# The Relationship Between School Facility Renovation and Student Achievement in Virginia High Schools

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

Doctor of Education
in
Educational Leadership and Policy Studies

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October 29, 2014
Blacksburg, Virginia

Keywords: renovation, construction, school facilities, achievement, high school

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## ABSTRACT

This dissertation examined the possible influence a complete renovation of a school facility had on student achievement as measured by performance on the Standards of Learning (SOL) in the areas of End-of-Course (EOC) Algebra I and EOC Reading in high schools within the Commonwealth of Virginia. This study replicated a prior study that researched the possible influence the complete renovation process had on student achievement as measured by performance on the SOL in the areas of mathematics and reading at the eighth grade level in the Commonwealth of Virginia.

For this study, a quantitative descriptive research methodology was used to determine the possible influences the renovation process would have on student achievement. To conduct such research, SOL scores in the areas of EOC Algebra I and EOC Reading, from high schools in Virginia were used one year prior to the renovation, during the renovation, and one year after the renovation.

The Virginia Department of Education recorded 514 school construction projects during the period beginning with the 2004-2005 school year through the 2010-2011 school year. From these 514 projects, only 20 projects met the criteria of being high school construction projects having conducted a complete renovation.

In order to determine stability of the student population and the quality of teachers across the renovation period, an analysis of demographic variables was conducted. These variables included the percentage of minority students, socioeconomic status, and percentage of highly qualified teachers. No statistical significance between the variables over the course of the renovation was found establishing sameness of these variables.

ANOVAs and *t*-tests were conducted to analyze student achievement across the renovation periods. The findings of the 20 high schools identified as having conducted a complete renovation were not statistically significant when comparing the EOC Algebra I and EOC Reading student performance to each stage of the renovation process. However, a positive trend was indicated when findings revealed an increase in the mean scaled score of mathematics when comparing the pre-renovation stage to the post-renovation stage.

# Dedication

I would like to dedicate this dissertation to my girls. My wife, Shannon, and my daughter, Rebecca, have loved me, supported me, and suffered with me as I have worked these past three years “in the basement” to complete this arduous journey. I am looking forward to reintroducing myself to both of them and spending much more family time getting to know each of them again. Thank you both for your understanding and for your belief in me. I love you very much.

I completed this program not only for myself, but also for the three of us as a family. At the age of 17, I want Rebecca to know that she can accomplish anything she sets her mind upon in this life. I very much look forward to her high school graduation in May so that we may all celebrate her accomplishments and her future together.

Acknowledgements

This journey has been such a wonderful experience for me in so many ways. There is no doubt that this achievement is due in large part to the assistance and support of so many others. The advice and guidance from all of my professors has been invaluable to this process. Dr. Carol Cash, Dr. Lewis Romano, and Dr. David Alexander as members of my dissertation committee, I would like to thank you for your patience and guidance in helping me to achieve this goal. I know that your time is valuable and I truly appreciate all you have offered me throughout this endeavor. As the chairman of my dissertation committee, I would like to offer a special thank you to Dr. Glen Earthman. His constant support motivated me to work on this project and he never allowed me to stop. There were times he threatened to "send the dogs out after me," but his words of encouragement, his thoughts about my ideas, and his guidance throughout this project have been invaluable.

I also want to thank my cohort of students that shared in this journey with me. Through the process of helping one another with our studies, there were definitely frustrating moments. We shared many hours of our weekends and nights with one another and we all endured together. Along with sharing in the experience of hard work, I am so glad to say that we also shared many laughs and good times. The support each of you has offered me has been instrumental in helping me reach this goal. As this particular journey comes to a close, I am proud to call many of you my colleagues and my friends. I look forward to other journeys with you down the road.

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# Chapter One

## Introduction

In the current era of public education in which there is great emphasis on high stakes assessments and student achievement, it is important for school administrators to place an equally high emphasis on the condition of school facilities. A good school facility supports the mission of successfully educating all students. Research has shown that clean air, good light, and a quiet, comfortable learning environment are important for academic achievement **(**Cash, 1993; Earthman, 2004; Lemasters, 1997; Schneider, 2002**)**. While influences such as student socioeconomic status and parental involvement are among the most substantial predictors of student academic achievement, the physical environment of the school facility does have an influence on student performance (Buckley, Schneider, & Shang, 2005). This is noteworthy because the condition of school facilities is a responsibility of school authorities and is directly under the control of the school district and state. While school authorities may have little control over a student's socioeconomic status and parental involvement at home, they have absolute control over the condition of the school facility. Therefore, improving school facilities offers a practical opportunity for improving academic performance.

From 2000 through 2008, money spent for school construction across the United States averaged more than 20 billion dollars each year (Abramson, 2012). Due to the recent recession that began in the latter part of 2008, annual spending for school construction has consistently decreased each year, and in 2012, only 12.2 billion dollars were spent on school construction. Because of this sudden decrease in funding, schools that were ready to proceed with construction projects have been forced to rethink their fiscal ability to do so.

The decrease in public funding during this time of weak economic growth has prevented school divisions with buildings needing improvement from completing much needed construction projects. With less money available for new construction, educators often look for other ways to spend their limited funds**.** In an effort to minimize the cost of building an entirely new school facility, many school districts are electing to conduct a complete renovation of an existing school facility. Often, this complete renovation must be embarked upon while students and teachers remain in some portion of the school facility. This lack of ability to relocate the students and teachers quite often exposes them to construction conditions such as noise, dust, and

less than ideal building temperatures resulting in an ineffective learning environment. Ineffective learning environments create huge challenges when attempting to maintain or increase student academic achievement.

The purpose of this study is to replicate the 2012 study conducted by John Mayo who researched the renovation process and student achievement using data from the Virginia Standards of Learning (SOL) Assessment for Mathematics and Reading at the eighth grade level. Mayo (2012) was one of the first to conduct a study that examined the relationship that building condition plays on student achievement before, during, and after the complete renovation process. For purposes of adding to the body of research, this replication of all components of the Mayo study will be completed using the same SOL content area assessments of mathematics and reading. However, rather than using the middle school levels of these assessments as Mayo did, I will utilize the EOC Algebra I and the EOC Reading SOL assessments at the high school level.

**Statement of the Problem**

The greatest single expense made by school officials is that of school facilities. It has been estimated that it would require more than $322 billion to meet the needs for new or renovated academic space across the nation (Rebuild, n.d.). While school facilities are in dire need of improvement, expectations and accountability for student academic success have increased dramatically over the past decade. During the recent economic decline across the United States, many school districts have forgone the opportunity to build a new school facility in favor of conducting a complete renovation on existing school buildings. With more school divisions looking at renovations as a viable option instead of new construction, based on the current state of the economy, understanding of the renovation process and the relationship with student achievement needs to be studied more thoroughly. In those school systems that choose to conduct a complete renovation while the school is fully operational, disruptions to the learning environment often occur.

**Research Questions**

Several studies have been done in an effort to show a relationship between the condition of the school facility and student academic achievement. However, there are a limited number of studies that have investigated the relationship between a complete school renovation and student

academic achievement. The purpose of this research is to examine any possible relationship between a school facility renovation process and student achievement on the high school level. Within this framework, the primary question for this study will be: Does the complete renovation process, which would include structural, plumbing, electrical, and heating and air conditioning improvements within a school building, influence student achievement? The Virginia Standards of Learning Assessments in End-of-Course (EOC) Algebra I and EOC Reading at the high school level will provide the student achievement data for this study. 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 in EOC Algebra I at the high school level before, during, and after the renovation process?
b. What difference, if any, is there in student scaled scores as measured by the Standards of Learning assessments in EOC Reading at the high school level before, during, and after the renovation process?

**Significance of the Study**

In recent years, public schools have been held to a higher level of accountability for student academic success. Due primarily to economic constraints, a vast majority of these same schools have long occupied facilities that were in a deteriorating state of physical condition. When faced with these same economic constraints, many school systems are choosing to conduct a complete renovation, often with students still occupying the school, rather than choosing to build a more costly new facility. This choice leaves school administrators with the challenge of achieving high student academic success while expecting students and teachers to focus and learn in an uncomfortable school environment.

This study will examine closely the possible influence that a complete renovation of a school facility might have upon student achievement at high schools within the Commonwealth of Virginia. This study will examine student achievement in the areas of reading and mathematics before, during, and after the renovation process. Data from this study will serve as a valuable resource for school divisions in determining the impact the renovation process has on student achievement. This information could lead the school divisions to consider ways to minimize the effect the renovation process has on student achievement or perhaps to consider

other options rather than conducting a facility renovation. In addition, the results of this study will be compared with previous studies dealing with renovations and student achievement to ascertain if commonalities exist.

**Limitations of the Study**

Mayo (2012) included five limitations within his original study. In this replication study, several limitations found in Mayo will also exist. This study will include data from only completely renovated high schools located in the Commonwealth of Virginia.

The first limitation could be the physical layout of individual schools. High schools conducting a complete renovation in the Commonwealth of Virginia may be comprised of a campus style layout or contained in one enclosed structure. Various renovation factors may be intensified or lessened in a campus-style setting. Such factors may include noise, dust, varying degrees of air temperature, and the presence of construction workers. The same limitation could be found in a relatively large high school that is contained in one enclosed structure. The larger the facility, the better the chances that certain parts of the facility will not experience the negative impact of attending school during a complete renovation.

The second limitation is that a different cohort of students was reviewed for each year of the renovation process. This study did not look at cohorts of students and follow their academic achievement data through the renovation process. Only high school students participating in the EOC Algebra I and EOC Reading Standards of Learning assessments were utilized in this study.

The third limitation is that scaled scores were not used for students who were assessed using some sort of alternate assessment from the Virginia Department of Education. Students taking alternate assessments such as the Virginia Substitute Evaluation Program (VSEP) or the Virginia Alternate Assessment Program (VAAP) are not calculated in the mean scaled scores used for this study.

As noted in Mayo (2012), a fourth limitation exists because only students in high school taking two particular assessments are studied. This study will not provide a high level of generalizability should readers attempt to extend the study findings to a larger or different population.

When analyzing student scaled scores for the SOL assessments of EOC Algebra I and EOC Reading, it was necessary to establish one scaled score for each participant high school for

the phase “during” the renovation. For some schools, the renovation lasted only one year and this was the used mean scale score. However, in order to establish one mean scaled score for EOC Algebra I and EOC Reading in high schools in which there were multiple renovation years, the researcher used the mean of the mean scaled scores from each renovation year. Using the method of taking a mean of means of student scaled scores creates a limitation of the study. The limitation is that the effect is lessened because this method causes a regression toward the mean.

A final limitation of the study is that the EOC Algebra I Standard of Learning assessment may be given at the middle school level. Many middle schools offer Algebra I to their higher ability mathematics students. Middle school students that had previously taken the EOC Algebra I SOL assessment were not included in this study. The trend of students taking Algebra I at the middle school level could have caused a decrease in the number of students taking the EOC Algebra I assessment at the high school level. Because typically higher ability math students will take Algebra I at the middle school level, students having less math ability may be left to take the EOC Algebra I SOL assessment at the high school level. Alternately, the EOC Reading SOL assessment is given to students at the high school level only.

**Definition of Terms**

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

*Campus-style School*: A school in which learning occurs in several separate buildings connected by sidewalks and courtyards. Due to the need of walking from classroom to classroom in various buildings, students are often exposed to the elements of weather.

*Complete Renovation*: The process of improving all four major elements of a renovation. These major elements include plumbing, electrical, heating, and ventilation/air systems, and structure (Earthman, 1994).

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

*High School*: A school in which students are in the following grading configurations and are educated using curricula mandated by the Virginia Department of Education: grades 8-12 or 9-12.

*Highly Qualified Teacher:* A teacher who is fully licensed by the Commonwealth of Virginia, has at least a bachelor’s degree and has demonstrated competency in each subject taught.

*End-of-Course (EOC)*: A Standards of Learning assessment given in the Commonwealth of Virginia after a student has completed a particular course rather than a particular grade level.

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

*Partial Renovation*: The process of improving a structure, such as a school, without conducting a complete renovation. Only certain areas of the building are improved as opposed to the entire the building. These improvements could be cosmetic and/or structural in nature.

*Scaled Score*: A scaled score is the conversion of a student's raw score on a Standards of Learning Assessment to a common scale that allows for a numerical comparison between students.

*Socioeconomic Status*: The total percentage of students receiving free or reduced pricing for the National School Lunch Program.

*Standards of Learning (SOL):* An assessment given to all students within the Commonwealth of Virginia to determine the level of proficiency of required curriculum for a specific subject.

*Student Achievement*: For the purposes of this study, student achievement refers to the mean scaled scores representing the level of proficiency of students having taken the Standards of Learning Assessment in EOC Algebra I and EOC Reading.

**Organization of Study**

This study is divided into five chapters. Chapter 1 of this study is an introduction of school facilities, complete renovations, and student achievement. For the purposes of this study, the topic of renovation is discussed at the high school level in the Commonwealth of Virginia. The reader is provided the statement of the problem, research questions to be addressed, and the significance of the study. Chapter 2 provides a review of available literature. The literature review emphasizes the relationship between building conditions and student achievement. In addition to explaining the methodology of the study, Chapter 3 also contains a description of the population. Chapter 4 contains the findings of the study, including a description of the data collection and data analysis. Chapter 5 concludes the study and provides the summary of findings, discussion, conclusion, and recommendations for further research.

# Chapter Two
# Review of Relevant Literature

## Introduction

When conducting a renovation of a school facility, it is vital to understand how that renovation may influence student achievement. Due primarily to cost factors, more school divisions are choosing to conduct much needed school renovation projects with students remaining in the facility. As with any renovation, conducting a school facility renovation with students in the building can cause a considerable disruption to the normal daily routine. Common disruptions during a school renovation typically include construction noise, uncomfortable room temperatures, and many contractors and work crews on the renovation site, to name a few. With all of these distractions in and around the learning environment, there is always the possibility of an interruption to the educational program. While there have been an abundant number of studies conducted reviewing the relationship between school facility condition and student achievement, there have been a limited number of studies that review the complete renovation process and how it may influence student achievement.

Due to recent and harsh economic times, many school districts have had their budgets cut dramatically. This dramatic decrease in funding has come at the same time when accountability for student achievement has increased significantly. With a newly refocused emphasis on student achievement and deteriorating school buildings, school districts have been forced to make difficult choices with regard to how to spend funds for capital improvements.

Because so many of America's public schools are currently in a state of disrepair, many school districts will be contemplating when and how to go through a complete renovation and still maintain high student achievement. With all of the renovation disruptions that can occur within the school facility through the renovation process, maintaining a conducive learning environment becomes a challenge for administrators and teachers. As teachers struggle to prepare and deliver lessons, students also face the challenge of maintaining their focus when forced to learn within a complete renovation process.

Because there are so many possible variables that may influence student achievement, many researchers in the field of school facilities will caution that they are not suggesting causation with study results. Rather, many researchers (Weinstein, 1979; McGuffey, 1982)

concluded that they merely found influences of building facility condition on student achievement. James Tuttle (2002) was one such researcher who was careful not to suggest a causal relationship in his study of a school renovation and the influence the renovation had on student achievement.

In 1998, the Clark County School Board commissioned a needs assessment to be completed on the outdated Johnson-Williams Middle School (JWMS) in Berryville, VA. This needs assessment revealed that JWMS badly needed renovation. James Tuttle (2002) conducted a study of this renovation process with the purpose of measuring the quality of the school renovation project based upon its value to the people who use the facility and its impact on students (p. 2). Rather than waiting years after the completion of the renovation project to conduct his study, Tuttle felt that it would be more beneficial to conduct his study while the renovation was taking place. By using this method, Tuttle was able to study the perceptions of his population concerning JWMS before and after the renovation process.

Prior to the beginning of any physical changes within JWMS, Tuttle (2002) explained that many stakeholders were involved in the planning process. The Clarke County School Board (CCSB) sought out and received input from students, teachers, staff members, JWMS administrators, parents, community members, and the Clarke County Board of Supervisors (p. 5). Including so many stakeholders not only in the planning process, but also in the construction phase, allowed all to offer valuable input into the needs, design, and construction of the renovated school. Because this group of stakeholders was so invested throughout the entire renovation process, Tuttle used these same groups as his study population.

A mixed methods approach was used in conducting the study of the quality of the renovation. Primary instruments used to collect quantitative data were a variety of survey instruments for different groups and from different stages of construction. Primary instruments used to collect qualitative data were mainly interviews of stakeholders, as well as photographic data.

According to industry standards of the renovation project coming in under budget and on time, the project was a success. Tuttle, however, was not using the industry standard to measure the quality of the renovation. Tuttle (2002) pointed out, “Study findings indicated that perceptions of facility quality recorded before renovation increased markedly after the renovation” (Tuttle, 2002, p. 19).

Prior to and following the completion of the renovation, Tuttle used a survey instrument to gather data from students, teachers, and parents. These groups were asked questions that targeted their perceptions of the overall importance and overall quality of JWMS. Across all three of these groups, perception of quality of the school increased greatly following the completion of the renovation. The group's perceptions of the importance of the school, however, remained constant.

