An Analytic Synthesis of Research Studies Dealing with the Relationship between School Building Condition and Student Academic Achievement

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ABSTRACT

This meta-analytic synthesis of research studies is assembled upon the findings of research conducted within the last 40 years. With the understanding that students spend a considerable amount of time within school buildings, one can hypothesize that the condition of the school building influences student academic achievement. A community of researchers have worked to give credibility to this assumption by providing concrete data in support of this belief, however, some researchers have provided contrary results, thus stalling the progress towards a definitive statement.

This study analyzed and compared 81 studies against a criteria for inclusion. Out of the 81 studies analyzed, 30 studies met the criteria and were included in this meta-analytic synthesis in order to answer two research questions. The two research questions investigated in this study are:

1) What are the characteristics of studies that investigated the relationship between school building condition and student achievement?

2) What does research inform educators about the relationship between the school building condition and student academic achievement?

The studies included in this meta-analytic syntheses are unique in the methods they used to assess school buildings, how they chose to measure student academic achievement, to what level of education was the focus, how large or how small was the student/school population, what statistical measures were used, and what confounding variables were controlled. These specific characteristics were then separated into categories where the findings were reported quantitatively using percentages to draw conclusions.

This study found patterns and trends that are noteworthy to future researchers and educational stakeholders. To a major degree, the assessment instrument used to measure school facilities and the people responsible for completing the assessments are important factors concerning the outcomes of studies. Additionally, the same can be said concerning the size of the student/school population used among studies.

The purpose of this meta-analytic synthesis was to synthesize existing research in order to make a definitive statement on behalf of the research community. Following the completion of this analytic synthesis of studies and data gathering process, this study ultimately found that school facility condition positively influences student academic achievement.

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GENERAL AUDIENCE ABSTRACT

This dissertation is a collection of findings from 30 studies which were conducted on the topic of school facility condition and student academic achievement. In all, 81 studies were located and were compared against a specific criteria. The 30 studies that met the criteria were: written in English, appeared in published or unpublished form after December 31, 1977, focused on public schools in the United States, and used an assessment instrument or survey to measure the overall condition of school facilities.

The study was driven by two research questions. The first question asked about similarities and differences among the 30 studies that met the criteria. The characteristics which were investigated involved methodologies of studies, the school facility assessment instruments or surveys used, who administered the assessment instruments or surveys used, sizes of study populations, and the confounding variables used by researchers. The second question focused on the relationship between the condition of school facilities and student academic achievement and presents that information to educators.

Findings extracted from all 30 studies were displayed in chart form along with percentages. The patterns and trends reported provides helpful information concerning the relationship between the condition of school facilities and student academic achievement. This study may be helpful to school administrators, school board members, parents, or community members interested in the topic of school facilities.

DEDICATION

   This dissertation is dedicated to my family, who cheered me on and provided endless support throughout this journey. To my wife, Sharon, you believed in me and encouraged me throughout this process. I cannot thank you enough for taking such good care of our children and our home while I worked to complete this endeavor. Thank you to my children, Abigail and Colin, for keeping me smiling and for understanding why I was pursuing this. To my mom and dad, Don and Pat, for instilling the importance of education and for always being involved in all my activities. To my brother Russ, thank you for always saying the right things. You are a great brother and friend.

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CHAPTER 1
INTRODUCTION

Schools are influenced by political and social developments from our federal, state and local governments. This influence is exerted through polices, regulations, and laws enacted by these governmental agencies. Schools are also influenced on the local level by parents and community groups. Even the quality and comprehensiveness of the educational program offered the students is controlled by regulations and funding capacity of all three levels of government. These sources of influence have shaped the schools and its educational offerings down to the present time.

Our public school students are in direct competition with students in other nations as seen by rankings provided by the Trends in International Mathematics and Science Study (TIMSS) (Mullis, Martin, Foy, & Hooper, 2016). The rankings are constant reminders to politicians, educators, and parents that we live in a global economy where children must access an education to suit their needs for tomorrow. With this undertaking in mind, many of our nation's children attend schools that were intended for students of generations past. In the United States today, many children are educated in outdated buildings that are poorly lighted, have no air conditioning, lack climate control and are not equipped to handle the technology infrastructure of a twenty-first century educational facility.

In its most recent publication concerning school facilities in the United States, the National Center for Education Statistics (NCES) reported that 53% of our nation's schools need to spend considerable money on …"repairs, renovations, and modernizations to put the schools' on sight buildings in good overall condition" (Alexander & Lewis, 2014, p. 3). This percentage represents a 13 percentage point improvement from the same report published in 2000 (NCES, 2000). According to the most recent study conducted in 2014, an estimated $197 billion is required to bring all public schools in the United States to a good overall condition (NCES, 2014).

Throughout the United States, rundown school facilities present a staggering problem for not only academic performance, but community pride for its schools. A focal point for any community is represented in the form of a school building. Not only do these facilities safely house children so they can access their education, but they are also community centers where social gatherings occur. As symbols of a community, school buildings also represent an

investment in society where children will grow to become valuable citizens; thus continuing to pave the way for posterity. Economic limitations, political factions and inertia on the part of certain school boards have contributed to the decline of school buildings, the backbone of many communities.

Almost forty years of research on the relationship between school building condition and student academic achievement has resulted in a mix of findings and conclusions. In general, previous research studies revealed significant differences between academic achievement scores among students attending school buildings identified as in good or poor condition. This would seem to indicate a strong association between the physical environment, particularly the school building, and student learning. However, there is not an absolute consensus among researchers as to what the findings of these studies are.

An analytic synthesis of research findings is a reputable and honored method of compiling the findings of several research studies in an effort to begin the formation of a theory. Stewart (2005) completed a meta-analytic synthesis of sixteen studies that included the variables of school building condition and student learning. Sixteen studies is just a small sample of research dealing with these two variables. The known number of such studies is much greater. A study encompassing all of the known studies would be more comprehensive and much more instructive to the educational establishment.

In an effort to bring together the existing literature on the relationship between building condition and student performance, Gunter and Shao (2016) analyzed nine studies reporting correlational analyses and nine studies reporting regression analyses. The result of their analysis indicated a slight, yet positive correlation among the variables, supporting the claim that school building condition is related to student performance. Therefore, it is a prudent activity to analyze and synthesize the research findings of a selected area of study in an effort to bring together findings into conclusions.

Purpose

The purpose of this study was to conduct a comprehensive analytic synthesis of studies that have been conducted on the topic of school facility condition and the relationship to student achievement. As school facilities age and the condition of buildings worsen, the number of research studies on the topic of school facilities and its relationship to student academic

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achievement continually grows. Yet there are studies where the researchers could not find any significant differences in student scores, possibly because of methodological differences.

The objective of this analytic synthesis was to report and quantitatively combine the results of previous studies, in a condensed organized manner, to assist future researchers and better educate public school stakeholders.   Furthermore, this study contains recent and relevant research that has not been included in previous synthesis of studies in an attempt to further explore the relationship between the school building condition and student achievement

Statement of the Problem

To date, no synthesis of research has completely limited itself to the two variables of overall condition of school facilities along with the academic achievement of students. Stewart (2005) analyzed a small percentage of studies related to this topic, but neglected to include studies considered valuable for researchers. By creating a thorough analytic synthesis of studies related to the condition of school facilities and student academic achievement, the body of existing research was merged along with a shared conclusion to assist future researchers.

Research Questions

There are two main research questions this study addressed. The first question is as follows: What are the characteristics of studies that investigated the relationship between school building condition and student achievement? The characteristics of the studies included the methodologies used within studies, the specific building instruments employed by previous researchers, sizes of student populations investigated, statistical methodologies utilized and noting the various confounding variables controlled in these studies. The second question is as follows: What does research inform educators about the relationship between the school building condition and student academic achievement? To answer this question, the researcher organized the findings of the identified research studies and developed an overall conclusion for the educational establishment.

Delimitations

This study is restricted to research studies performed within the United States that dealt only with the relationship between the condition of school facilities and student academic achievement. Additionally, this study is also delimited to research studies completed within the

last forty years. This broad focus of time allowed the researcher to compile a larger number of studies. Additionally, this time period included within it, the Commonwealth Assessment of Physical Environment (CAPE) which was created by Cash (1993). Her building assessment instrument set a standard of which there were no assessment instruments to this level before and provided a foundation for several studies to follow. Furthermore, in the later years of this time period, data became more readily available pertaining to student academic achievement because of state and federal mandated testing.

