in all three stages of the renovation process in comparison to the state's mean scaled scores in reading.

Conclusion

The main research question was, 'Does the complete renovation process, which includes structural, plumbing, electrical, and heating and air conditioning changes of a school building, influence student achievement?' There were no statistically significant differences between the relationship of student performance and the pre, during, and post stages of a renovation project. Therefore, the conclusion of this study is that no difference in student scores could be found during any of the phases of the renovation process.

An analysis of two sub-questions also did not find any significantly statistical evidence that the mean scaled scores on the fifth grade mathematics and the fifth grade reading Standards of Learning assessment was impacted by the complete renovation of the 15 schools within the study. Also noted is the fact that no relationship can be made as a cause of low student performance based on the effects of a complete renovation project.

Discussion

The data from this study did not indicate that there was a statistically significant difference between the stages of the renovation process and student achievement. To recap, in the area of the mathematics scaled scores, no statistical significance was observed during the renovation stages with $p = .784$ and likewise in reading with $p = .538$. Similar results showing no statistical significance was observed in the area of mathematics scaled scores from pre to post-renovation stages only with $p = .467$ and again in reading with $p = .883$. These results are validated based on the previous analysis of the three demographic variables of percent of minority of students, percent of socioeconomic status students, and the percent of highly qualified teachers within each school across the periods of pre-, during, and post-renovation stages. All three demographic variables showed no statistically significant change, which means the composition of the schools was consistent from one year of assessment data to the next, and therefore, the demographics of the student population stayed the same.

With the findings of this study, combined with the previous Mayo (2012) study, it is important to note that these results are in contrast to the majority of research studies that have been completed on aspects of the condition of a school facility and the impact on students. As reported in Chapter Two of this study, researchers such as Cash (1993), Earthman and Lemaster (1996), Lackney (1999), Maxwell (1999), Earthman (2002), and McGowan (2007) provided a distinct understanding that student performance whether in mathematics, reading, attendance, or behavior is influenced by the condition of the school facility. Duran-Narucki (2008) confirmed in her study on school facilities that building conditions were significantly related to attendance and scores on the standardized test. While researcher Weinstein (1979) and McGuffey (1982) were

the first to report a comprehensive look at research findings on the relationship between school facilities condition to student achievement and behavior showing a significant relationship.

It is noteworthy to discuss that while comparing the results of this study to other studies one cannot assume that the schools being renovated were declining to the extent of not being utilized, only that the building itself required the four major components for a complete renovation. Consequently, overall conditions of the school improved from pre-renovation status to post-renovation status. The lack of statistical significant difference in this study is in itself a finding. This new research data is contrary to the majority of previous research and disputes what most in the field of education believe to be true. The study looked at the renovation stages over a period of seven years, and past research leads one to believe that the findings would be similar to those studies that found statistical evidence that a building renovation influenced student achievement. However, the majority of past research included only one year of assessment data. The difference with this study is that it compared the three stages of the renovation process which automatically spanned more than one year of data, a minimum of three and a maximum of seven years' worth of assessment data. This different twist on the study of the relationship that building conditions have on student achievement is important, and showing no statistical significance validates the original findings from Mayo (2012).

Implications for Practice

While this replication study cannot establish guidelines or procedures for every school division to use when contemplating the decision to renovate a school facility, suggestions regarding the implications for practice are offered.

Linking student achievement to the concept of prior to, during, and after the complete renovation process will benefit others in the field when analyzing the impact of a facility upgrade

while maintaining successful student achievement. The goal of this research was to determine if there was a relationship between the renovation processes as each stage of the process related to student achievement. Data from this research provided school leaders additional information to use in determining if their actions to maintain and improve a school facility impact student achievement.

Along the spectrum of the entire capital outlay project, this research adds to previous data that may help determine the answer of budget concerns when deciding new construction versus renovation. Data on the overall financial needs of a project are necessary in order to rehabilitate public schools in America. Mayo (2012) confirmed in his study that local governments have continued to postpone building maintenance in an effort to stay within their budgets. This led to the understanding that with more school divisions opting to renovate rather than build, a deeper awareness of the renovation process and the relationship to student achievement needed to be addressed. Mayo stated, "Data from this study will serve as a valuable resource for school divisions in determining the impact of the renovation process…lead[ing] the school division to consider ways to minimize the effect of the stages of the renovation process on student achievement" (Mayo, 2012, p.3-4). This study adds to that data and allows school divisions to place their financial resources strategically.