In order to gather further data on student perceptions of the school, four randomly selected students were given disposable cameras prior to the start of the renovation project. These students were instructed to photograph their favorite and least favorite places in the school. Following the completion of the renovation, these same students were again asked to photograph their favorite and least favorite places in the school. By observing the before and after pictures, the data showed that the students took nearly twice as many "favorite" pictures following the renovation than they did prior to the renovation. The number of least favorite pictures taken following the renovation decreased by one-third compared to the number of least favorite pictures taken before the renovation (Tuttle, 2002).

Following the completion of the renovations, JWMS and CCSB administrators were pleased that the school had been enhanced to be in full compliance with the American with Disabilities Act (ADA) and Individual with Disabilities Education Act (IDEA) regulations (Tuttle, 2002). With this new compliance, the school was now capable of better meeting the needs of a more diverse student population to include students with intellectual and physical disabilities. Administrators were also pleased with the enhanced security and restricted visitor access the renovated JWMS provided.

Prior to the renovation, JWMS had several trailers and a computer lab that could not be accessed without leaving the safety of the main building. With the design of the new facility, all of the trailers were able to be removed, and the computer lab was able to be relocated. All instructional spaces were entirely under one roof, providing a safer learning environment. Prior to the renovation, there were several entry points in which visitors could enter the building. Some of these entry points were not near the main office of the school. With the renovation completed, all visitors now must enter the school through the main office upon entering the building. Due to each of these aspects of the renovation, study participants indicated that the school's safety, security, and ease of access had improved (Tuttle, 2002). In addition to the

perception of a safer space, Tuttle explained that there were perceptions of a larger, more flexible space.

The renovation allowed for a 30 percent increase in overall square footage of the school. Students and teachers alike indicated that the, “Increased space and improved flexibility were among the most noticeable benefits of the renovation” (Tuttle, 2002, p. 21). Teachers enjoyed larger classroom space and the flexibility this provided in enabling them to rearrange their classrooms to better meet student needs. Students felt that they had more flexible classroom space, especially in their elective classes such as art, band, and chorus. Prior to the renovation, the chorus room was in one of the trailers outside. One chorus student felt safer in the more flexible, new chorus room because now there was a fire escape that could be used should a fire break out.

Common areas within the newly renovated JWMS included the cafeteria, auditorium, and circulation areas. With respect to many of these common areas, a majority of the study participants stated that following the renovation, they had been improved for the better. “Before the renovation only 20% of teacher responses gave the cafeteria an “A” or “B” grade; after renovation, 87% reported an “A” or “B” rating” (Tuttle, 2002, p. 22).

Another area of study was the perception of teachers, students, and administrators regarding the new heating, ventilation, and cooling system (HVAC). All of these surveyed groups felt that the new HVAC systems were better than before the renovation; however, they still required improvements. Forty-three percent of students reported improved overall temperature in classroom spaces, while 12% reported feeling discomfort when asked about temperature. Fifty percent reported there was improved airflow, while only 8% reported worse airflow. Teachers were less enthusiastic about the new HVAC system. Teachers did not like the temperature fluctuations, and they would have preferred to have individual thermostat controls in each classroom (Tuttle, 2002).

The improved technology in the renovated school was positively perceived by students, teachers, and administrators. During interviews, students commented about the improved quality of the computers and the easier access to them. Students also commented that their teachers were teaching more technology-based lessons. Teachers enjoyed access to new technologies such as digital cameras and LCD projectors. All classrooms had a new teacher computer with four extra data ports for student computers in the classroom. The new teacher computers were linked to the

TV/VCRs in each room; each classroom had been renovated to include a new phone system allowing internal phone calls within the building, as well as phone calls outside the building (Tuttle, 2002).

Tuttle also studied the perceptions of changes in social interactions and school relationships because of the school renovation. Following interviews of 30 students, results showed that 18 of the 30 students perceived social relationships at the school to be good or improved. The remaining 12 students perceived social relationships to be unchanged from before the renovation (Tuttle, 2002).

The new design of the school allowed for the administration to cluster each of the student grade levels into a particular area of the building for the majority of the school day. County and school administrators, as well as teachers, perceived this grade-level clustering as a positive contribution to enhanced teaching and student learning. Students reported that the grade-level clusters were positive because, "this year everybody's in one big group – it's like we don't hardly leave anybody out. Folks are getting along better" (Tuttle, 2002, p. 25).

Tuttle (2002) cautioned that a relationship between student achievement and a school facility should not be drawn directly due to many other possible variables. However, Tuttle did review the Student Achievement Outcomes by studying the Standards of Learning (SOL) scores of JWMS before, during, and after the renovation project. Tuttle discovered that when looking at the mean scaled scores of each content area tested at JWMS, with the exception of history, SOL achievement rose each year during the renovation. See Table 2.1.

Table 2.1

*SOL Achievement Data During the Three Stages (Before, During, and After) of Renovation:*

| SOL Assessment Content Area | Before: 1998-1999 | During: 1999-2000 | After: 2000-2001 |
|---|---|---|---|
| Writing | 73.9 | 75.5 | 83.8 |
| English | 64.2 | 68.3 | 87.2 |
| Mathematics | 67.3 | 75.7 | 79.1 |
| History | 60.1 | 48 | 66.9 |
| Science | 87 | 89.2 | 90.6 |
| Computer/Technology | 83.7 | 97.1 | 98.7 |
| Algebra | 85.7 | 97 | 100 |

(Tuttle, 2002, p. 25)

In Table 2.1, it is clear that the teachers and students were able to maintain focus on learning in spite of the distractions related to construction during the renovation project. Tuttle noted that JWMS had always been a relatively high achieving school when it came to SOLs in years prior to the start of the renovation. However, because similar studies of school renovation projects had typically seen a dip in student SOL performance during the renovation, then a rise following the completion of the renovation, Tuttle (2002) found JWMS' continued success through the entire project, except in history, to be compelling.

Tuttle (2002) classified the findings of the study into two categories. The first category leads to suggested improvements in the field of educational facility research. Tuttle explained there is little value in attempting to find a causal relationship between renovated facilities and higher student achievement. Rather, it is more valuable to study multiple measurements of a school's academic program coupled with the perceptions of stakeholders concerning facility characteristics to assess the quality of the renovated facility.

The second category from Tuttle's (2002) findings addressed the process of designing and implementing a renovation project. Clarke County is a rural community with a relatively small population requiring one middle school. All of the stakeholders including architects, construction management, contractors, teachers, students, staff, administrators, parents, and community members were constantly communicating throughout the renovation and ultimately developed into a successful team. Tuttle points to four individuals and credits them with maintaining an effective communication network throughout the design and implementation phases of the renovation. These individuals include the building principal, the county superintendent, the architect, and the construction manager. The consistent communication of these four individuals led to the completion of a successful renovation project, and according to Tuttle (2002), "is an index of their abilities" (p. 30).

Tuttle conducted his study in a manner that was unique when he analyzed the success of the JWMS school renovation. Success or failure of previous school renovations have typically been judged based upon the industry standard of whether or not the renovation was completed on time and whether or not the renovation was completed within the budget. While these industry standards are important factors, they are purely quantitative and do not look at the perceptions of the individuals that use the facility.

By using a mixed methods approach in his study, Tuttle was able not only to gain quantitative data on student achievement and user perceptions, but he was also able to gain a more personal finding through his qualitative interviews and photographic data collection. By including so many stakeholders and using this mixed methods methodology throughout the entire renovation process, Tuttle gained a complete perspective of everyone from students and teachers to parents and community members. The mixed methods approach proved to be valuable in gaining this wide-ranging perspective.

The overall findings of the study show that nearly all of the stakeholders were pleased with the renovation process. Various stakeholders attributed the improved technology, larger classrooms and shared spaces, and improved social interaction and relationships to the renovation process. These overall positive perceptions by the users of the facility led the users to a perception that the renovation was a success.

Prior studies have shown that typically there is a decline in student achievement during the renovation process, followed by a rebound of increased performance after the renovation completion. Tuttle's findings show that in some circumstances this is not always the case. The data from Tuttle's analysis of student performance at JWMS during the renovation indicated that student achievement could increase during a renovation process (Tuttle, 2002). As previously noted, Tuttle did not attempt to draw a causal relationship between the renovation and student achievement due to the many other variables that could affect student achievement.

The comfort level of students should not be the only consideration when trying to maximize student performance. Student performance can be highly affected by the teacher performance in the classroom. If teachers are not comfortable in their work surroundings, their teaching performance is likely to suffer, resulting in lower student achievement. There is a need to be aware and to address the comfort level of teachers as well when conducting a school renovation project.

In 2010, Shifflett conducted a phenomenological case study investigating teacher experiences and perceptions during renovation projects at two separate high schools. These two high schools were Wilson Memorial High School (WMHS) in Fishersville, Virginia, and Stuarts Draft High School (SDHS) in Stuarts Draft, Virginia. The two schools were very similar in many ways. Both of the high schools were in the same rural school division in Virginia. Both schools were very close to having the same number of students, and both had principals with fewer than

two years of experience as a principal. The two high schools had the same renovation timeline, the same architectural firm that had designed both schools to have the same floor plan, and the same general contractor (Shifflett, 2010, p. 3).

The study conducted by Shifflett (2010) researched four questions:

1. What were the common perceptions reported by the teachers who had satisfying experiences during a renovation project?
2. What were the common perceptions reported by the teachers who had dissatisfying experiences during a renovation project?
3. Were there any differences in teacher perceptions between the two schools? If so, what were the differences?
4. Were there any relationships between teacher perceptions and the specific demographics? If so, what were they?

The teacher population that took part in the survey included only teachers who were in place at the beginning of the renovation and remained throughout the renovation until its completion. If a teacher arrived after the beginning of the renovation or left before the completion of the renovation, Shifflett (2010) chose to exclude them entirely from the study survey. From the fall of 2006 to the spring of 2008, there were a total of 42 full-time participants from the WMHS teaching faculty who met the requirements for the study. There were a total of 34 full-time participants from SDHS who met the same requirement. Full time participants from both schools were asked to complete the survey in November or December of 2009.

The researcher created the survey instrument given to each of the full-time participants. The instrument was reviewed and critiqued by doctoral candidates and non-participating teachers for clarity and accuracy (Shifflett, 2010). Following these critiques, the researcher made appropriate adjustments prior to issuing the survey to the full time participants.

Following receipt of approval from the Virginia Tech Institutional Review Board (IRB), Shifflett (2010) met with the participants at their respective high schools on different dates to explain the process and IRB protocols. Once the researcher had answered participant's questions, he distributed the survey instruments and asked that they complete them honestly and place them in a box before leaving the room. This helped to ensure participant anonymity and confidentiality.

The survey instrument included 24 questions that addressed content found in prior research to be relevant in building construction projects such as noise, distractions, safety, odor, construction workers, climate conditions, and morale (Shifflett, 2010). The participants' answers were assigned a numerical score based upon their responses of "strongly agree," "agree," "neutral," "disagree," or "strongly disagree." Using this Likert scale, a point value of one point was given for "strongly agree," two points were given for "agree," three points for "neutral," four points for "disagree," and five points were given for "strongly disagree." Twenty of the 24 total questions from the instrument dealt with specific criteria and participants' responses to these 20 questions were assigned a numerical value as previously described. The remaining four questions were less specific and more open in their nature. Shifflett (2010) chose not to include these four questions in his scoring.

Using the scores from each of the 20 questions, Shifflett (2010) totaled and averaged each participant's score. The average scores were then ranked using the following scale:

1.00 - 2.49 Satisfied
2.50 - 3.49 Neutral
3.50 - 5.00 Dissatisfied

Once each participant's survey was labeled with the appropriate label of "Satisfied," "Neutral," of "Dissatisfied," the data from the surveys were analyzed using the Statistical Package for Social Sciences (SPSS).

In order to determine distribution and to identify any data outliers or skewed data, descriptive statistics were run. Shifflett (2010) analyzed the variables of school, gender, subject area taught, years of experience, number of moves, age, and satisfaction category using *t*-tests and Analysis of Variance. All of the research questions and tests used for analysis were investigated at the .05 level of significance. This process allowed the data to have only a 5% probability of occurring due to chance. Shifflett also reported for each question using crosstabulation tables.

Shifflett (2010) utilized Pearson's product moment correlation coefficient to examine the data. This method allowed for the measurement of a relationship between two variables with score ranging from 1 to -1. If a measure of two variables resulted in a score of 1, then a total positive correlation existed. If a measure of two variables resulted in a score of 0, then no

correlation existed. If a measure of two variables resulted in a score of -1, then a total negative correlation existed. A significance level of $p < .05$ was used for these tests.

The independent variables that were analyzed for the strength of relationship among them were "teacher's gender, age, years of teaching experience, school in which they work, frequency of the teachers physically moving their classrooms, and subject areas in which they teach" (Shifflett, 2010, p. 30). Shifflett (2010) chose to measure the strength of the relationship among these variables by using the descriptive statistic of a Cohen's *d*. For this study Shifflett (2010) used the scale of 0-3.49 (weak), 3.50-7.49 (moderate), and 7.50-2.00 (strong).

Independent sample *t*-tests were applied to answer research questions 1, 2, 3, and 4. One-way ANOVAs were utilized to answer research questions 1, 2, and 4, and a correlation was completed for research question 3. Shifflett (2010) explained that he used the independent sample *t*-test because, "It is the best test to evaluate the means of two independent groups and their differences" (Shifflett, 2010, p. 38). The researcher explained that the one-way ANOVA aided in evaluating the individual scores on two variables, categorizing one as an independent and the other as a dependent variable.

When analyzing the survey responses to the open-ended questions, Shifflett (2010) totaled the primary themes from these questions and provided a summary of the findings. Question 23 asked the participants to describe a difficult experience that occurred due to the renovation. Question 23 also asked the participants to provide a recommendation of how it could have been successfully handled. If the participant did not have a difficult experience, a response of "none" was requested to be written for the question response. Twenty-six of the 74 participants (35%) responded with "None" for question 23. The next highest theme included communication where 12 participants (16%) listed this as a major concern. The temperature in the building ranked third, cited nine times (12%), and the dirt/dust ranked fourth, being cited eight times (11%). Lack of space was cited six times (8%), and noise levels were cited five times (7%). Two participants (3%) included construction workers, and two participants (3%) listed odor as a difficult experiences (Shifflett, 2010, p. 86).

In reviewing each research question, Shifflett (2010) determined that research questions 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. All other survey results for research question one and two aligned with the neutral category.

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 satisfied. Shifflett (2010) explained that the findings for this research question also showed that only 4% from SDHS and 2% from WMHS were coded as dissatisfied. This left 47% in the neutral category at SDHS and a large majority of 70% in the neutral category at WMHS.

The fourth research question was, “Were there any relationships between teacher perceptions and the specific demographics?” An independent sample *t*-test was completed on gender and each survey question. The research revealed eight survey questions with a significant difference between male and female response. The specific content of these questions dealt with safety, cleanliness, work environment, and difficulties with construction workers (Shifflett, 2010).

Shifflett attempted to fill a gap in the literature and create a tool that may benefit school administrators as they navigate through the school renovation process. On some level, he has accomplished this task; however, the limitations of the study may keep the study from reaching a large audience. Shifflett (2010) mentioned a limitation of his study was that he only included two rural high schools within the same school division. Both schools were very similar in size and demographic characteristics. While there was a benefit from the study, this limitation creates a narrow focus of usefulness for school administrators.

Shifflett chose to wait nine months following the completion of the renovation to collect the data used in his study. In most cases, the results showed that teachers had a positive or neutral experience throughout the renovation. Had the data been collected much closer to the end of the renovation project, teachers may have expressed more dissatisfaction. Time spent in a newly renovated facility may relieve the feelings of dissatisfaction and frustration felt during the actual renovation process.

While Shifflett (2010) focused on two rural high schools in Virginia, similar studies have been conducted in larger more urban areas looking at the relationship between recently renovated schools and student achievement. In 1999, Maxwell (1999) conducted a case study involving the Syracuse, New York, City School District (SCSD). The study focused on the facility planner’s

perspective and compares the quality of school facilities before, during, and after a renovation. The researcher also sought a relationship between the condition of the school facility and student achievement. Results of the study revealed a positive relationship between upgraded school facilities and math achievement.

The geographical borders of the city were also the actual school boundaries. Within the school district, students were allowed each year to select the school which they wanted to attend no matter the distance from home to school. This feature of student enrollment made it difficult to calculate from year to year where students would enroll. Ultimately, this dynamic created a new student body at each school every year.

A trend began in 1984, in which over the course of the next several years, many SCSD schools went through a renovation process. Once a school was newly renovated, due to the freedom of student choice in which school to attend, spikes in enrollment were common. Maxwell (1999) chose to include all of the schools in the SCSD that had been renovated since 1984.