Limitations

This study is an analysis of only those studies dealing with the relationship between school building condition and student achievement. This means the actual physical condition of the school building as measured by an instrument or survey tool designed to measure the overall condition of the school building; and student performance on a measure of academic achievement such as a standardized or norm referenced exam. By using studies that utilized an assessment instrument or survey to evaluate the overall condition of school facilities, it is believed the research community is provided a more accurate portrayal of the actual condition of school buildings.

There is a substantial amount of research dealing with the relationship between certain individual elements of the building and various student measures. This study does not include those research efforts that deal with the relationship between building condition and student attitudes, student health issues, performance on cognitive measures, or student performance of physical activities.

Further, this study is limited to the physical condition of the school building as measured by various instruments designed to calculate the overall condition of a school and not architectural design elements. Architectural design elements can be described as features of the building that are included in the design by architects or engineers. Thus, windows, hallways, office space, cafeterias, classrooms, and even entryways are examples of design elements that are included in school buildings by architects or engineers. Research studies utilizing such building elements as the independent variable in determining the relationship to student achievement will be purposefully excluded from this study. The main reason for such exclusion is that there is no

substantial research to indicate there is a relationship between selected design elements and student achievement.

This study will also exclude studies relating to the age of the building. The age of the school building may or may not represent all of the known building elements that directly relate to student achievement. Often, older buildings may be in good condition, but lack essential elements such as proper control of the thermal environment or good lighting. Control of the thermal environment and good lighting are necessary for an adequate learning environment for students, but may not represent the condition of the school building.

Other limitations will be the exclusion of research studies dealing with student attendance, school climate, student health measures, student cognitive development, student dropout rates, student attitudes, student manipulative measures, teacher productivity, teacher attitudes, and teacher retention. In addition, research studies that use one building element, such as lighting, HVAC, acoustical control, as the independent variable will not be included in the list of studies utilized in this study. The reason for these exclusions is that the purpose of this study is to ascertain if the overall condition of the school building has an influence upon student academic achievement.

By excluding all other variables, intense focus will be devoted to compiling the findings of studies that include only the two variables of school building condition and student academic achievement. In doing so, perhaps a statement can be made about the findings of these studies regarding the influence the physical environment, particularly the school building, has upon student learning without the confusing inclusion of different variables.

Definition of Key Terms

1.) Student Academic Achievement refers to the measurement of learning ascertained through the performance of students on state approved standardized assessments or national norm-referenced exams.

2.) School Building Condition refers to the overall state of a school, based upon the result of an objective assessment tool or survey conducted by professionals in the education, engineering or construction fields.

3.) Building Assessment Instrument refers to the assessment tool employed by researchers for the purpose of measuring the condition of a school building.

4.) Confounding Variables are the unrelated variables within an experiment that correlates with both the dependent variable and independent variable. It is recognized that there are infinite possibilities where a third variable is responsible for the relationship.

5.) Statistical Methodology is defined as the gathering, analyzing and the understanding of statistical data.

6.) Analytic Synthesis refers to the merging of several research results and conclusions beneath a vast body of research into a condensed and organized document.

Methodology

Electronic searches were conducted using databases located on the Virginia Tech on-line library. EBSCOhost, an on-line warehouse of databases, and Virginia Tech's Summon were the two primary search engines used. The main search strategy used a combination of key terms related to the topic; such as building condition, school facility, student achievement, and academic achievement. Additionally, the search process included cross-referencing several citations used within all dissertations reviewed.

Organization of the Study

This dissertation is structured upon four distinct chapters. Chapter one introduces the topic along with pertinent information such as the purpose of the study, statement of the problem, research questions, delimitations, limitations, definitions of key terms, methodology, and organization of the study. Chapter two provides an introduction to the chapter, a review of research questions, data analysis and data summary. Chapter three produces a detailed analysis based upon the summation of all studies that meet the criteria for inclusion. This chapter also includes information organized and studied using the dissertation review template (see Appendix C) and the meta-matrix document (see Appendix D), which were used to store relevant data results from each study reviewed. Chapter four includes the overall findings reported by categories that correspond with the research questions. Additionally, chapter four contains recommendations for future inquiry as well as the final conclusion to the analytic synthesis.

CHAPTER 2
REVIEW OF LITERATURE

This study is an analytic synthesis of research studies pertaining to the relationship between the variables of school facility condition and student academic achievement. A select group of researchers, spanning nearly forty years, have contributed to this growing body of research in an effort to improve student achievement, influence political authorities and educate all stakeholders for the benefit of children. During this time, four synthesis studies have been conducted.

Weinstein (1979) is credited with the first synthesis of studies associated with educational facilities and student achievement. Her study was divided into three sections: examining environmental variables, ecological studies of special behavior and effects of open space school designs. In all, Weinstein (1979) assembled more than 175 studies and reviewed roughly 100 studies. Within her conclusion, Weinstein (1979) stated …"that it would seem that the physical environment of the conventional classroom has little impact on [student] achievement" (p. 598). Additionally, she also indicated that the only physical variable that is associated with differences in student achievement was the seating location of students, but admitted that data were inconsistent. The findings lead Weinstein (1979) to make recommendations for future researchers. For instance, as one of the first to compile studies dealing with the physical environments of schools, she made it clear that future researchers must continue to collect data and improve upon the methodological weaknesses of past studies.

McGuffey (1982) discovered several studies that investigated the possible relationship between school building condition and student performance. He focused his attention on school facility factors such as, school building age, thermal features, visual elements, color and interior painting, hearing, and school building maintenance. Within his conclusion, McGuffey (1982) offered two important findings from his synthesis. First, old and outdated buildings are detrimental to student learning, whereas updated school buildings capable of controlling the instructional environment positively impact the learning process. Secondly, McGuffey (1982) concluded that the physical environment may have a different effect on the academic performance among various grade levels and subject areas.

Lemasters (1997) and Bailey (2009) followed with synthesis studies of a much narrower focus. Lemasters (1997) focused her research on studies pertaining to the relationship between

school facilities to student achievement and student behaviors. She synthesized 53 studies conducted between 1980 and 1997, concluding that all independent variables reviewed that dealt with the condition of school facilities, impacted student achievement and behavior. In essence, schools in good condition would enable students to achieve at a high rate and maintain better behavior in comparison to the achievement of students in schools in poor condition.

Bailey (2009) focused his research on studies completed from 1998 to 2008. Following a review of more than 100 studies, Bailey (2009) synthesized 54 studies that dealt with school building condition, student achievement, student behavior, and student attitude. In order to organize researchers and their findings, Bailey (2009) utilized a matrix similar to Lemasters. In the conclusion section of his study, he stated that …"the school building did in fact have an influence upon the health and productivity of students and teachers" (p. 191). Additionally, Bailey (2009) recognized various methodological differences throughout all studies synthesized. He noted the presence of confounding variables that had not been properly controlled, such as differences among teacher quality or among various curriculum issues. The identification of specific strains of research was also noted. For example, Bailey (2009) identified significant differences in student achievement among students learning in satisfactory or unsatisfactory buildings. Also, he identified a line of research where student attendance replaced student achievement as the dependent variable. Overall, these studies reported a relationship between school building condition and student attendance and achievement.

Review of Research Questions

There are two main research questions that guided this study. The first main question asked: What are the characteristics of research that investigated the relationship between school building condition and student academic achievement? While pursuing an answer to this question, sub-questions emerged that drove the investigation further. The sub questions that emerged are as follows:

    1.) What are the basic methodologies used within the studies?

    2.) What building assessment instrument have researchers used to assess the condition of school facilities and who was the assessor?

    3.) What were the sizes of student populations researched?

    4.) What statistical analyses were used in these studies?

5.) Were confounding variables controlled in these studies?

6.) What difference, if any, was there in research findings between elementary and secondary student assessments?