The final implication focuses on the fact that since no significant relationship was found between the renovation process and student achievement, school leaders who often believe that the renovation disrupts student learning in a way that shows an enormous decline in student performance can reassess their plans for moving students during the renovation of the building. Based on these findings, one can assume that the teachers and students in each of the 15 schools

in this study were resilient enough to withstand the movements and disruptions from the facility renovations.

Recommendations for Further Research

The following recommendations for further study are proposed:

1. Conduct a study that includes a mixed-methods approach that interviews and surveys teachers, students, parents, and school administrators. This study would use the same criteria for schools that met the four components of a complete renovation. The study would be a longitudinal study and could be conducted at elementary, middle, or high school.
2. Conduct a study at the high school level of the renovation process and student achievement. The study would look at the renovation process and determine its relationship with student achievement on the End-of-Course assessment for eleventh grade students in the area of reading and the Standards of Learning assessments for students at the high school level tracking geometry. The number of high schools within the Commonwealth of Virginia who meet the criteria of a having a complete renovation may provide a larger sample size than this elementary study or that of Mayo's (2012) middle school study.
3. Conduct the research study for a group of students using the mean scaled scores of students over a five year period. This study would track the cohort from one grade level to the next, in succession of a minimum of three years (pre-, during, and post-renovation) and determine if that cohorts of students were impacted based on the complete renovation of the school that they attended.

4. Conduct a study that researched the three stages of the renovation process and what additional instructional strategies are used by teachers to help them compensate for the ongoing construction in the school building.
5. Conduct the same study as this one and Mayo (2012), adding in the variables of attendance, discipline, and instructional differences from pre-, during, and post-renovations. This study would add to the previous research and allow for a more defined understanding of why no statistical significance was found in a relationship between student achievement and the renovation process.
6. Finally, conduct full qualitative study interviewing school leaders on the different aspects of the renovation process, the decisions they made and their justification for those decisions. Compare those themes to the overall themes of building conditions and student performance found in previous research.

References

21st Century School Fund. (2009). Research on the impact of school facilities on students and teachers: A summary of studies published since 2000. *Improving Urban Public School Facilities.* Washington, DC.

Abramson, P. (2013, February). 2012 Annual school construction report. *School Planning & Management Journal*. CR2-CR15. Mamaroneck, N.Y.

Branham, D. (2004, December*).* The wise man builds his house upon the rocks: The effects of inadequate school building infrastructure on student attendance. *Social Science Quarterly*, *85*(5). Blackwell Publishing, Houston, TX. Retrieved from http://www.attendanceworks.org/wordpress/wp-content/uploads/2012/10/Effects-of-Inadequate-Building-Infrastructure-David-Branham-Dec-2004.pdf

Cash, C.S. (1993). *A study of the relationship between school building condition and student achievement and behavior* (unpublished doctoral dissertation).Virginia Polytechnic Institute and State University, Blacksburg, VA.

Chan, T., & Petrie G. (1998). The brain learns better in well-designed school environments. *AIA Journal*, November, *2*(3).

Crampton, F., & Thompson, D. (December, 2002). The condition of America's schools: A national disgrace. *School Business Affairs*, *12,* 15-16. Retrieved from www.asbointl.org

Crampton, F., Thompson, D., & Vesely, R. (September, 2004). The forgotten side of school finance equity: The role of the infrastructure funding in student success. *National Association of Secondary School Principals Bulletin*, *88*(640). doi: 10.1177/019263650408864004.

Duran-Narucki, V. (2008). School building conditions, school attendance, and academic

achievement in New York City public schools: A mediation model. *Journal of Environmental Psychology, 28,* 278-286.

Earthman, G. (1994). *School renovation handbook: Investing in education*. Lancaster, PA: Technomic Publishing Company, Inc.