Due to the difficulty in establishing a consistent cohort of students at any given school, the case study did not focus on comparing school to school, but focused instead on looking at renovation projects and student performance across the entire school district. In order to establish a consistent source of data, Maxwell (1999) began by looking at students from across the entire school district that attended during the period of 1983 to 1997. Of these students, the researcher then focused further on students who participated in the Pupil Evaluation Program (PEP) at grades three and six. These students from 21 different elementary schools were included in the population of the study.

The PEP assessment was administered to all third and sixth grade students each May. The assessment was used to identify students who were struggling in reading and math. The data from the assessment results were displayed as a percentage of students in a school that scored at or above the state-determined minimum score. Results from the PEP that cited a high percentage meant there were a small number of students who were performing below grade level in reading and/or math (Maxwell, 1999).

Quantitative methodology utilizing a regression analysis was used to analyze the performance of third and sixth grade students attending recently renovated schools on the PEP assessments. According to Maxwell (1999), a “recently renovated” school was defined as a

major renovation within the last several years. When looking at performance data from math and reading, results revealed that only math scaled scores had a statistically significant correlation with the percentage of student attending recently renovated schools. Math scaled scores improved in the recently renovated schools while no statistically significant correlation was found in the analysis of reading scaled scores.

Maxwell offered several possible reasons as to why the quality of the school facility would affect math scaled scores but not reading scaled scores. She concluded her reasons by stating that due to a number of uncontrolled variables, the recent renovation of the schools may have had no bearing on the improved math scaled scores.

As previously noted, the researcher defined a "recent renovation" as a major renovation within the last several years. This definition is still vague, and in order to gain a deeper understanding of the nature of the renovations, Maxwell (1999) selected three elementary schools in SCSD to study further. These elementary schools were a) LeMoyne, b) Meachem, and c) Elmwood.

These three schools were selected because of their key similarities. All three schools were built within 14 years of each other (1914-1928). Each school had approximately the same square footage in floor space (64,200 to 72,666 sq. ft.). Prior to their recent renovations, LeMoyne and Meachem were built to be essentially identical. LeMoyne and Meachem had the same original design and were constructed by the same architectural firm. The renovation of the three schools had equal increases in square footage, and renovation costs averaged from $5 to $6 million each (Maxwell, 1999).

Many common elements were included in the renovations of the three elementary schools. These common elements included refinished floors and walls, completely renovated kitchens, new blackboards, and new fluorescent lighting replacing incandescent lighting. All three of these recently renovated elementary schools were considered relatively small schools with only 400 to 600 students in each school. Even though school enrollment at each of the schools increased following the completion of the renovation, school officials did not allow individual class sizes to increase. The number of students per class before, during, and after renovations remained the same, averaging 18 to 21 students (Maxell, 1999).

Using data from PEP assessment results beginning five years before through five years after the renovation of these three elementary schools, Maxwell (1999) provided plotted graphs

to reveal one major trend. The math scaled scores in all three schools showed an upward trend in performance each year, but the reading scaled scores for the same three schools varied year to year with no pattern of improvement. While the data provides interesting results, the fact that only three elementary schools were used for this more in-depth study caused Maxwell to acknowledge that the data set was not large enough to show any substantial findings.

While the results of Maxwell's study are intriguing, they do lend themselves to the need for further research. It is important to note that even though a relationship between the renovation project of an SCSD school building and an improvement in math scaled scores on the PEP were found, there should be no assumption that the renovation caused the scaled scores to increase. Making this assumption would require a much more thorough study controlling for many variables that may affect student achievement.

Several years following the Maxwell (1999) study, the research of Duran-Narucki (2008) examined school attendance as a mediator in the relationship between deteriorating facilities and student achievement. Educators have long believed that there was a relationship between student school attendance and student achievement. A less common belief is that the condition of a school facility may affect student attendance to the point that there is an effect upon student achievement.

According to Duran-Narucki (2008), school attendance is essential for positive student achievement. Logic dictates that if students are not in school, they cannot access the educational activities that are being provided for them within the school facility. Studies have shown that when school facilities are in a deteriorating state, higher student absentee rates exist. Branham (2004) confirmed in his study that students are more likely to be absent in schools that are in need of structural repair, use temporary structures, and have fewer custodial services.

Duran-Narucki (2008) included 95 elementary schools in New York City in the study (p. 280). Narrowing the sample further, the researcher specifically selected elementary schools located in the borough of Manhattan.

In order to establish the condition of the 95 elementary schools used in the study, Duran-Narucki (2008) accessed the New York Board of Education's website and used the "The Building Condition Survey" (p. 280). The Building Condition Survey is a comprehensive study conducted by architects and engineers who were not employees of the New York City Board of Education. The surveys were conducted through visual inspections of the condition of New York

City school buildings between 1997 and 1998. Duran-Narucki pointed out that this survey provides a very accurate depiction of the state of school facilities in New York City primarily because it is conducted consistently by individuals who are independent of the New York school system.

While the actual survey consisted of nearly 100 items, Duran-Narucki (2008) chose 20 items from the survey related to different school building features. The 20 chosen building features were, "based on their presence and relevance in students' everyday life" (p. 280). Features such as doors, boiler systems, windows, and stalls in the bathrooms were items chosen for the study. The building features were scored using a Likert scale from 1 – 5. A score of 1 for a building feature was considered to be "good," while a score of 5 was considered to be "poor."

School Report Cards list information about each public school in New York City and include student demographic characteristics; school characteristics such as percentage of students eligible for free lunch, numbers of students enrolled, percentage of certified teachers, as well as student achievement test results in English language arts and mathematics. The researcher found this source to be the most accurate and up-to-date database for basic information on New York City schools (Duran-Narucki, 2008).

Duran-Narucki (2008) chose school attendance as a candidate for mediating the relationship between school building conditions and academic achievement. In order to establish attendance as a true mediator, Duran-Narucki conducted the study by using a four-step process suggested by Baron and Kenny (1986) for testing the 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.

A quantitative methodology was used by the researcher to conduct a multiple regression analyses. This analysis 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 (SES), ethnicity, school size, and teacher quality. Duran-Narucki (2008) concluded that students in deficient school facilities attended fewer days and performed more poorly on mathematics and English standardized tests.

Regular and consistent student attendance is a constant battle for many schools. This study conducted by Duran-Narucki (2008) was conducted in a heavily urban area of New York City where the students are largely poor minorities. Students such as these often come from a home that brings many other challenges such as poor nutrition, lack of proper childcare and supervision, and inadequate educational support at home.

Results from this study show that students are more likely to attend school if the school has an appearance of a clean and safe environment. When students have a well-maintained and comfortable school environment in which to learn each day, they are more likely to attend than if they are forced to attend a school that is in a state of disrepair.

All schools should be community centers to provide families a welcoming environment in which to be educated. Renovating dilapidated schools not only sends a message that school buildings are important community centers; it also sends the message that education should be a top priority in every individual's life. It is up to school administrators to do whatever is necessary to ensure that their schools are not in a state of disrepair so that students feel welcomed and want to attend school more often.

John Mayo (2012) conducted a study of ten middle schools in Virginia that went through a complete renovation between the school years of 2004-2005 and 2010-2011. The operational definition of a complete renovation for the study was defined as the process of improving all four major elements of a renovation. These major elements include plumbing, electrical, heating, and ventilation/air systems, and structure (Earthman, 1994). Middle schools that experienced partial renovations were excluded from the study. Another key component in Mayo's study was that students had to remain within the same building while going through the complete renovation. School renovations in which students were afforded the opportunity to use other facilities away from construction were excluded from the study.

Mayo (2012) studied only eighth grade students that had taken the Mathematics 8 or the Reading 8 Standards of Learning (SOL) assessment. The goal of the study was to answer the question, "Does the renovation process of a school building influence student achievement?"

(Mayo, 2012, p. 2). Mayo's study further looked at two sub-questions that sought to examine the differences in student scaled scores of the mathematics and reading SOL assessments at the eighth grade level one year before, during, and one year after a complete renovation process.

When gathering his data, Mayo (2012) used the mean scaled scores of each state assessment before, during, and after a complete renovation to make comparisons of student achievement throughout the renovation process. Mayo obtained these data from the Virginia Department of Education. Virginia standards for mathematics 8 were changed in 2001, and the reading standards were changed in 2002. Because of these changes to the standards and subsequent changes to the SOL assessments, Mayo chose 2004 as the beginning year for his data acquisition. The decision to collect data from 2004 -2010 ensured that the data would allow for comparisons that are more accurate because during these years the standards and subsequent SOL assessments did not change.

In order to determine if the school renovation process had an influence on student achievement, Mayo (2012) utilized a descriptive research methodology. He did not, however, look solely at SOL assessment scaled scores to determine if a relationship existed. Demographic variables were used to determine if the composition of the student population in the schools remained consistent over the period of the study. Demographic variables that were accounted for in this study included minority status, socioeconomic factors, and highly qualified teachers. By choosing to use a descriptive research methodology, the researcher was able to use not only quantitative methodologies to organize the data, but also use qualitative methodologies to focus on and better describe elements of the study that may be of greater relevance.

When determining which schools had gone through a complete renovation, Mayo (2012) researched the Architectural Consultants working within the Support Services Division of the Virginia Department of Education (VDOE). Prior to starting the renovation project, any school being renovated within the Commonwealth of Virginia is required to submit to this organization forms detailing the scope of the renovation. The required form is called the Energy and Facilities Cost Construction Data form. From the detailed descriptions found within this form, a list of middle schools that met the criteria of a complete renovation was generated.

Because the study used data over an extended period, controls were put in place to help ensure uniformity of the population. The middle schools that met the criteria of a complete renovation were required to meet three conditions. The first required condition was that the

renovation process for the school had to have been completed before the summer of 2010. The second required condition was that the percentages of minority and socioeconomic status students had to be of similar composition each year of the study. The third required condition was that the teachers within the renovated school had to be classified as highly qualified based on criteria from the VDOE. The demographic data indicated that the student body and faculty remained basically the same over the period of the renovations.

These demographic variables were gathered by visiting the VDOE website. The number of minorities and the socioeconomic status were gathered from the Fall Membership Reports. The researcher used the Fall Membership of each school for information pertaining to the percentage of minorities and the socioeconomic status. Once the researcher gathered the number of minorities and the socioeconomic status of students, information was converted into a percentage. The percentage of highly qualified teachers was gathered by visiting each school's Report Card.

Mayo (2012) went a step further to ensure accurate collection of data by emailing the Director of Facilities in each of the school divisions that were homes to the ten middle schools meeting the criteria of a complete renovation. Mayo received responses from all of these school divisions to the following two questions: a) Describe the scope of the middle school's renovation project, and b) What were the beginning and ending dates of the renovation? (Mayo, 2012). These two questions helped solidify the accuracy of the data gathered from the VDOE by ensuring that each of the ten middle schools studied met the criteria of a complete renovation within the 2004-2010 period.

To determine how much variance existed within the chosen demographic variables (minorities, socioeconomic status, and highly qualified teachers) across the three stages of the renovation project (pre-renovation, renovation, and post-renovation), Mayo (2012) first compiled the percentages of these variables at three specified stages within the renovation. Mayo hypothesized that there would be minimal changes to these demographic variables across the stages of the project and, after finding the mean amount of the demographic variables, conducted an Analysis of Variance (ANOVA) to test his hypothesis (Mayo, 2012). The analysis revealed no statistical significance in the relationship among demographic variables when compared to the three stages of the renovation project. As a result, there were no significant changes to the student composition during the period of the study from 2004-2010.

To analyze the found variance, Mayo (2012) analyzed the total variance due to error and the variance due to the differences between the means. The pre-renovation and post-renovation means of the scaled SOL student scaled scores of each school were compared to the actual renovation stage to determine if there was a significant difference in student achievement throughout the entire renovation.

SPSS was used to further assess whether the means of the pre- and post-renovation stages were statistically different from one another. The analysis was completed through the conduction of a *t*-test on the mean scaled scores for mathematics and reading (Mayo, 2012). The analysis would accept or reject the null hypothesis. The acceptance of the null hypothesis would indicate that there is no statistical difference in student achievement before, during, or after the renovation.

To investigate the differences between the mean scaled scores of mathematics and reading and the three demographic variables from the ten participating middle schools, Mayo (2012) used a 1 x 3 ANOVA. Mayo hypothesized that the demographic variables would differ very slightly throughout the renovation process, and his analysis indicated there was very little change in the composition of the student bodies' composition in the schools over the renovation period.

Mayo (2012) found no statistical significance for any of the three demographic variables (minorities, socioeconomic status, or highly qualified teachers) when compared to the three stages of the renovation. Because no significance was found, Mayo concluded that any possible difference in student achievement in mathematics or reading could not be related to these demographic factors.

After conducting the 1 x 3 ANOVA on the renovation stages and demographic variables, Mayo (2012) conducted a *t*-test on the pre-renovation and post-renovation stages for the mean scaled scores for mathematics and reading. While the results of the *t*-test comparing mathematics mean scaled scores to the pre- and post-renovation stages did not reveal any statistical significance, results differed when comparing reading scaled scores.

When Mayo (2012) conducted a *t*-test to compare the mean scaled scores for reading at the pre- and post-renovation stages, a statistically significant impact on student achievement was found. The *t*-test results show a significant impact ($M = 466.46$, $SD = 20.17$); $t(18) = 2.4093$, $p = 0.027$ when $p < .05$. These results suggested that students actually did better on the Reading 8

SOL in the post-renovation stage when comparing pre- and post-renovation stages. Having found a significant relationship in this comparison, it is important to note that no statistical significance was found when comparing reading mean scaled scores across all three stages of the renovation process.

Many schools across the United States are in need of renovation. While there are many reasons for administrators to choose not to conduct a complete renovation of their school facility, according to Mayo (2012), concerns over student achievement as related to the 8$^{th}$ grade mathematics and reading should not be one of these concerns. Complete renovations certainly bring challenges to the normal routine of the school day. However, it is the overall attitude of teachers and administrators that will help determine how students will cope. Students tend to be very resilient, and their attitudes reflect those of their leaders. As often as possible, if teachers continue their daily routines of instruction with a positive outlook on the renovation process, students will typically not suffer academically.

**Summary of Literature Review**

The purpose of this chapter was to provide an understanding of studies that have noted a relationship between building conditions and student achievement. Many studies, including most in this review, point to increases in student achievement when building facility conditions are of high quality. Shifflett (2010) focused primarily on teacher perceptions of the renovation process, understanding that teacher perceptions could affect teacher performance and, ultimately, student performance.

Researchers contend that there are many variables that could affect student achievement when considering school facilities and their direct influence on students and teachers. The purpose of a school renovation is to improve school facilities to a level that is more conducive to learning. This analysis and review of the relevant literature has shown that the condition of the school facility can have a dramatic effect not only on the general engagement of students, but also in their overall academic performance.

When school administrators and school boards place a high emphasis on having quality school facilities, it demonstrates not only to the students, but also to the entire community, that school facilities matter when it comes to student achievement. It shows all stakeholders that education is a top priority in their community.

When choosing to upgrade an existing school facility, school districts have different routes they may choose. If the school district has the luxury of an available and large enough empty facility, they may choose to relocate students during the complete renovation process. However, such available facilities are rare, and more schools are choosing to conduct a complete renovation with students remaining within the school building. Because so many of America's schools are currently in a state of disrepair and will need to be completely renovated soon, further research is needed on the relationship between building conditions and student achievement when looking at schools before, during, and after the renovation process. Continued research in this field can help school leaders facing complete renovations make more informed decisions.

# Chapter Three
# Methodology

## Introduction

In 2012, John Mayo conducted a study that explored the relationship between student achievement and the renovation process of a school facility. Mayo (2012) focused on middle schools in the Commonwealth of Virginia that had gone through what Earthman (1994) identified as a complete renovation from 2004-2010. In measuring student achievement, Mayo narrowed his collection of data to the scaled scores from the Standards of Learning (SOL) assessments in reading and mathematics at the eighth grade level before, during, and after a complete renovation.

The purpose of this proposed study was to replicate the study conducted by Mayo (2012). All of the procedures, methodology, and processes of data analysis followed the Mayo study. The fundamental difference to be found in this study was that it focused on the influence the renovation process had on student achievement as measured by student performance on the SOL, in the areas of EOC Algebra I and EOC Reading, at the high school level, in the Commonwealth of Virginia. The scaled scores from the EOC Algebra I and the EOC Reading SOL assessments before, during, and after a complete renovation were compared to determine any possible influence.

A quantitative, descriptive research methodology was used in conducting this study. In a descriptive study, no attempt is made to account for change of behavior or conditions; data are measured as they are (Mayo, 2012). The researcher gathered data that described the event of complete renovations at the high school level and the influence on student achievement before, during, and after the renovation process.

## Population

The population for this study included students at the high school level within the Commonwealth of Virginia who had completed the EOC Algebra I or EOC Reading SOL assessment before, during, and after a complete renovation process. The population of students must have attended high schools that met the criteria of having conducted a complete renovation at some point during the period of the 2004-2005 school year to 2010-2011 school year.