The second main question asks: What does research inform educators about the relationship between the school building condition and student academic achievement? Answering these questions allowed the researcher to organize the findings of the identified research studies and develop an overall conclusion for the educational establishment. At its completion, this study makes a serious contribution to the theory concerning the physical environment, particularly the school building condition, and its influence upon student learning and provide a basis of understanding about this relationship. It is also believed this study establishes a platform for further inquiry.

Data Analysis

Four search strategies were implemented in an attempt to locate all research studies that deal with the relationship between school facility condition and student academic achievement. First, related studies were discovered using the methodology described in chapter one. Second, once studies were located, the researcher reviewed and cross-examined reference lists as a means to identify additional studies that met the criteria. Third, a list of studies (see References and Selected Bibliography) was created to organize those studies dealing with the two variables as previously stated. Once the list was complete and the researcher exhausted all search criteria to locate additional studies, a letter was sent to respected researchers (see Appendix C) requesting their assistance in verifying the studies and adding relevant studies to the list. This process ensured the list of research studies was an accurate collection of research, which allowed the researcher to begin the investigation. The experts, all of whom have completed significant studies in the field of school facilities, are as follows: Kenneth Tanner, University of Georgia; Linda Lemasters, The George Washington University, and Cynthia Uline, San Diego State University. Fourth, following the exhaustive search, all studies discovered were compared against the criteria for inclusion and exclusion to determine eligibility.

Inclusion criteria. Studies eligible for review met the following criteria: (a) written in English, (b) appeared in published or unpublished dissertation or journal form from December 31, 1977 to January 31, 2017, (c) focused on public school facilities in the United States, (d)

measured a school's overall condition by means of a building assessment instrument or survey completed by school personnel or professionals within the engineering or construction fields, (e) targeted public school students in the United States that completed a standardized or norm referenced exam given to all students in schools being studied.

Exclusion criteria. The studies that were excluded from this review (a) did not measure the overall condition of a school building with an objective building assessment instrument (b) did not measure student academic achievement with a standardized or norm referenced exam given to all students in schools being studied (c) did not test for a correlation between the overall condition of a school and student academic achievement.

Independent variable. The independent variable among all studies within this analytic synthesis was the overall building condition of schools as quantified by a building assessment instrument. An obstacle in this field of research is represented in multiple methods of defining the condition of a school building. For example, Cash (1993) addressed this in her creation of the Commonwealth Assessment of Physical Environment (CAPE). The CAPE is a building assessment instrument that assesses "factors related to climate control, acoustics, illumination, student density, science equipment adequacy, building age, and cosmetic facility condition" (Cash, 1993, p. 12). This tool was then implemented by school division personnel and the 27 factors were averaged together to formulate an overall score which defined the condition of a school facility.

Additionally, Cash accounted for the interrater reliability of the CAPE. She randomly selected 5 schools and evaluated the school buildings. Her results were compared to the results of the school division building evaluator. By doing so, she determined the interrater reliability of the CAPE as overall condition level scores were all similar (Cash, 1993). In the years following her study, a number of researchers used this instrument or a variation thereof, providing a common foundation for researchers to objectively assess and determine the overall condition of school facilities.

The CAPE is just one building assessment instrument used among researchers to assess overall building conditions. Some studies used instruments designed to incorporate maintenance concerns to assess the overall condition of school facilities. An example of this was a study conducted by Picus, Marion, Calvo, and Glenn, (2005). Within this study, the building assessment instrument used was created by the consulting firm, MGT of America, Inc. (MGT).

This agency was employed by the state of Wyoming in response to the Wyoming Supreme Court case, Campbell v. Wyoming. Their responsibility was to assess the …"condition, educational suitability, and technological readiness of each school in Wyoming" (Picus, Marion, Calvo, & Glenn, 2005, p. 80). Upon creating an assessment instrument intended to be objective, the agency assessed school facilities by evaluating 22 separate subsystems that included elements such as building foundations, ceilings and floors. These calculations were determined based upon an agreement between a school representative and a sub-contractor to the consulting firm (Picus et al. 2005). Roberts (2009) would classify this building assessment instrument as being engineered-based which focused on measures such as… "boilers, roofs, ducts, and foundations"… elements of a building that are questionable in relationship to student academic achievement (Roberts, 2009, p. 371). Though the building assessment instrument implemented by MGT assessed building elements that have not been researched to show a relationship to student academic achievement, it is considered to be a building assessment instrument which rates the overall condition of schools, and therefore will be included within this study.

Dependent variable. The dependent variable among all studies within this analytic synthesis was student academic achievement. There are various methods among researchers to determine student academic achievement. Though different, the researcher only synthesized studies containing data results from standardized state assessments or some form of norm referenced exam.

This analytic synthesis of studies identified research conducted within the last 40 years, dealing only with the relationship between school building condition and student academic achievement. The included research studies met the criteria set forth in the inclusion and exclusion sections of Chapter 2. This synthesis served as a focused endeavor to discover specific strands of research, adding to the existing body of research in an effort to make a definitive statement concerning the relationship between the physical condition of a school facility and student academic achievement.

Within the early stages of this study, the researcher thoroughly reviewed all studies. This task required using a Dissertation Review Template (see Appendix C). The template assisted in the extraction of factors deemed necessary for studies to be included within this synthesis and findings relevant to the review questions previously stated. Additionally, a meta-matrix document (see Appendix B) was employed to systematically and comprehensively code elements

of each study into the document to better organize the included studies. The meta-matrix document was designed to highlight important elements of included studies, such as, the title, name(s) of researcher(s), methodology used, student populations, variables employed, type of statistical analysis, and findings. In its completion, the meta-matrix document enabled the researcher to report patterns among research studies based upon the review questions.

Data Summary

The findings from individual studies were then pooled into categories to create an overall understanding of the synthesized research. This involved a process of categorizing and re-categorizing findings in an effort to best answer the research questions and sub-questions. By assigning studies to the appropriate category, the researcher was able to compare findings and report patterns among the included studies. The aggregations of findings were reported quantitatively using percentages to draw conclusions regarding the similarities and differences across all studies. By assigning a percentage to all categories and sub-categories, an overall understanding emerged concerning these two variables. Once the findings were interpreted through narration, tables and graphs, a discussion along with suggestions for further research was addressed.

The findings from this systematic review, along with the corresponding research question, were categorized accordingly:

1.) The findings of those studies where the condition of the building was assessed by building principals as compared to those that were not assessed by building principals (Research Question #1 – Sub-Question #1)

2.) The findings of those studies conducted using elementary school student assessment results as compared to studies using secondary school student assessment results (Research Question #1 – Sub-Question #2)

3.) The findings of those studies conducted using national assessment results as compared to those studies using state assessment results (Research Question #1 – Sub-Question #3)

4.) Percent of synthesized studies utilizing the CAPE or a hybrid thereof, reporting a positive relationship between school facility condition and student academic achievement (Research Question #1 – Sub-Question #4)

5.) Average student population among studies where a positive relationship was reported between school facility condition and student academic achievement (Research Question #1 – Sub-Question #5)

6.) Average student population among studies where no relationship was found between school facility condition and student academic achievement (Research Question #1 – Sub-Question #6)

7.) Percentage breakdown of statistical analyses used among all studies synthesized (Research Question #1 – Sub-Question #7)

8.) Percentage breakdown of statistical analyses used among studies reporting a positive relationship between school facility condition and student academic achievement (Research Question #1 – Sub-Question #8)

9.) Percentage breakdown of statistical analyses used among studies reporting no existence of a relationship between school facility condition and student academic achievement   (Research Question #1 – Sub-Question #9)

10.) Percentage of synthesized studies that controlled for confounding variables (Research Question #1 – Sub-Question #10)

11.) Percentage breakdown of specific confounding variables as compared to the total number of synthesized studies (Research Question #1 – Sub-Question #11)

12.) An analysis of the basic methodologies utilized in each study (Research Question #1 – Sub Question #12)

13.) Percent of synthesized studies indicating a positive relationship between school facility condition and student academic achievement (Research Question #2)

14.) Percent of synthesized studies indicating a positive relationship between school facility condition and student academic achievement among studies at the elementary school level (Kindergarten – Fifth Grade) (Research Question #2)

15.) Percent of synthesized studies indicating a positive relationship between school facility condition and student academic achievement among studies at the secondary school level (Sixth Grade – Twelfth Grade) (Research Question #2)

CHAPTER 3
METHODOLOGY

This study is an analytic synthesis of research studies pertaining to the relationship between the variables of school facility condition and student academic achievement. Chapter 3 contains an in-depth analysis of all studies pertaining to the relationship between school building condition and student academic achievement that met the criteria for inclusion. Additionally, it includes information organized and studied using the dissertation review template (see Appendix A) and the meta-matrix document (see Appendix B), which was used to store relevant data results from each study reviewed. Both of these documents were critical to reporting and quantitatively combining the results of previous studies. The meta-matrix document in particular allowed the data to be easily condensed in an organized manner. In doing so, the researcher was able to answer the research questions and detect patterns among studies that will assist future researchers and better educate public school stakeholders. Furthermore, this study contains recent and relevant research that has not been included in previous synthesis of studies in an attempt to further explore the relationship between the school building condition and student academic achievement.