Earthman, G. (2002). *School facility conditions and student academic achievement*. Retrieved from http://www.escholarship.org/uc/item/5sw56439

Earthman, G. (2004). *Prioritization of 31 criteria for school building adequacy*. American Civil Liberties Union Foundation of Maryland, Baltimore, Maryland.

Earthman, G. (2009). *Planning educational facilities*: *What educators need to know.* (3rd ed.) Lanham, MD: The Rowman & Littlefield Publishing Group, Inc..

Earthman, G., & Draeger, B. (2000). *Experiencing a renovation: A practical guide for principals*. Reston, VA: National Association of Secondary School Principals.

Earthman, G., & Lemasters, L. (1996, October) *Review of research on the relationship between school buildings, student achievement, and student behavior*. Council of Educational Facilities Planners, Tarpon Springs, FL, Retrieved from http://eric.ed.gov/?id=ED416666

Earthman, G. & Lemasters, L. (2009) Teacher attitudes about classroom conditions, *Journal of Educational Administration, 47*(3), 323 – 335. http://dx.doi.org/10.1108/09578230910955764

Filardo, M., Cheng, S., Allen, M., Bar, M. & Ulsoy, J. (2010) State capital spending on PK-12 school facilities. *21st Century School Fund*, November Report.

Holloway, J.H. (2000) Healthy buildings, Successful students. *Educational Leadership, 57*(6), 88. Retrieved from American Programs Source, 3332041.

Holmes, S. (2011) *The impact of school facility construction and renovation on academic achievement in Texas*. (Doctoral dissertation). Lamar University, Beaumont, Texas.

Lackney, J. (1999). The relationship between environmental quality of school facilities and student performance. *Environmental Energy Study Institute (EESI),* Washington, D.C.

Lemasters, L. (1997). *A synthesis of studies pertaining to facilities, student achievement, and student behavior*. Virginia Polytechnic Institute and State University, ProQuest, UMI Dissertations Publishing, 9722616.

Mayo, J. (2012). *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* (Doctoral dissertation). Virginia Polytechnic Institute and State University, Blacksburg, Virginia.

Maxwell, L (1999). School building renovation and student performance: One district's experience. *Council of Education Facility Planners International*. Scottsdale, Arizona.

McGowen, R. (2007) *The impact of school facilities on student achievement, attendance, behavior, completion rate, and teacher turnover rate in selected Texas high schools* (Doctoral dissertation). Texas A&M University, College Station, Texas.

McGuffey, C. (1982) Facilities. Chapter 10, Improving educational standards and productivity. Berkeley, CA: McCutchan Publishing Co.

New York State Education Department (2008). *NYSED Building Condition Survey*. Retrieved from http://www.p12.nysed.gov/facplan/BldgCondSurv.htm

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

Tennessee Advisory Commission on Intergovernmental Relations- TACIR. (1995). Do K-12 school facilities affect education outcomes?, *Staff Information Report*, Nashville, TN.

Tuttle II, J. (2002) Reconstructing school renovation: A study of the renovation of Johnson-Williams Middle School, Berryville, Virginia, *Building Blocks to a Better Learning Series, 6*, Thomas Jefferson Center for Education Design, Charlottesville, Virginia.

United States General Accounting Office (1996, June). Report to Congressional requesters: School facilities America's schools report differing conditions. *Health, Education, and Human Services Division*, Washington, D.C. Retrieved from http://www.gao.gov.

Uline, C., Tschannen-Moran, M., & Wolsey, T. (2009). The walls speak: The stories occupants tell. *Journal of Educational Administration, 47*(3), 400-426.

Virginia Department of Education (2013) School report card: Accountability terminology. VDOE Website. Retrieved from: http://www.doe.virginia.gov/statistics_reports/school_report_card/accountability_terminology.shtmll

Virginia Department of Education (2003-2011). Public school facilities cost data report. VDOE Website. Retrieved from: http://www.doe.virginia.gov/support/facility_construction/school_construction/costs/index.shtml

Weinstein, C. (1979). The physical environment of the school: A review of the research. *Review of Educational Research*. *49*(4).