According to Earthman (1994), complete renovations include four major areas of construction that are upgraded during the time of one single renovation period. These four major areas of construction include electrical, plumbing, heating/ventilation/air system (HVAC), and structural improvements (Earthman, 1994).

The researcher utilized the Virginia Department of Education (VDOE) Public School Facilities Cost Data Reports found within the VDOE website to identify some of the participants. While all of these reports provided information concerning school renovation projects under contract for any given school year, the researcher found the reports to be less than complete. A partial list of participants was assembled consisting of high schools that met the conditions of having conducted a complete renovation. Once this partial list of participants had been collected, in cases in which further clarification was necessary in determining whether or not a school renovation constituted a complete renovation, the researcher contacted the VDOE Office of School Facilities Services for such clarification.

Mayo (2012) chose to study middle school eighth grade students because the SOL assessments in both reading and mathematics at the eighth grade level had changed prior to the 2004-2005 school year and had changed again after 2010-2011 school year. This ensured that all student participants were being assessed under the same assessment standards. In order to remain as consistent as possible with Mayo, from the list of high schools meeting the criteria of having conducted a complete renovation, students that completed the SOL assessment in EOC Algebra I or EOC Reading during the same time period were identified as the participant group.
For the purposes of this study, specific grade level was not part of the criteria for participant inclusion. Most commonly, EOC Algebra I and EOC Reading SOL assessments are given to ninth grade and eleventh grade students respectively in high schools within the Commonwealth of Virginia. However, because students at the high school level advance through grade levels based upon varying degrees of achievement, rather than simply because they have gained another year in school, such as in most middle school settings, it was more likely for high school students to take SOL assessments at varying grade levels.

The final component of the population was the demographic variables used by Mayo (2012) to determine if the composition of the student body remained the same over the period of the study. The variables studied were socioeconomics, minorities, and highly qualified teachers.

## Data Needed

A crucial component of this study was the importance of comparing similar data across the time span of the complete renovation process. This was accomplished by studying the school years ranging from the 2004-2005 school year through the 2010-2011 school year. During this time frame, the EOC Algebra I and EOC Reading SOL remained consistent because each were based upon the same curriculum frameworks established by the VDOE. Using this time frame and assessments based upon the same framework allowed for uniformity within the data. EOC Algebra I and EOC Reading SOL scaled scores were used from the school years of 2004-2005 to 2010-2011 in order to replicate and remain consistent with the Mayo (2012) study.

In order to study any changes in demographics over the course of the complete renovation process, the following data were needed: percentage of minority students, percentage of students on free/reduced lunch, and the percentage of highly qualified teachers. In order to remain consistent with the Mayo (2012) study, the following definitions were used in selecting these demographic data:

(1) The percentage of minority students within the total student population were 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 before, during, and after the complete renovation.

(2) The socioeconomic status was determined by the percentage of students within the total student population that were eligible to receive free and reduced meals before, during, and after the complete renovation.

(3) The percentage of highly qualified teachers was determined for each school that conducted a complete renovation utilizing VDOE data.

(4) The study utilized the means of the student scaled scores in EOC Algebra I and EOC Reading for each school SOL assessment to measure student achievement.

## Data Collection

Data were retrieved for this study from available resources from the VDOE. If data were not available through the VDOE website, (www.doe.virginia.gov), email, phone, or personal

correspondence with staff from the Virginia Department of Support Services was utilized to obtain data. Two forms of data were collected: (1) demographic data consisting of minority students, socioeconomic status of students, and highly qualified teachers and (2) scaled scores for student performance on the EOC Algebra I and EOC Reading Standards of Learning (SOL) assessments for the years 2004-2005 through 2010-2011. The decision to collect data from 2004 -2010 ensured that the data would allow for comparisons that are more accurate because, while SOL standards and SOL assessments change periodically, during these years the standards and subsequent SOL assessments did not change.

A list was collected of all high schools in the Commonwealth of Virginia that had gone through some sort of renovation. This was accomplished by utilizing the VDOE website beginning at the VDOE homepage (www.doe.virginia.gov). From this homepage, the researcher navigated to the Student and School Support page and from there selected the Facility Construction and Maintenance link. From this page, the School Construction Projects link was accessed, and the researcher found the School Construction Cost Data link under the Project Costs heading. Selecting the School Construction Cost Data link revealed cost reports for all Virginia schools construction projects dating back to the 1999-2000 school year.

The Construction Cost Data reports 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. From the Construction Cost Data reports, because this study focused on the high school level, the researcher discarded any listed renovations that were completed on elementary or middle schools. The reports provided to VDOE by each school division, detailed the scope of the work, noting if the renovation was a partial or complete renovation.

A final list of high schools having complete renovations during the 2004-2005 through 2010-2011 school years was then assembled. To ensure that each high school renovation was a complete renovation, an email was sent to each school division 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 for the renovation project? End date?

If the school division chose not to answer the two questions by email, the researcher located any available contact information for the Director of Facilities or Director of Maintenance & Operations for that specific school division. The researcher called or emailed the Director again 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 would have been contacted. Fortunately, for the purposes of this study, all requested data in reference to the complete renovations were gathered without the need to contact any general contractor or architectural firms.

After the dates for each completed renovation project were verified, all demographic variables were gathered by utilizing additional data that was also found on the VDOE website. Beginning on the VDOE home page, (www.doe.virginia.gov), the Statistics and Reports link was found. On this page, Enrollment & Demographics link was found. After accessing the Enrollment & Demographics page, under the Fall Membership heading, a link was found entitled, “Explore Fall Membership data and create custom reports”. Utilizing this link allowed the researcher to gather all necessary data pertaining to the number of minorities in the participant high schools during the school years before, during, and after the complete renovation. The socioeconomic status was collected from the National School Lunch Program (NSLP) Free and Reduced Price Lunch Program Eligibility Report found within VDOE website. The percentage of highly qualified teachers was located by sending a formal written request to the VDOE Office of Program Administration & Accountability.

The final data collected was the mean scaled scores for the students attending the selected high schools in EOC Algebra I and EOC Reading on the SOL assessments. To collect this information, a formal written request to the VDOE Office of School Improvement requesting the release of said data were made.

**Data Analysis**

In order to analyze the collected demographic data, demographic variables, including the percentage of socioeconomic status, the percentage of minority students, and the percentage of highly qualified teachers was studied from one year before, during, and one year after the complete renovation process. Once the demographic variable data were collected, the data were entered into the software program, Statistical Package for Social Sciences (SPSS), and a

descriptive statistics analysis was run. This analysis summarized and compared the demographic variables across the time periods and determined if there was a significant difference between the demographics of the students in the schools. For this study, the demographic variables were assembled in a table format combining all schools and each school individually to identify any changes during the study. Mayo (2012) assumed that there would be minimal change, if any, in his study of these demographic variables over this period of time. For the purposes of this study, the same assumption was made.

In order to determine if the completed renovation had any influence on student achievement on the EOC Algebra I and EOC Reading SOL assessments at the high school level, an analysis of the data covering the same time period (one year before, during, and one year after the renovation) was conducted. As with the demographic data, once all data were gathered, the data were entered into the SPSS software. Analysis of this data entailed running two additional analyses: a 1 x 3 Analysis of Variance (ANOVA), and a *t*-test.

It was important to determine if there was any statistical significance among the three stages of the renovation process. By conducting the Analysis of Variance (ANOVA), the stages of renovation (before, during, and after) were compared to the demographic variables.

Another ANOVA test was run to analyze the difference in means of scaled scores and compared for each stage of the renovation. This analysis also revealed the total variance due to error and the variance due to the differences between the means. The final review of the ANOVA determined if there is 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 achievement data from pre-renovation and post-renovation. The analysis also compared the following timeframes: a) pre-renovation and renovation – year 1, b) pre-renovation and renovation – year 2, if necessary, c) and renovation and post-renovation.

Mayo (2012) conducted one additional analysis in his study. For this reason, the final analysis conducted in the current study was a *t*-test on the mean scaled scores for EOC Algebra I and EOC Reading for only the pre- and post-stages of the renovation process. The outcome of the *t*-test were used to determine if there was any statistically significant difference in the pre- and post- stages of renovation on student achievement.

Mayo (2012) established a null hypothesis stating that there would be no statistical difference found regarding student achievement before, during, or after the renovation process. This final analysis was conducted using the Statistical Package for Social Sciences (SPSS) software in order to accept or reject this same null hypothesis. An alpha level of .05 was used for all statistical tests, and the effect size was calculated by using *r*. If alpha was less than .05, these findings were considered to be statistically significant with the stages of the renovation process on student achievement; if alpha was greater than .05, then these findings were not considered to be statistically significant.

For the purposes of this study, only the EOC Algebra I and EOC Reading Standards of Learning assessment data were used. These data were targeted for a comparison of the high 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.

# Chapter Four
# Findings

## Introduction

This study looked at the possible influence the complete renovation of a school facility had upon student achievement at the high school level within the Commonwealth of Virginia. An examination of student performance was conducted in the areas of EOC Algebra I and EOC Reading on the Standards of Learning Assessment prior to the renovation, during the renovation, and after the renovation for 20 high schools. Findings from this study will add to the research and serve as a valuable resource for school division administrators in determining the impact the renovation process will have upon student achievement among high school students.

## Procedures

Following receipt of approval to conduct the study from the Institutional Review Board (IRB) (Appendix A), the office of School Facilities Services (http://www.doe.virginia.gov/about/finance/facilities_about.shtml) at VDOE was contacted to request needed data. A request was made to Hunter Barnes, VDOE Architectural Consultant, to visit the office of Support Services in Richmond, Virginia in order to begin the process of locating high schools that had conducted a complete renovation during the period beginning with the 2004-2005 school year through the 2010-2011 school year.

During the visit to the office of School Facility Services, it was found that 514 schools had reported construction projects to the VDOE during the appropriate period beginning with the 2004-2005 school year through the 2010-2011 school year. Of these 514 school construction projects, it was determined that 87 of these projects were high school construction projects. In order to determine how many of the high schools had conducted a complete renovation, VDOE files were studied and an email (Appendix B) was then sent to the Director of Facilities for each of the school divisions with high schools within this population. The email was originally sent on May 26, 2014. The email briefly explained the study and asked two questions:

1. Based on the definition of a complete renovation, please describe the scope of work for the renovation of _____High 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?

Email responses were received from a majority of the Directors that either confirmed or disputed the inception and end dates of the construction project. The responses also confirmed or disputed the actual scope of the renovation and helped determine if it met the operational definition of a complete renovation. If an email response was not received, the researcher spoke with the Director of Facilities on the telephone to obtain the requested information. Following the review of the VDOE files and with the information from the Directors of Facilities, it was determined that 20 out of the 87 high school construction projects met the requirement of having conducted a complete renovation.

Having determined the participant schools for the study, a letter was sent to the VDOE Office of School Improvement (Appendix C). This letter listed the 20 participating high schools and the school years one year prior to, during, and one year after each complete renovation. The email then requested the following information in reference to these high schools:

1. Scaled SOL assessment scores in EOC Algebra I and EOC Reading at the high school level for the specified time periods of the renovation process.
2. Means of the scaled scores for the entire state for each of the specified time periods in the areas of EOC Algebra I and EOC Reading at the high school level.
3. Information on demographic variables (percentage of minority students, socioeconomic status represented by the percentage of students eligible for free or reduced lunch prices, and percentage of highly qualified teachers) for each school during the specified periods of one year prior to, during, and one year after each school's complete renovation.

The Office of School Improvement responded to the emailed request by directing the researcher to the Virginia Department of Education webpage entitled "Virginia SOL Assessment Build-A-Table." Through this website (http://bi.virginia.gov/BuildATab/rdPage.aspx), all student mean scaled scores for EOC Algebra I and EOC Reading were gathered for each participant high school before, during, and after the school's complete renovation. In addition to student scaled score data for individual schools, the mean scaled score for the entire state for

each of the specified time periods in the areas of EOC Algebra I and EOC Reading at the high school level were gathered.

Some demographic variable data were also available on the Virginia Department of Education website. From the Office of School Nutrition Programs, socioeconomic data were gathered by reviewing the yearly "Free and Reduced Price Lunch Program Eligibility Report" (http://doe.virginia.gov/support/nutrition/statistics/index.shtml) for each high school during the years of the complete renovations. Beginning on the VDOE home page (www.doe.virginia.gov), the Statistics and Reports link was also found. On this page, the Enrollment & Demographics link was found. After accessing the Enrollment & Demographics page, under the Fall Membership heading, a link was found entitled, "Explore Fall Membership data and create custom reports." Utilizing this link, (http://bi.vita.virginia.gov/doe_bi/rdPage.aspx?rdReport=Main&subRptName=Fallmembership), the researcher gathered all necessary data pertaining to the number of minority students in the participant high schools during the school years before, during, and after the complete renovation.

The Office of School Improvement had limited resources with reference to data on the highly qualified status of teachers. However, data for the highly qualified status of teachers was obtained from the Office of Program Administration and Accountability. A formal request was sent to this office (Appendix D) requesting the percentage of highly qualified teachers at each of the participant high schools during the schools years before, during, and after each school's complete renovation. The Office of Program Administration and Accountability responded to the emailed request by attaching all requested data with respect to the highly qualified status for teachers working within the participant schools during the specified period.

Demographic data for the study included (1) the percentage of minority students, (2) the percentage of students eligible for free/reduced lunch, and (3) the percentage of highly qualified teachers. All data were organized in an Excel spreadsheet and imported into the SPSS program for analysis. In order to determine the means and standard deviations of the three demographic variables, a descriptive statistics analysis was run for the three stages of the complete renovation process. In order to determine the statistical difference, if any, between the three variables at the different stages of the renovation process: pre, during, and post, an ANOVA analysis was then conducted. Two additional ANOVA analyses were then conducted to compare the mean scaled

scores in EOC Algebra I and EOC Reading with the three stages of the renovation process: pre, during, and post. A *t*-test was the final test completed to determine any statistical difference between the pre-and post-renovation stages and student performance on the EOC Algebra I and EOC Reading standards of learning assessments.

It is necessary to emphasize that while only 20 schools were studied, the *n* value (the *n*umber of samples) included not only the number of schools in the study (20 pre, 20 post), but also the number of years for each school's renovation project (34) for a total *n* value of 74. Five schools had a renovation period of two years; three schools had a renovation period of three years; one school had a renovation period of four years; and 11 schools had a renovation period of only one year each. With nine schools having multiple years for renovation, the scaled scores for the EOC Algebra I and EOC Reading during the years of the renovation were averaged together to calculate the means during the renovation. Table 4.1 displays a summary of the 20 schools and the renovation stages for each year of the renovation process.

**Demographic Variables**

Because this study examined the possible influence a complete renovation of a school facility had upon student achievement, it was important to attempt to rule out other potential influences that may exist. A descriptive statistical analysis of three variables (percentage of minority students, percentage of socioeconomic status, and percentage of highly qualified teachers) was conducted in order to determine that there were no significant changes to the compositional make-up in these three demographic variables throughout the course of the complete renovation. Of the 20 high schools that met the criteria of a complete renovation, seven schools were in the pre-renovation process in the 2004-2005 school year. Three schools were also in the pre-renovation stage in 2005-2006 with only four schools in the pre-renovation stage in 2006-2007. During the 2007-2008 school year, four different schools were in the pre-renovation phase while the final two schools that met the study criteria were in the pre-renovation stage in the 2008-2009 school year.

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 | Renovation | Post-Renovation | | |
| B | Pre-Renovation | Renovation | Renovation | Renovation | Post-Renovation | | |
| C | | | Pre-Renovation | Renovation | Renovation | Post-Renovation | |
| D | | | Pre-Renovation | Renovation | Renovation | Post-Renovation | |
| E | | Pre-Renovation | Renovation | Renovation | Post-Renovation | | |
| F | | | Pre-Renovation | Renovation | Post-Renovation | | |
| G | | Pre-Renovation | Renovation | Renovation | Renovation | Post-Renovation | |
| H | Pre-Renovation | Renovation | Renovation | Renovation | Renovation | Post-Renovation | |
| I | Pre-Renovation | Renovation | Post-Renovation | | | | |
| J | | Pre-Renovation | Renovation | Renovation | Post-Renovation | | |
| 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 |
| P | | | Pre-Renovation | Renovation | Post-Renovation | | |
| Q | Pre-Renovation | Renovation | Post-Renovation | | | | |
| R | | | | | Pre-Renovation | Renovation | Post-Renovation |
| S | Pre-Renovation | Renovation | Renovation | Post-Renovation | | | |
| T | Pre-Renovation | Renovation | Post-Renovation | | | | |

As for the actual renovation years, a total of seven schools were under renovation during the 2005-2006 school year, seven schools during the 2006-2007 school year, 10 schools during the 2007-2008 school year, eight schools during the 2008-2009 school year, two final schools during the 2009-2010 school year. The post-renovation stage included three schools for the 2006-2007 school year, one school for the 2007-2008 school year, six schools for the 2008-2009 school year, eight schools during the 2009-2010 school year, and two schools during the 2010-2011 school year (Table 4.1).