Electronic searches were conducted using databases located on the Virginia Tech on-line library. EBSCOhost, an on-line warehouse of databases, and Virginia Tech's Summon were the two primary search engines used. The main search strategy used a combination of key terms related to the topic; such as building condition, school facility, student achievement, and academic achievement. This search procedure produced a number of studies directly related to this topic. Each study pertaining to building condition and student achievement was downloaded into a PDF format and saved within a secure, password protected file. When studies were discovered, the reference sections and citations were cross-referenced in an effort to locate additional studies. As a result, multiple studies surfaced and the procedure was repeated using the author's name as an additional key term within the combination of keywords. Following this extensive search procedure, a total of 81 studies were identified and listed alphabetically into the meta-matrix document. It is important to note that any and all studies dealing with or mentioning the two variables of condition of schools along with student achievement in some capacity were included in this initial list.

Following the identification of all 81 studies, the process of reading and analyzing the studies began. Each study was approached with the same procedure. The name of the researcher along with the title of the study was written into a blank dissertation review template and saved into a password protected file using the author's name within the file. The study was reviewed while carefully searching for the predetermined criteria for inclusion. As previously stated, the criteria for inclusion was as follows: (a) studies must have been written in English, (b) appeared in published or unpublished dissertation or journal form from December 31, 1977 to January 31, 2017, (c) focused on public school facilities in the United States, (d) measured a school's overall condition by means of a building assessment instrument or survey completed by school personnel or professionals within the engineering or construction fields, (e) and targeted public school students in the United States that completed a standardized or norm referenced exam given to all students in schools being studied.

While analyzing each study, the dissertation review template was used to collect and store relevant information pertaining to each study. The first step in completing the dissertation review template was to determine whether the study met the criteria for inclusion. This was completed by comparing each study against the criteria check boxes at the top of the dissertation review template. If the researcher was not able to check each box, the study was removed from the meta-matrix document and included into a separate document (see Appendix D). Only those studies that did not meet the criteria for inclusion were identified within this list along with the reason for exclusion. If all 5 criteria were check marked on the dissertation review template, the study, indicated by the author's name, was included into the meta-matrix document, and the dissertation review template was completed whereby all items related to the research questions were answered. Therefore, the meta-matrix document contained only those studies that met all 5 required criteria for inclusion. In all, 30 out of the 81 studies reviewed met the predetermined criteria for inclusion and were identified within the meta-matrix document.

The final part of the analysis was to complete the meta-matrix document, which organized relevant information pertaining to the research questions and sub-questions. This process was completed by transferring information from the dissertation review template to the meta-matrix document. The completed chart displayed trends and patterns among the studies that met the criteria for inclusion. The examination of the completed meta-matrix document provided a basis of understanding for the following findings:

1.) The findings of those studies where the condition of the building was assessed by building principals as compared to those that were not assessed by building principals (Research Question #1 – Sub-Question #1)

The Findings Of Those Studies Where The Condition Of The Building Was Assessed By Building Principals As Compared To Those That Were Not Assessed By Building Principals
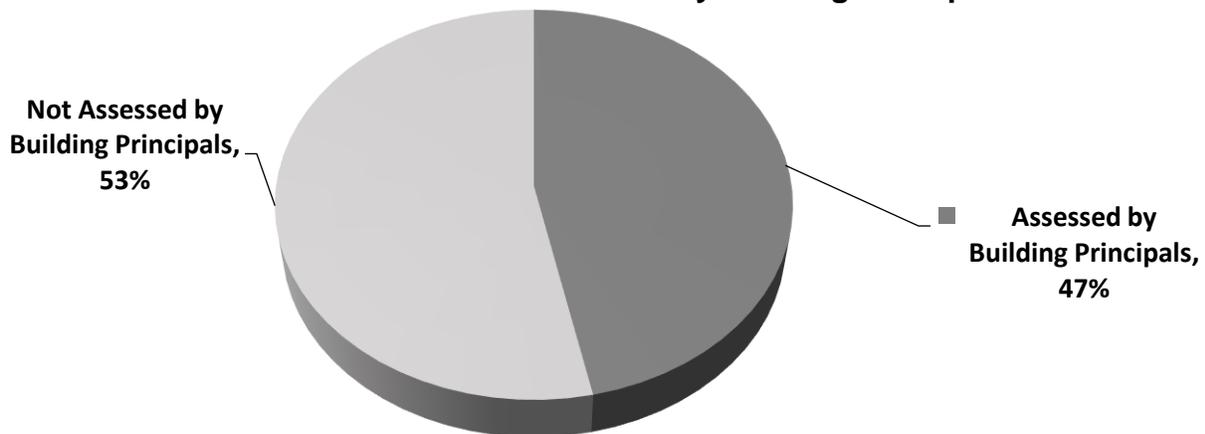
Figure 1. Building Assessment Personnel.

Based upon the findings described in Figure 1, 47% of studies that met the criteria for inclusion identified the school building principal as the person responsible for assessing the condition of school facilities. Within these studies, school building principals used an assessment instrument, tool, or survey to complete this task. The remaining 53% of studies that met the criteria for inclusion did not utilize school building principals to assess the overall condition of school facilities. In such cases, researchers elected to rely on school personnel, teachers, architects, engineers, or a combination thereof to assess the overall condition of school facilities.

Findings Among Studies Where School Building Condition Was Assessed By Building Principals
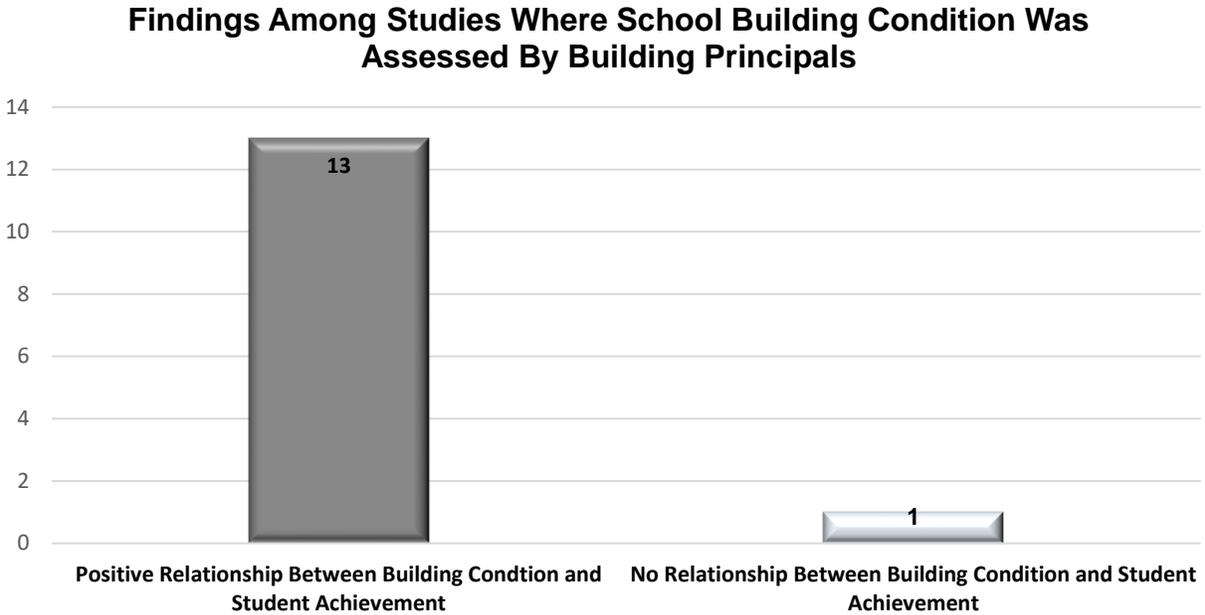
Figure 2. Findings among studies where school building condition was assessed by principals.