Wright, F.L. (1957). *A testament*. New York : Bramhall House. pp.155.

Young, E. (2003). Do K-12 school facilities affect education outcomes?. Tennessee Advisory Commission on Intergovernmental Relations – TAIRC *Staff Information Report*, Nashville, TN

Appendix A

VirginiaTech

Office of Research Compliance
Institutational Review Board
North End Center, Suite 4120, Virginia Tech
300 Turner Street NW
Blacksburg, Virginia 24061
540/231-4606 Fax 540/231-0959
email irb@vt.edu
website http://www.irb.vt.edu

MEMORANDUM

DATE: October 23, 2013

TO: Glen I Earthman, Dana Burton Norman

FROM: Virginia Tech Institutional Review Board (FWA00000572, expires April 25, 2018)

PROTOCOL TITLE: School Facility Renovation and Student Achievement

IRB NUMBER: **13-948**

Effective October 23, 2013, the Virginia Tech Institution Review Board (IRB) Administrator, Carmen T Papenfuss, approved the New Application request 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 within 5 business days 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 responsibilities before the commencement of your research.)

PROTOCOL INFORMATION:

Approved As:	**Exempt, under 45 CFR 46.110 category(ies) 4**
Protocol Approval Date:	**October 23, 2013**
Protocol Expiration Date:	**N/A**
Continuing Review Due Date*:	**N/A**

*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 federal 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.

(IRB continued)

Date*	OSP Number	Sponsor	Grant Comparison Conducted?

* Date this proposal number was compared, assessed as not requiring comparison, or comparison information was revised.

If this IRB protocol is to cover any other grant proposals, please contact the IRB office (irbadmin@vt.edu) immediately.

Appendix B

Email to the School Division Director of Facilities

November 9, 2013

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 fifth 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 fifth grade level will be reviewed one year prior to, during, and one year after a complete renovation process.

I have had the opportunity to review all elementary school renovations since 2004 in the Commonwealth of Virginia and I wanted to find out additional information on the renovation of _____Elementary 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 follow 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 work for the renovation of _____Elementary School (i.e. replacements of HVAC mechanical systems, 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.

Dana B. Norman
Doctoral Student, VaTech
dbnorman@vt.edu or 434-944-3284

Appendix C

Email to the Virginia Department of Education Office of School Improvement

November 10, 2013

Dr. Kathleen Smith
Director of School Improvement
Virginia Department of Education,
[mailto:Kathleen.Smith@doe.virginia.gov]
101 North 14th Street
P.O. Box 2120
Richmond, VA 23218-2120

Dear Dr. Smith:

I am a doctoral student at Virginia Polytechnic Institute and State University in the School of Education. I am currently working on a dissertation that focuses on the possible influences the renovation process has on student achievement, in the areas of mathematics and reading, at the fifth 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 fifth grade level will be reviewed one year prior to, during, and once 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 elementary 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 15 schools. For the schools selected to the study, access will be needed to scaled SOL assessment scores in mathematics and reading at the fifth 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 fifth grade level. Information on demographic variables (minority percentile, socio economic status percentile, and highly qualified teacher percentile) will also be needed for each school noted below during the specified time periods.

(VDOE letter continued)

School Name	SOL Assessment Data – School Years
School A	06-07, 07-08, 08-09, 09-10
School B	06-07, 07-08, 08-09, 09-10, 10-11
School C	05-06, 06-07, 07-08
School D	05-06, 06-07, 07-08
School E	08-09, 09-10, 10-11
School F	06-07, 07-08, 08-09
School G	07-08, 08-09, 09-10
School H	05-06, 06-07, 07-08
School I	05-06, 06-07, 07-08
School J	08-09, 09-10, 10-11
School K	05-06, 06-07, 07-08
School L	05-06, 06-07, 07-08
School M	05-06, 06-07, 07-08
School N	05-06, 06-07, 07-08
School O	05-06, 06-07, 07-08

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 atdnorman@vt.edu.

Sincerely,

Dana B. Norman
Virginia Tech Doctoral Student