When analyzing the demographic variables, Mayo (2012) hypothesized that findings would reveal no statistically significant changes in the three demographic variables of minority, socioeconomic status, and highly qualified teachers over the course of the three phases of the complete renovation process. The same hypothesis was made for the purposes of this current study. 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 22.85% for the pre-renovation stage with a standard deviation of 16.30% ($M$ = 22.85, $SD$ = 16.30), 20.38% during renovation, with a standard deviation of 14.48% ($M$ = 20.38, $SD$ = 14.48), and 24.70% post-renovation with a standard deviations of 16.35% ($M$ = 24.70, $SD$ = 16.35). Data for the variable of socioeconomic status of students reveal the mean of the percentage was 22.50% for the pre-renovation stage with a standard deviation of 13.45% ($M$ = 22.50, $SD$ = 13.45), 25.58% during renovation, with a standard deviation of 14.95% ($M$ = 25.58, $SD$ = 14.95), and 25.76% post-renovation with a standard deviation of 15.89% ($M$ = 25.76, $SD$ = 15.89). The final demographic variable data found the mean of the percentage of highly qualified teachers was 96.88% for the pre-renovation stage with a standard deviation of 4.42 ($M$ = 96.88, $SD$ = 4.42), 97.77% during renovation with a standard deviation of 3.00% ($M$ = 97.77, $SD$ = 3.00), and 97.71% post-renovation with a standard deviation of 4.22% ($M$ = 97.71, $SD$ = 4.22).

Table 4.2

*Mean Amount of Demographic Variables by Renovation Stage (N=20 schools)*

| | | Pre-Renovation (n=20) | | Renovation *(n=34) | | Post-Renovation (n=20) | |
|---|---|---|---|---|---|---|---|
| | Measure | M | SD | M | SD | M | SD |
| 1. | % of Minorities | 22.85 | 16.30 | 20.38 | 14.48 | 24.70 | 16.35 |
| 2. | % SES | 22.50 | 13.45 | 25.58 | 14.95 | 25.76 | 15.89 |
| 3. | % Highly Qualified | 96.88 | 4.42 | 97.77 | 3.00 | 97.71 | 4.22 |

**Renovation N = 34 instead of 20 because renovation = # schools plus # years. Total N=74*

Investigating more extensively into the three demographic variables by year revealed comparable outcomes as to those in Table 4.2. Table 4.2 was displayed by the different renovation stages of complete renovation. Table 4.3 displays the means and standard deviation of the three demographic variables by year, 2005-2007. During the year 2004-2005, seven schools were analyzed, in 2005-2006 10 schools, and in 2006-2007, the school sample was 14. The mean of the percentage of minorities in 2004-2005 was 17.24%, with a standard deviation of 9.58% (*M* = 17.24, *SD* = 9.58), a 18.46% mean in 2005-2006 with a standard deviation of 14.27% (*M* = 18.46, *SD* = 14.27), and a mean of 20.07% in 2006-2007 with a standard deviation of 13.74% (*M* = 20.07, *SD* = 13.04). Data for the variable of socioeconomic status of students during the 2004-2005 school year showed the mean of the percentage was 23.99% with a standard deviation of 13.65%, (*M* = 23.99, *SD* = 13.65). In 2005-2006, there was a mean of the percentage of 20.84% with a standard deviation of 15.39% (*M* = 20.84, *SD* = 15.39), and a percentage of mean of 15.22% in 2006-2007, with a standard deviation of 12.32% (*M* = 15.22, *SD* = 12.32). The last demographic variable data showed the mean of the percentage of highly qualified teachers was 97.59% for the years of 2004-2005 with a standard deviation of 3.92% (*M* = 97.59, *SD* = 3.92), 98.75% in 2005-2006 with a standard deviation of 1.81% (*M* = 98.75, *SD* = 1.81), and 98.92% in 2006-2007 with a standard deviation of 1.90% (*M* = 98.92, *SD* = .1.90).

Table 4.3

*Mean Amount of Demographic Variables by Year (2005-2007)*

| | | 2004-2005 *(n=7) | | 2005-2006 *(n=10) | | 2006-2007 *(n=14) | |
|---|---|---|---|---|---|---|---|
| | Measure | M | SD | M | SD | M | SD |
| 1. | % of Minorities | 17.24 | 9.58 | 18.46 | 14.27 | 20.07 | 13.74 |
| 2. | % SES | 23.99 | 13.65 | 20.84 | 15.39 | 15.22 | 12.32 |
| 3. | % Highly Qualified | 97.59 | 3.92 | 98.75 | 1.81 | 98.92 | 1.90 |

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

During the 2007-2008 school year, 15 schools were analyzed, school year 2008-2009, 16 schools were analyzed, and in 2009-2010, 10 schools made up the school sample. Table 4.4 (Years 2008-2010) displays the mean of the percentage of minorities was 32.75% for the year 2007-2008 with a standard deviation of 8.45% (*M* = 32.75, *SD* = 8.45). Table 4.4 also shows a mean of 13.87% in 2008-2009, with a standard deviation of 12.19% (*M* = 13.87, *SD* = 12.19), and a mean of 26.03% in 2009-2010 with a standard deviation of 11.33% (*M* = 26.03, *SD* = 11.33). Data for the demographic variable of socioeconomic status of students indicated the mean of the percentage was 39.40% for the year 2007-2008 with a standard deviation of 8.40%, (*M* = 39.40, *SD* = 8.40), 21.48% in 2008-2009, with a standard deviation of 11.83% (*M* = 21.48, *SD* = 11.83), and 30.91% in 2009-2010, with a standard deviation of 16.6% (*M* = 30.91, *SD* = 16.6). The last demographic variable data showed the mean of the percentage of highly qualified teachers was 93.14% for the school year of 2007-2008 with a standard deviation of 4.18% (*M* = 93.14, *SD* = 4.18), 98.81% in 2008-2009 with a standard deviation of 1.77% (*M* = 98.81, *SD* = 1.77). In the 2009-2010 school year, a mean of 96.70% was found with a standard deviation of 4.00% (*M* = 96.70, *SD* = 4.00).

Table 4.4

*Mean Amount of Demographic Variables by Year (2008-2010)*

| | | 2007-2008 *(n=15) | | 2008-2009 *(n=16) | | 2009-2010 *(n=10) | |
|---|---|---|---|---|---|---|---|
| | Measure | M | SD | M | SD | M | SD |
| 1. | % of Minorities | 32.75 | 8.45 | 13.87 | 12.19 | 26.03 | 11.33 |
| 2. | % SES | 39.40 | 8.40 | 21.48 | 11.83 | 30.91 | 16.6 |
| 3. | % Highly Qualified | 93.14 | 4.18 | 98.81 | 1.77 | 96.70 | 4.00 |

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

The 2010-2011 school year was the final year included in the study. During this year, only two schools were analyzed. Table 4.5 indicates the mean of the percentage of minorities was 38.33% for the school year of 2010-2011 with a standard deviation of 32.18% (*M* = 38.33, *SD* = 32.18). Data for the demographic variable of socioeconomic status of students indicated the mean of the percentage was 30.33% for the year 2010-2011 with a standard deviation of 11.83% (*M* = 30.33, *SD* = 11.83). The final demographic variable data showed the mean of the percentage of highly qualified teachers was 99.89% for the 2010-2011 school year with a standard deviation of .269% (*M* = 99.89, *SD* = .269).

Table 4.5

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

| | | 2010-2011 *(n=2) | |
|---|---|---|---|
| | Measure | M | SD |
| 1. | % of Minorities | 38.33 | 32.18 |
| 2. | % SES | 30.33 | 11.83 |
| 3. | % Highly Qualified | 99.89 | .269 |

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

Table 4.3, Table 4.4, and Table 4.5 illustrated the range of means when comparing the three demographic variables across the time span of 2004-2010 with all studied schools in any stage of the renovation process. Six of the seven school years identified in these tables included a larger number of schools (*n*) as part of the analysis. These six years had the number of schools ranging from six schools to 16 schools. This allowed for the means and standard deviations of the three demographic variables to be a better representation of all schools studied. Because of varying completion dates across all studied schools renovations, the 2010-2011 school year had only two schools represented during the analysis of the demographic variables. Due to the smaller sample size during this school year, the mean and standard deviation during this school year is less representative of all the schools studied.

Due to a sample size twice as large as was included in the original study conducted by Mayo (2012), the 20 schools included within the current study represented an even more diverse group of schools located all across the Commonwealth of Virginia. A 1 x 3 ANOVA was conducted in order to analyze the difference between means against the variability within the sample. This analysis revealed if changes in demographic variables occurred during the stages of the renovation. Each demographic variable was compared to the pre-renovation, renovation, and post-renovation data.

Table 4.6 is a summary of the demographic variables when compared within the factors of pre, during, and post renovation stages of a complete renovation. The percentage of minorities were not statistically significant over the renovation stages at the $p < .05$ level for the three conditions, $p = 0.602$. The percentage of socioeconomic status of students were not statistically significant over the renovation stages at the $p < .05$ level for the three conditions, $p = .721$. The percentage of highly qualified teachers were not statistically significant over the renovation stages at the $p < .05$ level for the three conditions, $p = .677$. As Mayo (2012) found in his study, Table 4.6 illustrated that there was not a significant difference between the demographic variables and the renovation stages at the $p < .05$ level for the three conditions. The demographic variables did not have any influence upon the means of the scaled scores in EOC Algebra I and EOC Reading, and, as a result, further analysis was conducted of the mean scaled scores in both the EOC Algebra I and EOC Reading at the high school level on the Virginia Standards of Learning assessments.

Table 4.6

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

| | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| % of Minorities | | | | | |
| Factor | .025 | 2 | .012 | .512 | .602 |
| Within Groups | 1.704 | 71 | .024 | | |
| Total | 1.729 | 73 | | | |
| % SES | | | | | |
| Factor | 144.298 | 2 | 72.149 | .328 | .721 |
| Within Groups | 15612.302 | 71 | 219.892 | | |
| Total | 15756.600 | 73 | | | |
| % Highly Qualified | | | | | |
| Factor | 11.135 | 2 | 5.567 | .392 | .677 |
| Within Groups | 1007.996 | 71 | 14.197 | | |
| Total | 1019.131 | 73 | | | |

$p<0.05$

**Means of Scaled Scores**

The Virginia Department of Education (2012) assesses students with the Standards of Learning (SOL) assessments in various content areas from grade three through grade 12. Standards of Learning assessments in English reading and mathematics measure critical thinking skills, mathematical processes, reasoning, and content knowledge. Upon completion of an SOL assessment, a raw score is determined by the number of points a student received for correctly answering questions on a test. A scale score is a conversion of a student‘s raw score to a common scale that allows for a numerical comparison among students. For all SOL tests, the scale scores are set in the range from zero to 600. A scale score of zero is set to correspond to a raw score of zero, and a scale score of 600 is set to correspond to a perfect raw score. A student scale score of 400 represents the minimum level of acceptable proficiency, and 500 represents advanced proficiency. For the purposes of this study, the mean (average) of the scaled scores were collected from the VDOE in order to analyze whether or not a complete renovation influenced student achievement.

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

a. What difference, if any, is there in student scaled scores as measured by the Standards of Learning assessment in EOC Algebra I at the high school level before, during, and after the renovation process?
b. What difference, if any, is there in student scaled scores as measured by the Standards of Learning assessments in EOC Reading at the high school level before, during, and after the renovation process?

The EOC Algebra I and EOC Reading scaled scores were reported and calculated separately for each stage of the renovation process: pre-renovation, during, and post-renovation. Because it may have taken, for some schools, several years to renovate the facility, the 'during' stage of the renovation process included an average which combined the mean scaled score of all the years during renovation. The total sample size for the 'during' renovation stage was 34 years of school data. The pre-renovation and post-renovation were both made up of 20 schools equating to the total number of schools in the study. The sample size totaled 74 years of school data. This consisted of 20 years for pre-renovation, 34 years for during renovation, and 20 years for post-renovation.

**Sub-research question 1:** What difference, if any, is there in student scaled scores as measured by the Standards of Learning assessment in EOC Algebra I at the high school level before, during, and after the renovation process?

Illustrated in Table 4.7 are the EOC Algebra I Mean Scaled Scores for the three renovation stages of the combined 20 schools in the study. The pre-renovation stage revealed a mean EOC Algebra I scaled score of 444.18 with a standard deviation of 13.76 ($M = 444.18$, $SD = 13.76$). The mean score during renovation was 447.75 with a standard deviation of 19.30 ($M = 447.75$, $SD = 19.30$). The post-renovation mean Algebra I scaled score was 452.53 with a standard deviation of 18.51 ($M = 452.53$, $SD = 18.51$).

Table 4.7

*Mean Amount of EOC Algebra I Scaled Scores by Renovation Stage (N=20 schools)*

| | Pre-Renovation (n=20) | | Renovation *(n=34) | | Post-Renovation (n=20) | |
|---|---|---|---|---|---|---|
| Measure | M | SD | M | SD | M | SD |
| 1. EOC Algebra I Mean Scaled Scores | 444.18 | 13.76 | 447.75 | 19.30 | 452.53 | 18.51 |

**Renovation N = 34 instead of 20 because renovation = # schools plus # years. Total N is 74.*

Table 4.8 illustrates the results of an ANOVA that was conducted in order to determine if the stages of the renovation process showed any differences on student achievement in the area of EOC Algebra I. Because the Sig. value is higher than *p*-value of .05, the results of this analysis indicated that in the area of EOC Algebra I, as measured by a means of scaled scores, student achievement is not statistically significantly different among schools when looking at different stages of the renovation process.

Table 4.8

*Summary of ANOVA for EOC Algebra I Mean Scaled Scores vs. Stages of Renovation*

| Source | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| EOC Algebra I Mean Scaled Scores | | | | | |
| Factor | 703.384 | 2 | 351.692 | 1.115 | .334 |
| Within Groups | 22,398.272 | 71 | 315.469 | | |
| Total | 23,101.656 | 73 | | | |

**Sub-research question 2:** What difference, if any, is there in student scaled scores as measured by the Standards of Learning assessment in EOC Reading at the high school level before, during, and after the renovation process?

Illustrated in Table 4.9 are the EOC Reading mean scaled scores for the three renovation stages of the combined 20 schools in the study. The pre-renovation stage revealed a mean EOC Reading scaled score of 488.13 with a standard deviation of 13.19 (M = 488.13, SD = 13.19). The mean score during renovation was 487.30 with a standard deviation of 16.86 (M = 487.30, SD = 16.86). The post-renovation mean EOC Reading scaled score was 488.45 with a standard deviation of 15.37 (M = 488.45, SD = 15.37).

Table 4.9

*Mean Amount of EOC Reading Scaled Scores by Renovation Stage(N=20 Schools)*

| | Pre-Renovation (n=20) | | Renovation *(n=34) | | Post-Renovation (n=20) | |
|---|---|---|---|---|---|---|
| Measure | M | SD | M | SD | M | SD |
| 1. EOC Reading Mean Scaled Scores | 488.13 | 13.19 | 487.30 | 16.86 | 488.45 | 15.37 |

**Renovation N = 34 instead of 20 because renovation = # schools plus # years. Total N is 74.*

As with Table 4.8 with respect to EOC Algebra I, Table 4.10 illustrates the results of an ANOVA that was conducted in order to determine if the stages of the renovation process showed any differences in student achievement in the area of EOC Reading. Because the Sig. value is higher than *p*-value of .05, the results of this analysis indicated that in the area of EOC Reading, as measured by a means of scaled scores, student achievement is not statistically significantly different among schools when looking at different stages of the renovation process.

Table 4.10

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

| Source | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| EOC Reading Mean Scaled Scores | | | | | |
| Factor | 19.094 | 2 | 9.547 | .039 | .961 |
| Within Groups | 17182.450 | 71 | 242.006 | | |
| Total | 17201.543 | 73 | | | |

A 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 EOC Algebra I and EOC Reading in order to determine if an influence existed from pre-renovation to post-renovation stages. The findings from the *t*-test analysis did not indicate any statistically significant influence on student achievement in EOC Algebra I or EOC Reading when comparing the pre-renovation stage to the post-renovation stage. Table 4.11 illustrates the results of the *t*-test for pre-renovation and post-renovation stages for the EOC Algebra I and EOC Reading mean scaled scores. Because the found Sig. value is higher than the *p*-value of .05, the analysis revealed no significance: $t(38) = -1.618$, $p = 0.406$ for EOC Algebra I. EOC Reading also revealed no significance: $t(38) = -.072$, $p = 0.703$.

Table 4.11

*Group Differences Between Renovation Stages on EOC Algebra I and EOC Reading Scaled Scores*

| | | Pre-Renovation (n=20) | | Post-Renovation (n=20) | | | | |
|---|---|---|---|---|---|---|---|---|
| | Measure | M | SD | M | SD | *df* | *t* | Sig. |
| 1. | EOC Algebra I Mean Scaled Scores | 444.18 | 13.76 | 452.53 | 18.51 | 38 | -1.618 | .406 |
| 2. | EOC Reading Mean Scaled Scores | 488.13 | 13.19 | 488.45 | 15.37 | 38 | -.072 | .703 |

$p<0.05$

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

Further analysis of each school's means scaled scores in EOC Algebra I and EOC Reading was conducted and compared to the state means scaled scores in order to align with the methodology used by Mayo (2012) in his original study. All schools' analyses were conducted individually due to the varying inception dates, as well as varying completion dates for each complete renovation project. To demonstrate the comparison, Tables 4.12 and 4.13 display the 20 schools separately with the state averages for each school year of the renovation process.