Figure 2 examines the studies where school building principals were utilized to assess the overall condition of school facilities. Out of 30 studies that met the criteria for inclusion, 14 studies (47%) utilized the school building principal as the person responsible for assessing the overall condition of the school facility. Out of the 14 studies where this was the case, 13 studies (93%) reported a positive relationship between the overall condition of school facilities and student academic achievement. Therefore, a statement can be made that when the overall condition of school facilities are assessed by building principals, and the results are compared to student academic achievement results, a positive relationship between these two variables are likely to be found.

Findings Among Studies Where School Buildings Were Not Assessed By Building Principals
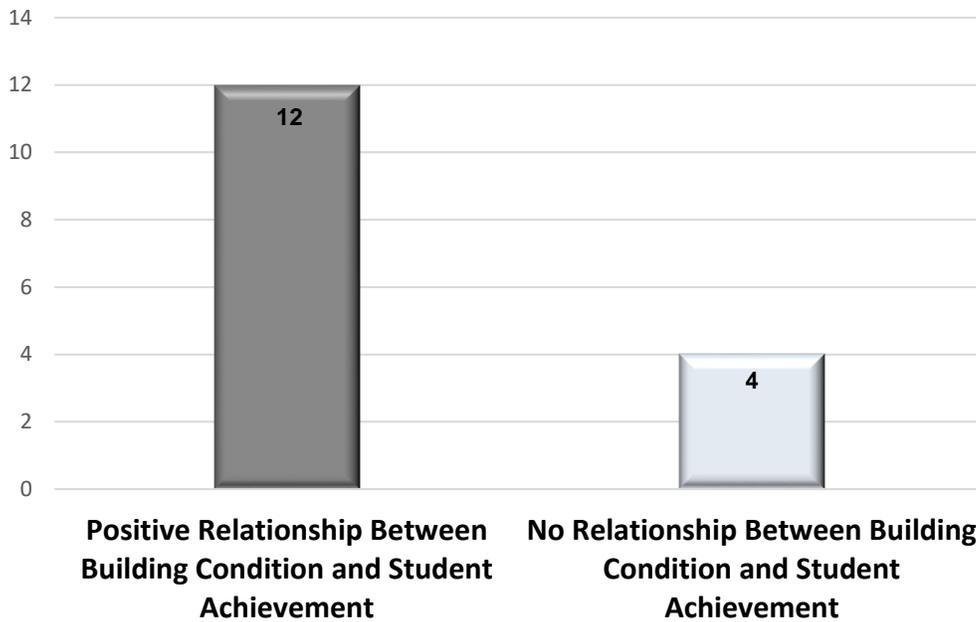
Figure 3. Findings from studies that did not use principals to assess the condition of schools.

Figure 3 examines studies where school building principals were not used to assess the overall condition of school facilities. Out of 30 studies that met the criteria for inclusion, 16 studies (53.3%) did not use the school building principal as the person responsible for assessing the overall condition of the school facility. This means that someone other than the school building principal assessed the overall condition of school facilities. The researchers of these studies elected to use personnel other than the school principal. In such studies, teachers, architects, engineers, or a combination thereof were used to complete this task. The findings indicate that out of the 16 studies where someone other than the building principal assessed school facilities, 12 studies (75%) reported a positive relationship between school facility condition and student academic achievement. The remaining 4 studies (25%) reported that no relationship existed between school building condition and student academic achievement. Therefore, a statement can be made that when the overall condition of school facilities are assessed by someone other than building principals, and the results are compared to student

academic achievement results, a positive relationship between these two variables are likely to be found, but to a lesser degree than when building principals assess school facility conditions.

2.) The findings of those studies conducted using elementary school student assessment results as compared to studies using secondary school student assessment results (Research Question #1 – Sub-Question #2)

Findings Of Those Studies Conducted Using Elementary School Student Assessment Results As Compared To Studies Using Secondary School Student Assessment Results
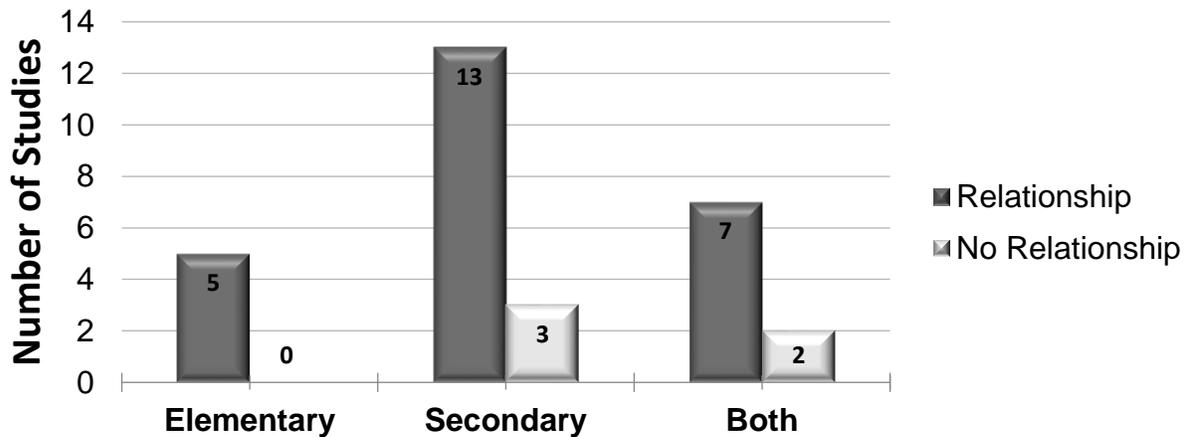
Figure 4. Comparison of results from elementary and secondary schools.

Figure 4 explains the findings of studies conducted at the elementary level, secondary level, or a combination of both. As shown, there were 5 studies conducted that compared the building condition of elementary schools to student academic achievement results among elementary school students. Among these 5 studies, all 5 (100%) resulted in a positive relationship between school facility condition and student academic achievement.

The majority of the studies that met the criteria for inclusion were conducted at the secondary level. This means that these studies compared the overall building condition of secondary schools to student achievement results of secondary students. Out of the 16 studies conducted from data at the secondary level, 13 (81%) reported a positive relationship between school facility condition and student academic achievement.

The remaining 9 studies used a combination of student assessment data at both the elementary and secondary education levels to measure student academic achievement. Out of

these 9 studies, 7 (78%) reported a positive relationship between school facility condition and student academic achievement.

3. The findings of those studies conducted using national assessment results as compared to those studies using state assessment results (Research Question #1 – Sub-Question #3)

The Findings Of Those Studies Conducted Using National Assessment Results As Compared To Those Studies Using State Assessment Results
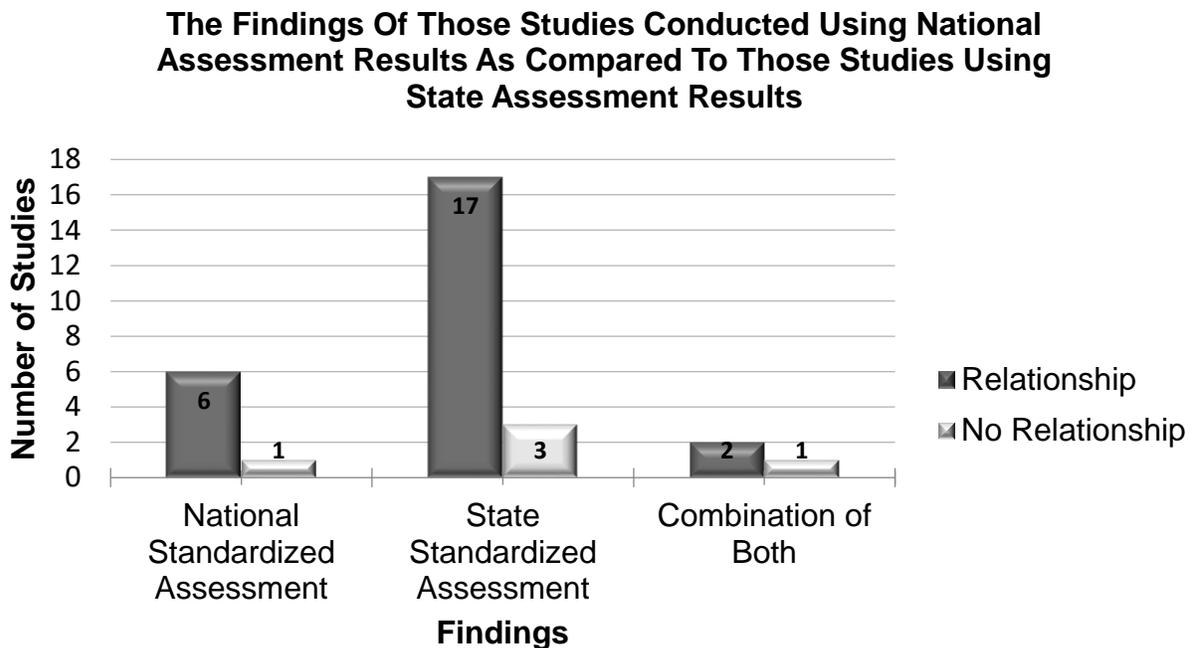
Figure 5. National standardized assessments and state standardized assessments.

Among all studies that met the criteria for inclusion, researchers used some form of standardized assessment as a measure of student academic achievement. Therefore, some researchers in this field elected to use national standardized assessments such as the Stanford Nine achievement test, while other researchers used state standardized achievement tests such as the Virginia Standards of Learning (SOL) assessments to measure student academic achievement. Figure 5 breaks down the findings of the 30 studies that met the criteria for inclusion. It is evident that the majority of studies in this meta-analytic synthesis used state standardized assessments to measure student academic achievement. Out of the 30 studies that met the criteria for inclusion, 20 studies (66.7%) utilized state standardized assessments as a measure of student academic achievement. Out of the 20 studies that used state standardized

assessments, 17 of the studies (85%) reported a positive relationship between school building condition and student academic achievement.

Fewer studies in this meta-analytic synthesis used national standardized assessments as a measure of student academic achievement. Out of the 30 studies that met the criteria for inclusion, 7 studies (23.3%) utilized national standardized assessments as a measure of student academic achievement. Out of the 7 studies that used national standardized assessments, 6 studies (85.7%) reported a positive relationship between school building condition and student academic achievement.

Out of the 30 studies that met the criteria for inclusion, 3 studies (10%) used a combination of state standardized assessments and national standardized assessments to measure student academic achievement. Of the remaining 3 studies that used both state and national standardized assessment data, 2 studies (66.7%) reported a positive relationship between school building condition and student academic achievement.

4.) Percent of synthesized studies utilizing the CAPE or a hybrid thereof, reporting a positive relationship between school facility condition and student academic achievement (Research Question #1 – Sub-Question #4)

Studies that Used the Commonwealth Assessment of Physical Environment Compared to Studies that Used a Different Assessment Instrument
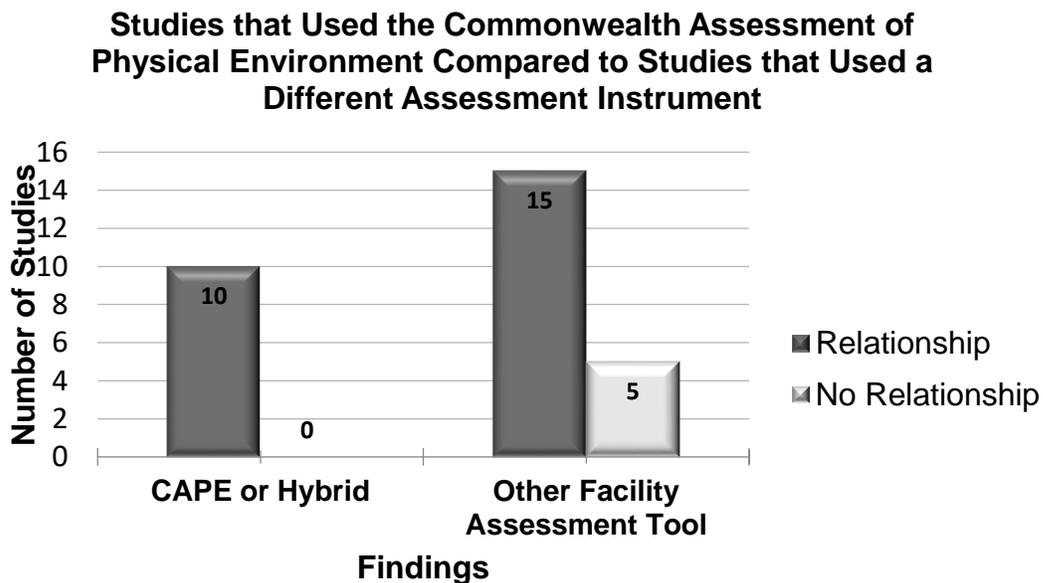
Figure 6. Facility assessment instruments.

Figure 6 indicates that out of all 30 studies that met the criteria for inclusion, 10 studies (33.3%) used the Commonwealth Assessment of Physical Environment, or a hybrid thereof, to measure the overall condition of school facilities. Of the 10 studies that used the CAPE assessment instrument, all 10 studies (100%) reported a positive relationship between the overall condition of school facilities and student academic achievement. Therefore, a statement can be made that when the Commonwealth Assessment of Physical Environment, or a hybrid thereof, is used to assess the overall condition of school facilities, and the results are compared to student academic achievement results, a positive relationship between these two variables are likely to be found.

Out of the 30 studies that met the criteria for inclusion, 20 studies (66.7%) did not use the CAPE assessment instrument to assess the overall condition of school facilities. Of the 20 studies that did not use the CAPE assessment instrument, 15 studies (75%) reported a positive relationship between the overall condition of school facilities and student academic achievement.

5.) Average student population among studies where a positive relationship was reported between school facility condition and student academic achievement (Research Question #1 – Sub-Question #5)

Out of the 30 studies that met the criteria for inclusion, only 5 studies provided data related to the number of students within the study populations. The majority of researchers identified the number of schools that participated in studies. As such, this research sub-question cannot be answered. However, to gain a better understanding of the existing research, perhaps answering the sub-question using the number of schools in studies might add to the overall findings of this meta-analytic synthesis. In this case, the sub-question might read: What is the average school population among studies where a positive relationship was reported between school facility condition and student academic achievement?

Through a careful analysis of the 25 studies that reported a positive relationship among overall condition of school buildings and student academic achievement, the total population of schools averages out to be approximately 187 schools. This average contains a combination of both elementary and secondary schools.

6.) Average student population among studies where no relationship was found between school facility condition and student academic achievement (Research Question #1 – Sub-Question #6)

Out of the 30 studies that met the criteria for inclusion, only 5 studies provided data related to the number of students within study populations. The majority of researchers identified the number of schools that participated in studies. As such, this research sub-question cannot be answered. However, to gain a better understanding of the existing research, perhaps answering the sub-question using the number of schools in each study might add to the overall findings of this meta-analytic synthesis. In this case, the sub-question might read: What is the average school population among studies where no relationship was found between school facility condition and student academic achievement?

Through a careful analysis of the 5 studies that reported no relationship among overall condition of school buildings and student academic achievement, the total population of schools averages out to be approximately 106 schools. This average contains a combination of both elementary and secondary schools.