Table 4.12 compares the EOC Algebra I scaled scores of all schools in the study to the EOC Algebra I scaled scores of the state. The mean scaled score for School A was 459.93 in pre-renovation stage and the mean scaled score for the state was 478.24. During the renovation years, the mean score was 464.06 with a standard deviation of 3.81 (M = 464.06, SD = 3.81), while the state compared with a mean score of 462.17 and a standard deviation of 4.26 (M = 462.17, SD = 4.26). The mean scores during the post-renovation stage were 447.56 for School A and 469.64 for the state.

School B had a mean scaled score of 431.62 for the stage of pre-renovation, and the mean scaled score for the state was 478.24. The years of renovation illustrated the mean scaled score was 431.62 with a standard deviation of 32.64 (M = 431.62, SD = 32.64) and the state mean score during renovation was 462.17 with a standard deviation of 4.26 (M = 462.17, SD = 4.26). The mean scores of the post-renovation stage were 443.76 and 469.64, respectively.

School C had a mean scaled score of 436.66 in the pre-renovation stage, and the mean scaled score of the state was 461.01. During the renovation years, the mean scaled score was 460.51 with a standard deviation of 13.90 (M = 460.51, SD = 13.90), while the state compared at 468.26 with a standard deviation of 1.94 (M = 468.26, SD = 1.94). The mean scaled scores of the post-renovation stage were 452.16 for School C and 472.91 for the state.

School D posted a 439.04 as a mean scaled score in the pre-renovation stage, and the state compared at 461.01. The two years during renovation listed the mean scaled score as 438.04 with a standard deviation of 3.21(M = 438.04, SD = 3.21). The mean scaled score for the state was 468.26 with a standard deviation of 1.94 (M = 468.26, SD = 1.94). The post-renovation stage for School D illustrated a mean scaled score as 433.73, and the state's mean scaled score as 472.91.

The mean scaled score for School E was 437.70 in pre-renovation stage and the mean scaled score for the state was 458.61. During the renovation years, the mean score was 447.53 with a standard deviation of 2.31 (M = 447.53, SD = 2.31), while the state compared with a mean score of 463.95 and a standard deviation of 4.16 (M = 463.95, SD = 4.16). The mean scores during the post-renovation stage were 439.07 for School E and 469.64 for the state.

School F had a mean scaled score of 446.12 for the stage of pre-renovation, and the mean scaled score for the state was 461.01. The single year of renovation illustrated the mean scaled score was 436.40, while the state mean score during renovation was 466.89. The mean scores of the post-renovation stage were 439.07 and 469.64, respectively.

School G had a mean scaled score of 472.02 for the stage of pre-renovation, and the mean scaled score for the state was 458.61. The years of renovation illustrated the mean scaled score was 476.74 with a standard deviation of 7.92 (M = 476.74, SD = 7.92), and the state mean score during renovation was 465.85 with a standard deviation of 4.41 (M = 465.85, SD = 4.41). The mean score of the post-renovation stage for School G was 489.51, and the state's mean score was 472.91.

School H posted a 437.74 as a mean scaled score in the pre-renovation stage, and the state compared at 478.24. The four years during renovation listed the mean scaled score as 436.33 with a standard deviation of 14.04 (M = 436.33, SD = 14.04). The mean scaled score for the state was 464.04 with a standard deviation of 5.10 (M = 464.04, SD = 5.10). The post-renovation stage for School H illustrated a mean scaled score as 443.40 and the state's mean scaled score as 472.91.

School I had a mean scaled score of 438.64 in the pre-renovation stage, and the mean scaled score of the state was 478.24. During the renovation year, the mean scaled score was 438.16, while the state compared at 458.61. The mean scaled scores of the post-renovation stages were 439.12 for School I and 461.01 for the state.

School J had a mean scaled score of 460.01 in the pre-renovation stage, and the mean scaled score of the state was 458.61. During the renovation year, the mean scaled score was 469.90 with a standard deviation of 16.82 (M = 469.90, SD = 16.82), while the state compared at 463.95 with a standard deviation of 4.16 (M = 463.95, SD = 4.16). The mean scaled scores of the post-renovation stage were 486.86 for School J and 469.64 for the state.

School K had a mean scaled score of 431.42 in the pre-renovation stage, and the mean scaled score of the state was 466.89. During the renovation year, the mean scaled score was 439.95, while the state compared at 469.64. The mean scaled scores of the post-renovation stages were 453.49 for School K and 472.91 for the state.

School L had a mean scaled score of 441.45 during the pre-renovation, and the mean scaled score of the state was 466.89. During the renovation year, the mean score was 451.17, and the state was 469.64. The mean scores during the post-renovation were 461.41 and 472.91 corresponding with the school and state, respectively.

School M posted a 473.22 as a mean scaled score in the pre-renovation stage, and the state compared at 466.89. The one year during renovation listed the mean scaled score as 477.16 with the mean scaled score for the state at 469.64. The post renovation stage for School M illustrated a mean scaled score as 489.24, and the state's mean scaled score as 472.91.

School N had a mean scaled score of 427.61 for the stage of pre-renovation, and the mean scaled score for the state was 466.89. The year of renovation illustrated the mean scaled score was 434.43, and the state mean score during renovation was 469.64. The mean scaled score of

the post-renovation stage for School N was 431.78, and the state had a mean scaled score of 472.91.

School O had a mean scaled score of 444.77 during the pre-renovation, and the mean scaled score of the state was 469.64. During the renovation year, the mean score was 458.41, and the state was 472.91. The mean scores during the post-renovation were 465.38 and 472.39 corresponding with the school and state, respectively.

School P had a mean scaled score of 448.87 in the pre-renovation stage, and the mean scaled score of the state was 461.01. During the renovation year, the mean scaled score was 450.87, while the state compared at 466.89. The mean scaled scores of the post-renovation stages were 454.49 for School P and 469.64 for the state.

School Q had a mean scaled score of 440.64 during the pre-renovation, and the mean scaled score of the state was 478.24. During the renovation year, the mean score was 435.43, and the state was 458.61. The mean scores during the post-renovation were 445.85 and 461.01 corresponding with the school and state, respectively.

School R posted a 456.15 as a mean scaled score in the pre-renovation stage, and the state compared at 469.64. The one year during renovation listed the mean scaled score as 457.27 with the mean scaled score for the state at 472.91. The post-renovation stage for School R illustrated a mean scaled score as 455.20, and the state's mean scaled score as 472.39.

School S had a mean scaled score of 423.04 for the stage of pre-renovation, and the mean scaled score for the state was 478.24. The years of renovation illustrated the mean scaled score was 409.59 with a standard deviation of .176 (M = 409.59, SD = .176), and the state mean score during renovation was 459.81 with a standard deviation of 1.70 (M = 459.81, SD = 1.70). The mean score of the post-renovation stage for School S was 449.93, and the state's mean score was 466.89.

School T had a mean scaled score of 436.96 in the pre-renovation stage, and the mean scaled score of the state was 478.24. During the renovation year, the mean scaled score was 430.46, while the state compared at 458.61. The mean scaled scores of the post-renovation stages were 443.49 for School T and 461.01 for the state.

Table 4.12

*Comparison of EOC Algebra I Mean Scaled Scores by School vs. State*

| Measure | School | | State | |
|---|---|---|---|---|
| | M | SD | M | SD |
| School A | | | | |
| 1. Pre-renovation (2004-2005) | 459.93 | . | 478.24 | . |
| 2. Renovation (2005-2008) | 464.06 | 3.81 | 462.17 | 4.26 |
| 3. Post-renovation (2008-2009) | 447.56 | . | 469.64 | . |
| School B | | | | |
| 1. Pre-renovation (2004-2005) | 431.62 | . | 478.24 | . |
| 2. Renovation (2005-2008) | 431.62 | 32.64 | 462.17 | 4.26 |
| 3. Post-renovation (2008-2009) | 443.76 | . | 469.64 | . |
| School C | | | | |
| 1. Pre-renovation (2006-2007) | 436.66 | . | 461.01 | . |
| 2. Renovation (2007-2009) | 460.51 | 13.90 | 468.26 | 1.94 |
| 3. Post-renovation (2009-2010) | 452.16 | . | 472.91 | . |
| School D | | | | |
| 1. Pre-renovation (2006-2007) | 439.04 | . | 461.01 | . |
| 2. Renovation (2007-2009) | 438.04 | 3.21 | 468.26 | 1.94 |
| 3. Post-renovation (2009-2010) | 433.73 | . | 472.91 | . |

(table continued)

Table 4.12 (*Cont.*)

| | | | | |
|---|---|---|---|---|
| School E | | | | |
| 1. Pre-renovation (2005-2006) | 437.70 | . | 458.61 | . |
| 2. Renovation (2006-2008) | 447.53 | 2.31 | 463.95 | 4.16 |
| 3. Post-renovation (2008-2009) | 439.07 | . | 469.64 | . |
| School F | | | | |
| 1. Pre-renovation (2006-2007) | 446.12 | . | 461.01 | . |
| 2. Renovation (2007-2008) | 436.40 | . | 466.89 | . |
| 3. Post-renovation (2008-2009) | 439.07 | . | 469.64 | . |
| School G | | | | |
| 1. Pre-renovation (2005-2006) | 472.02 | . | 458.61 | . |
| 2. Renovation (2006-2009) | 476.74 | 7.92 | 465.85 | 4.41 |
| 3. Post-renovation (2009-2010) | 489.51 | . | 472.91 | . |
| School H | | | | |
| 1. Pre-renovation (2004-2005) | 437.74 | . | 478.24 | . |
| 2. Renovation (2005-2009) | 436.33 | 14.04 | 464.04 | 5.10 |
| 3. Post-renovation (2009-2010) | 443.40 | . | 472.91 | . |
| School I | | | | |
| 1. Pre-renovation (2004-2005) | 438.64 | . | 478.24 | . |
| 2. Renovation (2005-2006) | 438.16 | . | 458.61 | . |
| 3. Post-renovation (2006-2007) | 439.12 | . | 461.01 | . |

(table continued)

Table 4.12 (*Cont.*)

| | | | | |
|---|---|---|---|---|
| School J | | | | |
| 1. Pre-renovation (2005-2006) | 460.01 | . | 458.61 | . |
| 2. Renovation (2006-2008) | 469.90 | 16.82 | 463.95 | 4.16 |
| 3. Post-renovation (2008-2009) | 486.86 | . | 469.64 | . |
| School K | | | | |
| 1. Pre-renovation (2007-2008) | 431.42 | . | 466.89 | . |
| 2. Renovation (2008-2009) | 439.95 | . | 469.64 | . |
| 3. Post-renovation (2009-2010) | 453.49 | . | 472.91 | . |
| School L | | | | |
| 1. Pre-renovation (2007-2008) | 441.45 | . | 466.89 | . |
| 2. Renovation (2008-2009) | 451.17 | . | 469.64 | . |
| 3. Post-renovation (2009-2010) | 461.41 | . | 472.91 | . |
| School M | | | | |
| 1. Pre-renovation (2007-2008) | 473.22 | . | 466.89 | . |
| 2. Renovation (2008-2009) | 477.16 | . | 469.64 | . |
| 3. Post-renovation (2009-2010) | 489.24 | . | 472.91 | . |
| School N | | | | |
| 1. Pre-renovation (2007-2008) | 427.61 | . | 466.89 | . |
| 2. Renovation (2008-2009) | 434.43 | . | 469.64 | . |
| 3. Post-renovation (2009-2010) | 431.78 | . | 472.91 | . |

(table continued)

Table 4.12 (*Cont.*)

| | | | | |
|---|---|---|---|---|
| School O | | | | |
| 1. Pre-renovation (2008-2009) | 444.77 | . | 469.64 | . |
| 2. Renovation (2009-2010) | 458.41 | . | 472.91 | . |
| 3. Post-renovation (2010-2011) | 465.38 | . | 472.39 | . |
| School P | | | | |
| 1. Pre-renovation (2006-2007) | 448.87 | . | 461.01 | . |
| 2. Renovation (2007-2008) | 450.87 | . | 466.89 | . |
| 3. Post-renovation (2008-2009) | 454.49 | . | 469.64 | . |
| School Q | | | | |
| 1. Pre-renovation (2004-2005) | 440.64 | . | 478.24 | . |
| 2. Renovation (2005-2006) | 435.43 | . | 458.61 | . |
| 3. Post-renovation (2006-2007) | 445.85 | . | 461.01 | . |
| School R | | | | |
| 1. Pre-renovation (2008-2009) | 456.15 | . | 469.64 | . |
| 2. Renovation (2009-2010) | 457.27 | . | 472.91 | . |
| 3. Post-renovation (2010-2011) | 455.20 | . | 472.39 | . |
| School S | | | | |
| 1. Pre-renovation (2004-2005) | 423.04 | . | 478.24 | . |
| 2. Renovation (2005-2007) | 409.59 | .176 | 459.81 | 1.70 |
| 3. Post-renovation (2007-2008) | 449.93 | . | 466.89 | . |

(table continued)

Table 4.12 (*Cont.)*

| School T | | | | |
|---|---|---|---|---|
| 1. Pre-renovation (2004-2005) | 436.96 | . | 478.24 | . |
| 2. Renovation (2005-2006) | 430.46 | . | 458.61 | . |
| 3. Post-renovation (2006-2007) | 443.49 | . | 461.01 | . |

Table 4.13 compares the EOC Reading scaled scores of all schools in the study to the EOC Reading scaled scores of the state. The mean scaled score for School A was 481.04 in pre-renovation stage, and the mean scaled score for the state was 478.82. During the renovation years, the mean score was 482.66 with a standard deviation of 4.30 (M = 482.66, SD = 4.30), while the state compared with a mean score of 488.45 and a standard deviation of 2.31 (M = 488.45, SD = 2.31). The mean scores during the post-renovation stage were 476.16 for School A and 494.08 for the state.

School B had a mean scaled score of 469.30 for the stage of pre-renovation, and the mean scaled score for the state was 478.82. The years of renovation illustrated the mean scaled score was 469.30 with a standard deviation of 3.82 (M = 469.30, SD = 3.82), and the state mean score during renovation was 488.45 with a standard deviation of 2.31 (M = 488.45, SD = 2.31). The mean scores of the post-renovation stage were 476.16 and 494.08, respectively.

School C had a mean scaled score of 495.95 in the pre-renovation stage, and the mean scaled score of the state was 489.20. During the renovation years, the mean scaled score was 504.14 with a standard deviation of 7.41 (M = 504.14, SD = 7.41), while the state compared at 492.19 with a standard deviation of 2.67 (M = 492.19, SD = 2.67). The mean scaled scores of the post-renovation stage were 505.38 for School C and 492.58 for the state.

School D posted a 474.44 as a mean scaled score in the pre-renovation stage, and the state compared at 489.20. The two years during renovation listed the mean scaled score as 485.27 with a standard deviation of 9.88 (M = 485.27, SD = 9.88). The mean scaled score for the state was 492.19 with a standard deviation of 2.67 (M = 492.19, SD = 2.67). The post-renovation stage for School D illustrated a mean scaled score as 470.51 and the state's mean scaled score as 470.51.

The mean scaled score for School E was 478.74 in pre-renovation stage, and the mean scaled score for the state was 485.86. During the renovation years, the mean score was 485.27 with a standard deviation of 3.13 (M = 485.27, SD = 3.13), while the state compared with a mean score of 489.75 and a standard deviation of .778 (M = 489.75, SD = .778). The mean scores during the post-renovation stage were 495.55 for School E and 494.08 for the state.

School F had a mean scaled score of 482.82 for the stage of pre-renovation, and the mean scaled score for the state was 489.20. The single year of renovation illustrated the mean scaled score was 487.84, while the state mean score during renovation was 490.30. The mean scores of the post-renovation stage were 477.05 and 494.08, respectively.

School G had a mean scaled score of 510.15 for the stage of pre-renovation, and the mean scaled score for the state was 485.86. The years of renovation illustrated the mean scaled score was 523.66 with a standard deviation of 5.52 (M = 523.66, SD = 5.52), and the state mean score during renovation was 491.19 with a standard deviation of 2.56 (M = 491.19, SD = 2.56). The mean score of the post-renovation stage for School G was 526.68, and the state's mean score was 492.58.

School H posted a 476.90 as a mean scaled score in the pre-renovation stage, and the state compared at 478.82. The four years during renovation listed the mean scaled score as 475.78 with a standard deviation of 13.10 (M = 475.78, SD = 13.10). The mean scaled score for the state was 489.86 with a standard deviation of 3.39 (M = 489.86, SD = 3.39). The post-renovation stage for School H illustrated a mean scaled score as 481.39 and the state's mean scaled score as 492.58.