Comparison Of School Population Averages Among All Studies That Met The Criteria For Inclusion
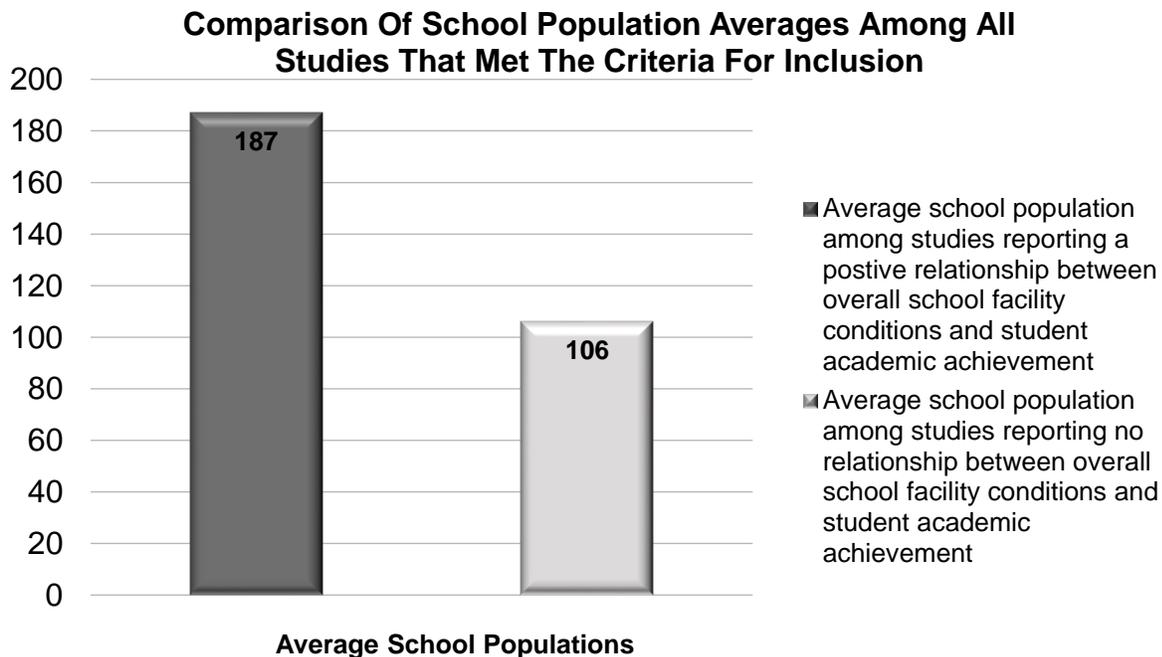
Figure 7. School population averages.

Figure 7 offers a visual representation of the comparison of the average school populations among studies that reported a positive relationship between the overall condition of

school facilities and student academic achievement to the average school populations among studies that reported no relationship between the overall condition of school facilities and student academic achievement. Based upon the analysis of the studies that met the criteria for inclusion, studies that reported that no relationship exists between the variables in question did so using smaller populations of schools within their data. In fact, three of the five studies that reported that no relationship exists between the overall condition of schools and student academic achievement did so with school populations of less than 75 schools. The studies that meet this description are Cervantes (1999), Morris (2003), and Sheets (2009). Cervantes (1999) collected data using a school population of 19 schools, Morris (2003) collected data using a school population of 28 schools, and Sheets (2009) collected data using a school population of 72 schools.

7.) Percentage breakdown of statistical analyses used among all studies synthesized (Research Question #1 – Sub-Question #7)

Percentage Breakdown Of Statistical Analyses Used Among All Studies Synthesized
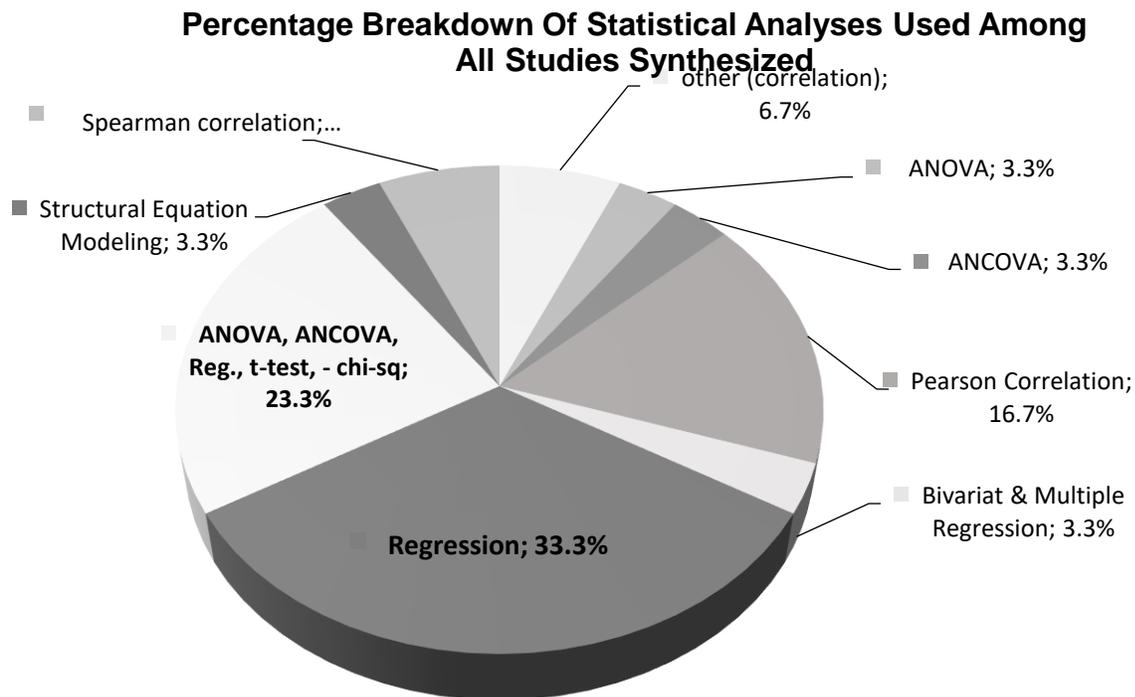
Figure 8. Statistical analyses used among all studies in the criteria for inclusion.

Figure 8 indicates that the greatest percentage of all 30 studies that met the criteria for inclusion used multiple regression as the statistical analysis used to investigate the relationship

between school facility condition and student academic achievement. Out of the 30 studies synthesized, 10 studies (33.3%) used multiple regression as the preferred statistical analysis.

Out of the 30 studies that met the criteria of inclusion, the second most recognized statistical measure used a combination of either ANOVA, ANCOVA, regression, t-test, or chi-square. This category of statistical measures represent 23.3% of the 30 synthesized studies.

8.) Percentage breakdown of statistical analyses used among studies reporting a positive relationship between school facility condition and student academic achievement (Research Question #1 – Sub-Question #8)

Percentage Breakdown Of Statistical Analyses Used Among Studies Reporting A Positive Relationship Between School Facility Condition And Student Academic Achievement
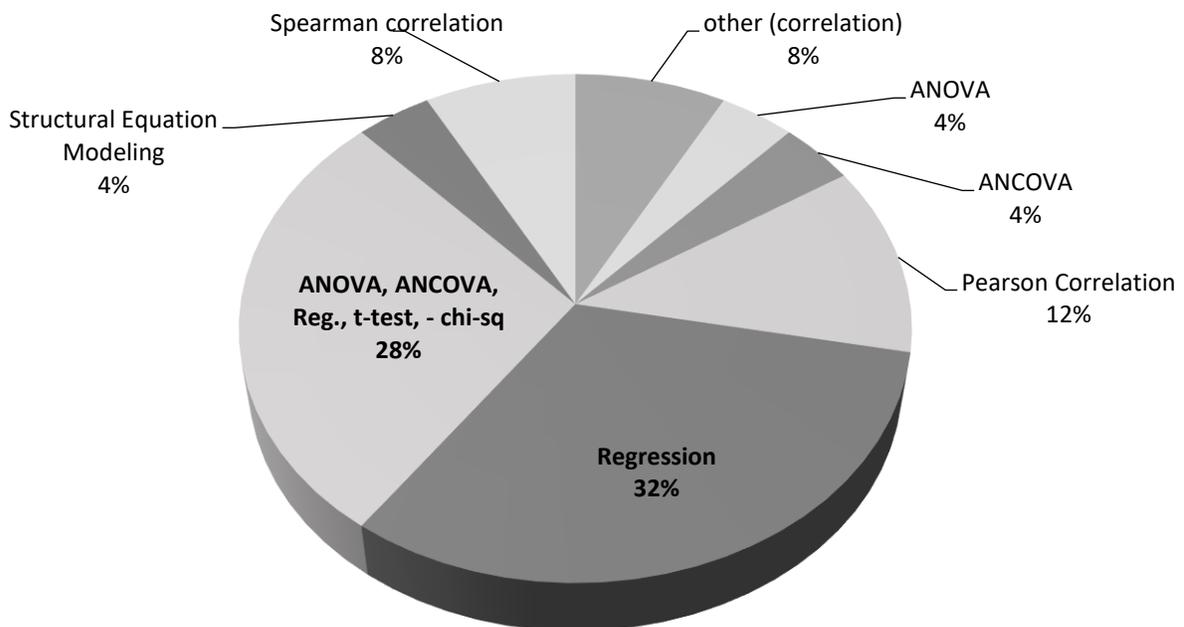
Figure 9. Statistical analyses among studies that met the criteria for inclusion reporting a positive relationship.