School I had a mean scaled score of 498.83 in the pre-renovation stage, and the mean scaled score of the state was 478.82. During the renovation year, the mean scaled score was 497.26, while the state compared at 485.86. The mean scaled scores of the post-renovation stages were 500.39 for School I and 489.20 for the state.

School J had a mean scaled score of 479.60 in the pre-renovation stage, and the mean scaled score of the state was 485.86. During the renovation years, the mean scaled score was 476.24 with a standard deviation of 8.39 (M = 476.24, SD = 8.39), while the state compared at 489.75 with a standard deviation of .778 (M = 489.75, SD = .778). The mean scaled scores of the post-renovation stage were 496.48 for School J and 494.08 for the state.

School K had a mean scaled score of 495.01 in the pre-renovation stage, and the mean scaled score of the state was 490.30. During the renovation year, the mean scaled score was 480.16, while the state compared at 494.08. The mean scaled scores of the post-renovation stages were 489.62 for School K and 492.58 for the state.

School L had a mean scaled score of 486.31 during the pre-renovation, and the mean scaled score of the state was 490.30. During the renovation year, the mean score was 468.87, and the state was 494.08. The mean scores during the post-renovation were 466.55 and 482.58 corresponding with the school and state, respectively.

School M posted a 502.55 as a mean scaled score in the pre-renovation stage, and the state compared at 490.30. The one year during renovation listed the mean scaled score as 503.10 with the mean scaled score for the state at 464.08. The post renovation stage for School M illustrated a mean scaled score as 496.63, and the state's mean scaled score as 492.58.

School N had a mean scaled score of 487.44 for the stage of pre-renovation, and the mean scaled score for the state was 490.30. The year of renovation illustrated the mean scaled score was 491.84, and the state mean score during renovation was 494.08. The mean scaled score of the post-renovation stage for School N was 480.48, and the state had a mean scaled score of 492.58.

School O had a mean scaled score of 506.83 during the pre-renovation, and the mean scaled score of the state was 494.08. During the renovation year, the mean score was 489.49, and the state was 492.58. The mean scores during the post-renovation were 492.79 and 493.01 corresponding with the school and state, respectively.

School P had a mean scaled score of 495.67 in the pre-renovation stage, and the mean scaled score of the state was 489.20. During the renovation year, the mean scaled score was 498.61, while the state compared at 490.30. The mean scaled scores of the post-renovation stages were 494.18 for School P and 494.08 for the state.

School Q had a mean scaled score of 491.79 during the pre-renovation, and the mean scaled score of the state was 478.82. During the renovation year, the mean score was 494.55, and the state was 485.86. The mean scores during the post-renovation were 489.04 and 489.20 corresponding with the school and state, respectively.

School R posted a 468.58 as a mean scaled score in the pre-renovation stage, and the state compared at 494.08. The one year during renovation listed the mean scaled score as 470.75 with

the mean scaled score for the state at 492.58. The post renovation stage for School R illustrated a mean scaled score as 466.46, and the state's mean scaled score as 493.01.

School S had a mean scaled score of 472.01 for the stage of pre-renovation, and the mean scaled score for the state was 478.82. The years of renovation illustrated the mean scaled score was 472.32 with a standard deviation of 1.41 (M = 472.32, SD = 1.41), and the state mean score during renovation was 487.53 with a standard deviation of 2.36 (M = 487.53, SD = 2.36). The mean score of the post-renovation stage for School S was 471.38, and the state's mean score was 490.30.

School T had a mean scaled score of 508.54 in the pre-renovation stage, and the mean scaled score of the state was 478.82. During the renovation year, the mean scaled score was 509.18, while the state compared at 485.86. The mean scaled scores of the post-renovation stages were 507.90 for School T and 489.20 for the state.

Table 4.13

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

| | School | | State | |
|---|---|---|---|---|
| Measure | M | SD | M | SD |
| School A | | | | |
| 1. Pre-renovation (2004-2005) | 481.04 | . | 478.82 | . |
| 2. Renovation (2005-2008) | 482.66 | 4.30 | 488.45 | 2.31 |
| 3. Post-renovation (2008-2009) | 476.16 | . | 494.08 | . |

(table continued)

Table 4.13 (*Cont.*)

| | | | | |
|---|---|---|---|---|
| School B | | | | |
| 1. Pre-renovation (2004-2005) | 469.30 | . | 478.82 | . |
| 2. Renovation (2005-2008) | 469.30 | 3.82 | 488.45 | 2.31 |
| 3. Post-renovation (2008-2009) | 484.42 | . | 494.08 | . |
| School C | | | | |
| 1. Pre-renovation (2006-2007) | 495.95 | . | 489.20 | . |
| 2. Renovation (2007-2009) | 504.14 | 7.41 | 492.19 | 2.67 |
| 3. Post-renovation (2009-2010) | 505.38 | . | 492.58 | . |
| School D | | | | |
| 1. Pre-renovation (2006-2007) | 474.44 | . | 489.20 | . |
| 2. Renovation (2007-2009) | 485.27 | 9.88 | 492.19 | 2.67 |
| 3. Post-renovation (2009-2010) | 470.51 | . | 492.58 | . |
| School E | | | | |
| 1. Pre-renovation (2005-2006) | 478.74 | . | 485.86 | . |
| 2. Renovation (2006-2008) | 485.27 | 3.13 | 489.75 | .778 |
| 3. Post-renovation (2008-2009) | 495.55 | . | 494.08 | . |
| School F | | | | |
| 1. Pre-renovation (2006-2007) | 482.82 | . | 489.20 | . |
| 2. Renovation (2007-2008) | 487.84 | . | 490.30 | . |
| 3. Post-renovation (2008-2009) | 477.05 | . | 494.08 | . |

(table continued)

Table 4.13 (*Cont.*)

| | | | | |
|---|---|---|---|---|
| School G | | | | |
| 1. Pre-renovation (2005-2006) | 510.15 | . | 485.86 | . |
| 2. Renovation (2006-2009) | 523.66 | 5.52 | 491.19 | 2.56 |
| 3. Post-renovation (2009-2010) | 526.68 | . | 492.58 | . |
| School H | | | | |
| 1. Pre-renovation (2004-2005) | 476.90 | . | 478.82 | . |
| 2. Renovation (2005-2009) | 475.78 | 13.10 | 489.86 | 3.39 |
| 3. Post-renovation (2009-2010) | 481.39 | . | 492.58 | . |
| School I | | | | |
| 1. Pre-renovation (2004-2005) | 498.83 | . | 478.82 | . |
| 2. Renovation (2005-2006) | 497.26 | . | 485.86 | . |
| 3. Post-renovation (2006-2007) | 500.39 | . | 489.20 | . |
| School J | | | | |
| 1. Pre-renovation (2005-2006) | 479.60 | . | 485.86 | . |
| 2. Renovation (2006-2008) | 476.24 | 8.39 | 489.75 | .778 |
| 3. Post-renovation (2008-2009) | 496.48 | . | 494.08 | . |
| School K | | | | |
| 1. Pre-renovation (2007-2008) | 495.01 | . | 490.30 | . |
| 2. Renovation (2008-2009) | 480.16 | . | 494.08 | . |
| 3. Post-renovation (2009-2010) | 489.62 | . | 492.58 | . |

(table continued)

Table 4.13 (*Cont.*)

| | | | | |
|---|---|---|---|---|
| School L | | | | |
| 1. Pre-renovation (2007-2008) | 486.31 | . | 490.30 | . |
| 2. Renovation (2008-2009) | 468.87 | . | 494.08 | . |
| 3. Post-renovation (2009-2010) | 466.55 | . | 492.58 | . |
| School M | | | | |
| 1. Pre-renovation (2007-2008) | 502.55 | . | 490.30 | . |
| 2. Renovation (2008-2009) | 503.10 | . | 494.08 | . |
| 3. Post-renovation (2009-2010) | 496.63 | . | 492.58 | . |
| School N | | | | |
| 1. Pre-renovation (2007-2008) | 487.44 | . | 490.30 | . |
| 2. Renovation (2008-2009) | 491.84 | . | 494.08 | . |
| 3. Post-renovation (2009-2010) | 480.48 | . | 492.58 | . |
| School O | | | | |
| 1. Pre-renovation (2008-2009) | 506.83 | . | 494.08 | . |
| 2. Renovation (2009-2010) | 489.49 | . | 492.58 | . |
| 3. Post-renovation (2010-2011) | 492.79 | . | 493.01 | . |
| School P | | | | |
| 1. Pre-renovation (2006-2007) | 495.67 | . | 489.20 | . |
| 2. Renovation (2007-2008) | 498.61 | . | 490.30 | . |
| 3. Post-renovation (2008-2009) | 494.18 | . | 494.08 | . |

(table continued)

Table 4.13 (*Cont.*)

| | | | | |
|---|---|---|---|---|
| School Q | | | | |
| 1. Pre-renovation (2004-2005) | 491.79 | . | 478.82 | . |
| 2. Renovation (2005-2006) | 494.55 | . | 485.86 | . |
| 3. Post-renovation (2006-2007) | 489.04 | . | 489.20 | . |
| School R | | | | |
| 1. Pre-renovation (2008-2009) | 468.58 | . | 494.08 | . |
| 2. Renovation (2009-2010) | 470.75 | . | 492.58 | . |
| 3. Post-renovation (2010-2011) | 466.46 | . | 493.01 | . |
| School S | | | | |
| 1. Pre-renovation (2004-2005) | 472.01 | . | 478.82 | . |
| 2. Renovation (2005-2007) | 472.32 | 1.41 | 487.53 | 2.36 |
| 3. Post-renovation (2007-2008) | 471.38 | . | 490.30 | . |
| School T | | | | |
| 1. Pre-renovation (2004-2005) | 508.54 | . | 478.82 | . |
| 2. Renovation (2005-2006) | 509.18 | . | 485.86 | . |
| 3. Post-renovation (2006-2007) | 507.90 | . | 489.20 | . |

**Summary**

Analyses were conducted utilizing data from 20 high schools in the Commonwealth of Virginia to add to the available literature on research previously conducted by Mayo (2012). All analyses were run in order to explore further the notion that a relationship may exist between school facility renovation and student achievement in Virginia high schools.

The findings of the 20 high schools identified as being complete renovations were summarized by a descriptive statistical analysis. This analysis summarized and compared the demographic variables across the renovation stages and determined if there was a significant

difference between the demographics of the students in the schools. For the purposes of this study, the assumption was made that there would be minimal change in these demographic variables throughout the renovation stages.

A 1 x 3 ANOVA and a *t*-test were conducted to determine if the completed renovation had any influence on student achievement on the EOC Algebra I and EOC Reading SOL assessments at the high school level.

# Chapter Five
# Analysis of Findings, Conclusions, Discussion, Implications for Practice and Recommendation for Further Research

## Introduction

The purpose of chapter five is to analyze and discuss the findings from chapter four addressing the main research question: Does the complete renovation process, which would include structural, plumbing, electrical, and heating and air conditioning improvements within a school building, influence student achievement? Sub questions referring to student scaled scores as measured by the Standards of Learning assessment in EOC Algebra I and EOC Reading at the high school level before, during, and after the renovation process will also be discussed. Conclusions and recommendations for further research will then be addressed.

The intent of this study was to add to the body of current research available pertaining to any actual or perceived relationship between a complete school renovation project and student achievement. This study was to be another piece of data that could assist school divisions when considering ways to minimize the effect the renovation process has on student achievement or perhaps to consider other options rather than conducting a facility renovation.

The Virginia Department of Education recorded 514 school construction projects during the time frame of 2004 through 2010. From these 514 projects, 87 were classified as high school renovation projects. From these 87 high school renovations, 20 renovations were found to meet the criteria of being a high school conducting a complete renovation. The four necessary components to be considered a complete renovation are to include the following upgrades in the renovation project: (1) structural, (2) plumbing, (3) electrical, and (4) heating and air conditioning.

## Analysis of Findings

The findings of the 20 high schools identified as having conducted a complete renovation displayed no statistical significance between the demographic variables and were not statistically significant when comparing student performance to each stage of the renovation process. A detailed examination follows of each conducted analysis.

**Demographic variables: Finding one.** As illustrated in Table 4.5 from Chapter 4, no statistically significant difference occurred in the demographic variables of the student population within the stages of renovation. As a result, the demographic variables did not significantly influence the means of the scaled scores in EOC Algebra I or EOC Reading.

A descriptive statistical analysis of three variables (percentage of minority students, percentage of socioeconomic status, and percentage of highly qualified teachers) was conducted in order to determine that there were no significant changes to the compositional make-up in the student population in these three demographic variables throughout the course of the complete renovation. From the 20 high schools that met the criteria of a complete renovation, the total percentage of minorities, percentage of socioeconomic status, and the percentage of highly qualified teachers were calculated for each stage of the renovation process: pre-renovation, renovation, and post-renovation.

Of the 74 sample years of demographic data used during the renovation stages, as shown in Table 4.2 from Chapter 4, no significant change was found in any of the three demographic variables. The percentage of minorities remained relatively stable showing little difference in the number of minority students served at each school across the three stages of the renovation project. The percentage of minority students decreased slightly (2.47%) from the pre-renovation stage to the renovation stage. However, minority percentage then increased by 4.32% during the post-renovation stages. By averaging the means of the percentage of minority students during the renovation and post-renovation stages, a total mean of 22.54% was found. This percentage is only .31% less than the percentage of minorities during the pre-renovation stage (22.85%). The percent of socioeconomic status students showed a slight increase of 3.08% during the renovation stage, then increasing slightly again by .18% at post-renovation. The percentage of highly qualified teachers only increased slightly by .89% from the pre-renovation stage to the renovation stage. From the renovation stage to the post-renovation stage, there was a decrease of .06% in the percentage of highly qualified teachers.

**Means of scaled scores for EOC algebra I and EOC reading: Finding two.** There was no statistical significance found in the relationship between student achievement and the three stages of the renovation process. The means of the scaled scores in EOC Algebra I and EOC Reading at the high school level were analyzed for the 20 schools following the analysis of the demographic variables. The analysis of the scaled scores consisted of one year prior to the

renovation and one year after the renovation. Because the length of the renovations varied across the 20 schools, the years during the renovation period for each school were averaged together. These averaged years during the renovation were also included in the analysis. Table 4.8 from Chapter 4 illustrated the results of the ANOVA indicating that in the area of EOC Algebra I, as measured by a means of scaled scores, student achievement was not different among schools when different stages of the renovation process were targeted. Also from Chapter 4, as noted in Table 4.8, the level of .334 (p-value of .05) indicated that the influence of any particular stage of the renovation process had no bearing upon student achievement. As indicated for EOC Algebra I, Table 4.10 from Chapter 4 illustrated the results of the ANOVA indicating similar results in the area of EOC Reading as measured by a means of scaled scores. The found level of .961 (p-value of .05) in Table 4.10 from Chapter 4 indicated once again that the influence of any particular stage of the renovation process had no bearing upon student achievement.

In Chapter 4, Table 4.11 illustrated the *t*-test analysis, and neither EOC Algebra I nor EOC Reading showed any statistically significant difference. The mean scaled score for EOC Algebra I increased from the pre-renovation stage to the post-renovation stage by 8.35 points. However, as previously noted, with $p$=.406, there was no significant difference across the two renovation stages for EOC Algebra I. The mean scaled score for EOC Reading remained nearly unchanged from the pre-renovation stage to the post-renovation stage increasing slightly by only .32 points. With a $p$=.703, there was no significant difference across the two renovation stages for EOC Reading.

**Comparison of mean scaled scores in EOC algebra I and EOC reading vs. the State.** Each school's mean scaled student scores in EOC Algebra I and EOC Reading was compared to the state mean scaled score for the same assessments. From Chapter 4, Table 4.12 illustrates this comparison with respect to EOC Algebra I. Only three of the 20 schools showed higher mean scaled scores in all three stages of the renovation process in comparison to the state. Only one school showed a combination of higher and lower scores within the renovation process in comparison to the state. The other 16 schools in the study showed lower mean scaled scores in the area of EOC Algebra I in all three stages of the renovation process in comparison to the state mean scaled scores. Also from Chapter 4, as illustrated in Table 4.13, the scores in the area of EOC Reading were more closely grouped across the three same categories. Six schools showed higher mean scaled scores in all three stages of the renovation process in comparison to the state.

Six schools showed a combination of higher and lower scores within the renovation process in comparison to the state, and eight scored lower in all three stages of the renovation process in comparison to the state's mean scaled scores in EOC Reading.

When comparing the mean scaled scores of individual schools with the state averages in EOC Algebra I and EOC Reading, 11 of the schools had the same trends for both SOL assessments. An assumption could be made that the schools with higher scaled scores in both EOC Algebra I and EOC Reading than the state averages in these same areas would indicate that these were higher performing schools overall when compared to schools that scored lower than the state averages in both EOC Algebra I and EOC Reading. In order to find this assumption true, however, further research would be necessary to determine if schools scoring higher than the state averages in EOC Algebra I and EOC Reading are higher performing schools versus schools that scored lower than the state average.

## Conclusion

The main research question for this study was, 'Does the complete renovation process, which would include structural, plumbing, electrical, and heating and air conditioning improvements within a school building, influence student achievement?' The findings of this study showed that there was no statistically significant relationship between student performance and the three stages of a complete renovation project. Therefore, the conclusion of this study is that student scaled scores did not significantly change during the renovation stages indicating the renovation process did not make any difference in student scaled scores.

Further analysis of the two sub-questions also did not find any statistical significance that the mean scaled scores on the EOC Algebra I and EOC Reading Standards of Learning assessment were influenced by the complete renovation of the 20 high schools within the study.

## Discussion

The purpose of this study was to replicate the 2012 study conducted by John Mayo who researched the renovation process and student achievement using data from the Virginia Standards of Learning (SOL) Assessment for Mathematics and Reading at the eighth grade level. Mayo (2012) was one of the first to conduct a study that examined the possibility that student achievement scores may be influenced during the renovation process. For purposes of adding to

the body of research, Norman (2014) completed a replication of all components of the Mayo study using the same SOL content area assessments of Mathematics and Reading. Norman's replication study used SOL assessments for Mathematics and Reading at the fifth grade level. Further adding to the body of research, the current replication study used SOL assessments for EOC Algebra I and EOC Reading at the high school level.

All findings were similar when comparing the studies conducted by Mayo (2012), Norman (2014), and the current study. It is important to note that all three studies were dealing with different student populations throughout the renovation process of each school. When gathering data of student achievement from a particular assessment that is only given one time each year, it is impossible to utilize a cohort of students across a number of years. Without being able to study a cohort of the same students, controlling for the demographic variables was the only way to determine sameness across multiple student populations.

Mayo (2012), Norman (2014), and the current study controlled for the composition of the demographic variables consisting of the student demographic variables of percent of minority students, as well as the percent of students receiving free or reduced lunch prices as measures of comparison of the various student populations. All three studies also used the percent of highly qualified teachers over the renovation period in order to determine if there were any changes in the quality of the faculty. In each of the three studies, the analysis of the student demographic variables and the quality of teachers indicated there were no significant changes during the course of the renovation period. The results of this analysis allowed the researchers to believe that the student and teacher populations did not vary significantly, and therefore did not have an impact on student achievement during the renovation process. By utilizing this methodology, however, the lack of the ability to use a single cohort of students may have influenced the findings of all three studies.

One of the more important findings when comparing all three studies revealed an increase in the mean scaled score of mathematics when comparing the pre-renovation stage to the post-renovation stage. Mayo (2012) found an overall increase of 6.93 points in the mean scaled scores of mathematics. Norman (2014) and the current study found increases of 5.17 points and 8.35 points, respectively. While none of these increases was found to be statistically significant, these findings do indicate a trend. These findings support the findings of Maxwell (1999), who found that student scores in mathematics were higher in the post-renovation phase

than in the pre-renovation phase. All of these studies support the theory that student scores are higher in a newly renovated facility than student scores in older buildings that may be in need of renovation. Although it was not possible to assess the condition of the buildings in this study before the renovation, it is safe to assume that these buildings were in good enough condition to be renovated. In other words, the school boards thought the buildings were sufficiently valuable enough to justify an investment of funds to bring the building up to modern standards as opposed to investing in the construction of a brand new facility.

It is important to note that while the suggested trend that student achievement typically will increase in mathematics when a school has gone through the renovation process may be true, further research is needed in order to determine if this is truly the case. Further research may find that, as Norman (2014) suggested, during the renovation process, perhaps teachers employed new research based teaching strategies, and increased the quality of their lesson design to meet the challenge of teaching in the midst of a complete renovation. The suggestion is that these instructional variables may account for the trend of an increase in mathematics scores and overall student achievement.

The experience of learning through a complete renovation is different from the experience of learning day after day in a deficient school facility. Attending school in the same environment each day for administrators, teachers, and students will become routine. A routine environment will often bring routine teaching strategies and practices that may or may not equate to student achievement. However, when a school is going through a complete renovation, that routine is severely interrupted. This interruption causes administrators to be more focused on what needs to be done to ensure student learning occurs. More consideration and thought will be given to what barriers to academic success can be removed so that student achievement is not sacrificed during the renovation process. Administrators will work more closely with teachers and teachers will focus and work more closely with students in the same manner.

A similar trend could not be noted when comparing the findings of all three studies with respect to the mean scaled scores of reading when comparing the pre-renovation stage to the post-renovation stage. One of the more important findings in the Mayo (2012) study was the fact that he did find a significant difference in student academic scores in reading when the pre-renovation and post-renovation scaled scores were compared. Mayo's found significant difference in reading scaled scores was an increase of 20.32 points. This same finding was not

observed in the Norman (2014) study, or in the current study. While the current study, like Mayo, did find a slight increase (.32 points) when comparing scaled scores in reading from the pre-renovation stage to the post-renovation stage, this increase was not statistically significant. When looking at the same comparison of reading scaled scores, Norman found a decrease of 5.73 points; however, this finding also was not statistically significant.

Over the years there have been many studies that have found that clean air, good lighting, and a quiet, comfortable learning environment are important for student academic achievement **(**Cash, 1993; Earthman, 2004; Lemasters, 1997; Schneider, 2002**)**. An assumption can be made that following the complete renovation of an outdated building; the newly renovated building would possess these qualities. The combined findings from these studies with the Mayo (2012), Norman (2014), and the current study would indicate that modern, either newly constructed or newly renovated buildings would support the learning process of students.

This study, along with the studies from Mayo and Norman investigated the possible condition that a complete renovation, which includes disruptions of students and teachers, considerable noise, ever-present dust, the presence of workers throughout the building during school hours, and any number of other inconveniences would result in lower student academic scores. Such was not the case.

Researchers such as Duran-Narucki (2008) found that school facility conditions were significantly related to scores on standardized tests as well as student attendance. Maxwell (1999) found a significantly positive relationship between upgraded school facilities and math achievement. When looking at the pre-renovation scores of middle school students and comparing them to the post-renovation scores of middle school students, Tuttle (2002) found that reading scores on the middle school reading SOL increased 23 percent following the renovation process. Earthman, et al. (1995) indicated that schools rated as having above standard building conditions scored one to nine percentage points higher on the Comprehensive Test of Basic Skills. Cash (1993) concluded that student achievement was higher in facilities with above standard ratings compared to substandard school facilities on every subtest of the Test of Academic Proficiency.

It is important to discuss that when comparing to other similar studies, very few took the approach of Mayo (2012), Norman (2013), and the current study. Where so many others have studied school facilities in their current physical condition, Mayo, Norman, and the current study

looked at student achievement across the years of a complete renovation process. By encompassing pre-renovation, during the renovation, and post-renovation within the study, the complete renovation process is shown to be a process of disruption and disorder for the school environment. However, the assumption cannot be that the complete renovation process will substantially change the physical condition of the school facility to the point that an influence on student achievement is found.

## Implications for Practice

The goal of this research was to examine any possible relationship between the school facility renovation process and student achievement at the high school level. Data from this research will provide school board members and school administrators additional information to determine if they will build a newly constructed school facility or if they will conduct a complete renovation of a deteriorating school facility.

Finding available funds for school division budgets is an ever-increasing challenge. When school divisions are faced with the need of an improved school facility, this research shows that a complete renovation can occur without removing the entire student population to another facility during the complete renovation process. By removing the need to relocate the entire student body during a complete renovation, funds that would be required to do so can be used in other areas of need.

School administrators that have increased pressures of higher academic standards are often concerned that the process of a complete renovation will disrupt student learning in a way that will cause great decline in student performance. It is important to note once again that no significant relationship was found between the different stages of the complete renovation process and student achievement. Student achievement did not increase significantly; however, student achievement also did not decrease significantly. Due to the findings of this research, school administrators can reevaluate their concerns and may choose not to move students during the renovation of the building.

## Recommendations for Further Research

The following recommendations for further study are proposed:

1. Conduct a study of renovated schools utilizing the same complete renovation stages of pre-renovation, during, and post-renovation. Analyze any effects the complete renovation process may have upon student discipline, medical incidents, and attendance. 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 complete renovation process.
2. Conduct a replication study of the current study in other states utilizing and high stakes assessments that are similar to Virginia's Standards of Learning assessments.
3. Conduct a study investigating the instructional practices utilized by teachers in mathematics and/or English classrooms that have the highest success rate on the Virginia Standards of Learning compared to instructional practices by teachers in poor performing classrooms following the conclusion of a complete renovation.
4. Conduct a study for a cohort of high school students using the mean scaled scores of students over the four-year period while attending grades 9-12. This study would follow the cohort from one grade level to the next for a minimum of three years (pre-, during, and post-renovation) and determine if that cohort were impacted based upon the complete renovation of the high school that they attended. An emphasis of the study could be placed on student achievement in Mathematics versus student achievement in Reading.
5. Conduct a study that researched the three stages of the renovation process and what instructional practices were modified by teachers during the renovation process to help them compensate for the construction in the school building.
6. Conduct a study utilizing qualitative methods to include surveys, questionnaires, and/or interviews of teachers, administrators, or community members to determine if they perceived differences in student behavior and/or achievement during the renovation process.
7. Finally, conduct a study that would determine the effect of the construction process in the school on student achievement by understanding the specific resources necessary to minimize disruption to the learning process and maximize student achievement.

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# Appendix A

## IRB Approval

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:** April 21, 2014

**TO:** Glen I Earthman, Phillip Joel Thompson

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

**PROTOCOL TITLE:** The Relationship Between School Facility Renovation and Student Achievement in High Schools

**IRB NUMBER:** **14-485**

Effective April 21, 2014, the Virginia Tech Institution Review Board (IRB) Chair, David M Moore, 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: | **April 21, 2014** |
| 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? |
|---|---|---|---|
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* 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

May 24, 2014

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 Algebra and Reading, at the high school 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 student scaled scores of the End-of-Course Algebra I and the End-of-Course Reading SOL assessments, at the high school 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 high school renovations since 2004 in the Commonwealth of Virginia, and I wanted to find out additional information on the renovation of _____High School. With my study, I am reviewing schools that had a complete renovation, the process of improving the mechanical, structural, and the addition of space within a building. Key components would improve every mechanical and structural system (electrical, plumbing, and HVAC), 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 _____High 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.

Phillip Thompson
Doctoral Student, Virginia Tech
phijthom@vt.edu

## Appendix C

### Email to the Virginia Department of Education Office of School Improvement

June 21, 2014

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 high school level. Reviewing scaled scores on the End-of-Course Algebra I and End-of-Course (EOC) 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 EOC Algebra I and EOC Reading SOL assessments, at the high school level will be reviewed one year prior to, during, and one year after a complete renovation process. Data from this study will serve as a valuable resource for school divisions in determining the impact of the renovation process on student achievement. This information could lead school divisions to consider ways to minimize the effect of the renovation process on student achievement.

After reviewing all high schools renovated since 2004 wherein improvements were made to every mechanical and structural system, and also included the addition of educational space, I have narrowed the study down to 20 schools. For the schools selected for the study, I would like to request access to the following information:

> 1: Scaled SOL assessment scores in EOC Algebra I and EOC Reading at the high school level for the specified time periods of the renovation process.
> 2: Means of the scaled scores for the entire state also will be needed for each of the specified time periods in the areas of EOC Algebra I and EOC Reading at the high school level.

*(Appendix C, Continued)*

3: Information on demographic variables (minority percentile, socioeconomic status percentile, and highly qualified teacher percentile) will also be needed for each school noted below during the specified time periods.

| **School Name** | **SOL Assessment Data – School Years (Renovation Years)** |
|---|---|
| School A | 04-05, 05-06, 06-07, 07-08, 08-09 |
| School B | 04-05, 05-06, 06-07, 07-08, 08-09 |
| School C | 06-07, 07-08, 08-09, 09-10 |
| School D | 06-07, 07-08, 08-09, 09-10 |
| School E | 05-06, 06-07, 07-08, 08-09 |
| School F | 06-07, 07-08, 08-09 |
| School G | 05-06, 06-07, 07-08, 08-09, 09-10 |
| School H | 04-05, 05-06, 06-07, 07-08, 08-09, 09-10 |
| School I | 04-05, 05-06, 06-07 |
| School J | 05-06, 06-07, 07-08, 08-09 |
| School K | 07-08, 08-09, 09-10 |
| School L | 07-08, 08-09, 09-10 |
| School M | 07-08, 08-09, 09-10 |
| School N | 07-08, 08-09, 09-10 |
| School O | 08-09, 09-10, 10-11 |
| School P | 06-07, 07-08, 08-09 |
| School Q | 04-05, 05-06, 06-07 |
| School R | 08-09, 09-10, 10-11 |
| School S | 04-05, 05-06, 06-07, 07-08 |
| School T | 04-05, 05-06, 06-07 |

Understanding how valuable your time is, I appreciate your consideration in assisting with this study. If additional information is needed, or if there is anything I can do to help facilitate this process, please do not hesitate to contact me via email at phijthom@vt.edu.

Sincerely,

Phillip Thompson
Virginia Tech Doctoral Student

## Appendix D

## Email to the Virginia Department of Education, Office of Administration and Accountability

June 27, 2014

Dr. Carol Sylvester
Virginia Department of Education
101 North 14th Street
P.O. Box 2120
Richmond, VA 23218-2120

Dear Dr. Sylvester:

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 high school level. Reviewing scaled scores on the End-of-Course Algebra I and End-of-Course (EOC) 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 EOC Algebra I and EOC Reading SOL assessments, at the high school level will be reviewed one year prior to, during, and one year after a complete renovation process. Data from this study will serve as a valuable resource for school divisions in determining the impact of the renovation process on student achievement. This information could lead school divisions to consider ways to minimize the effect of the renovation process on student achievement.

After reviewing all high schools renovated since 2004 wherein improvements were made to every mechanical and structural system, and also included the addition of educational space, I have narrowed the study down to 20 schools. For the schools selected for the study, with the assistance of Dr. Kathleen Smith, I have been fortunate to locate the majority of my needed data. The one piece of data I am still having a difficult time finding is information on highly qualified teacher percentiles for each school noted below during the specified school years.

Dr. Smith mentioned that you might have the necessary resources to assist me in locating this highly qualified teacher historical percentile data. If so, I would be very grateful if you were willing to assist me so that I may continue my research.

*(Appendix D, Continued)*

| School Name | HQT Data Needed – School Years |
|---|---|
| School A | 04-05, 05-06, 06-07, 07-08, 08-09 |
| School B | 04-05, 05-06, 06-07, 07-08, 08-09 |
| School C | 06-07, 07-08, 08-09, 09-10 |
| School D | 06-07, 07-08, 08-09, 09-10 |
| School E | 05-06, 06-07, 07-08, 08-09 |
| School F | 06-07, 07-08, 08-09 |
| School G | 05-06, 06-07, 07-08, 08-09, 09-10 |
| School H | 04-05, 05-06, 06-07, 07-08, 08-09, 09-10 |
| School I | 04-05, 05-06, 06-07 |
| School J | 05-06, 06-07, 07-08, 08-09 |
| School K | 07-08, 08-09, 09-10 |
| School L | 07-08, 08-09, 09-10 |
| School M | 07-08, 08-09, 09-10 |
| School N | 07-08, 08-09, 09-10 |
| School O | 08-09, 09-10, 10-11 |
| School P | 06-07, 07-08, 08-09 |
| School Q | 04-05, 05-06, 06-07 |
| School R | 08-09, 09-10, 10-11 |
| School S | 04-05, 05-06, 06-07, 07-08 |
| School T | 04-05, 05-06, 06-07 |

Understanding how valuable your time is, I appreciate your consideration in assisting with this study. If additional information is needed, or if there is anything I can do to help facilitate this process, please do not hesitate to contact me via email at phijthom@vt.edu.

Sincerely,

Phillip Thompson
Virginia Tech Doctoral Student

## Appendix E

## Identification Chart of High Schools Represented Within This Study.

| School Letter | High School Name/School Division |
|---|---|
| School A | Wilson Memorial/Augusta County |
| School B | Stuarts Draft/Augusta County |
| School C | Jefferson Forest/Bedford County |
| School D | Staunton River/Bedford County |
| School E | James River/Botetourt County |
| School F | Lloyd C Bird/Chesterfield County |
| School G | W.T. Woodson/Fairfax County |
| School H | Galax HS/Galax City |
| School I | Loudoun County/Loudoun County |
| School J | Patrick County/Patrick County |
| School K | Chatham/Pittsylvania County |
| School L | Dan River/Pittsylvania County |
| School M | Tunstall/Pittsylvania County |
| School N | Gretna/Pittsylvania County |
| School O | William Byrd/Roanoke County |
| School P | Northside/Roanoke County |
| School Q | Massaponax/Spotsylvania County |
| School R | Surry/Surry County |
| School S | Warren County/Warren County |
| School T | York/York County |