Figure 9 represents only those studies that reported a positive relationship between school facility condition and student academic achievement. Out of the 30 studies that met the criteria for inclusion, 25 studies (83.3%) reported a positive relationship between school facility condition and student academic achievement. Of these 25 studies, 8 studies (32%) used multiple

regression analysis as the preferred statistical measure to investigate the relationship. The second most recognized statistical measure that resulted in a positive relationship used a combination of either ANOVA, ANCOVA, regression, t-test, or chi-square. Of the 25 studies that resulted in a positive relationship between school facility condition and student academic achievement, 7 studies (28%) fit this category.

9.) Percentage breakdown of statistical analyses used among studies reporting no existence of a relationship between school facility condition and student academic achievement (Research Question #1 – Sub-Question #9)

Percentage Breakdown of Statistical Analyses Used Among Studies Reporting No Existence Of A Relationship Between School Facility Condition and Student Achievement
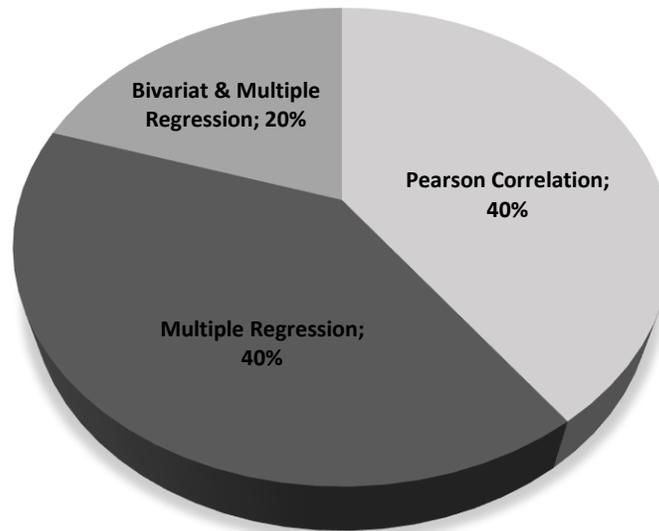
Figure 10. Statistical analyses among studies that met the criteria for inclusion reporting no relationship.

There were 5 out of 30 synthesized studies that reported no existence of a relationship between school facility condition and student academic achievement. The 5 studies that reported no existence of a relationship between the two variables are as follows: Cervantes (1999), Morris (2003), Picus et al. (2005), McGowen (2007), and Sheets (2009).

10.) Percentage of synthesized studies that controlled for confounding variables (Research Question #1 – Sub-Question #10)

Percentage of synthesized studies that controlled for confounding variables

Did Not Controll for Confounding Variables, 10%

Controlled for Confounding Variables , 90%
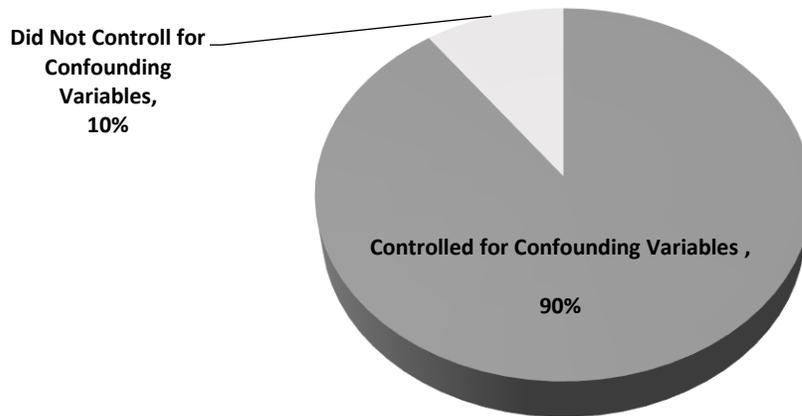
Figure 11. Confounding variables among all studies.

Figure 11 indicates the percentage of studies that controlled for confounding variables versus those studies that did not control for confounding variables. Among the 30 studies that met the criteria for inclusion, 27 studies (90%) controlled for at least one confounding variable. There were 3 studies (10%) identified that did not control for any confounding variables. The 3 studies that did not control for any confounding variables were as follows: Boese-Shaw (2005), Cervantes (1999), and Syverson (2005).

    11.) Percentage breakdown of specific confounding variables as compared to the total
          number of synthesized studies   (Research Question #1 – Sub-Question #11)

**Most Common Confounding Variables Among Studies That Met
The Criteria For Inclusion**
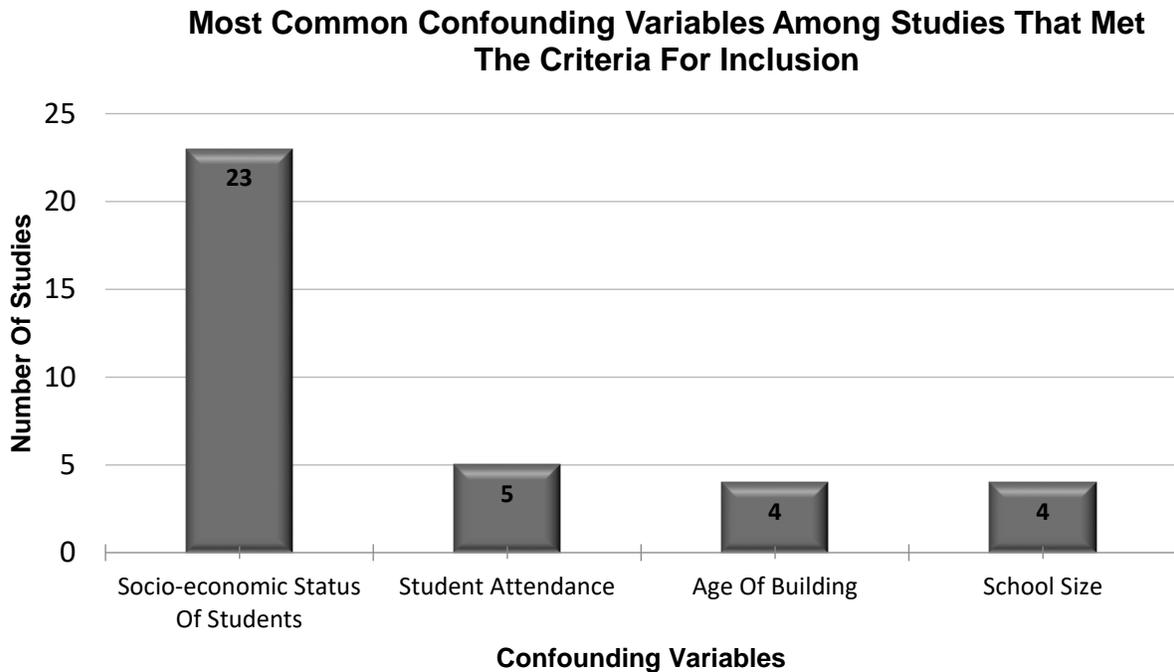
Figure 12. Most common confounding variables.

Figure 12 is a representation of the most used confounding variables among the studies that met the criteria for inclusion. Out of the 30 studies that met the criteria for inclusion, 23 studies (76.6%) controlled for the socio-economic status of students. Of these 23 studies, 19 studies, ended up reporting that a positive relationship existed between the condition of school facilities and student academic achievement. The second most recognized confounding variable among studies that met the criteria for inclusion was student attendance. Of the 30 studies that met the criteria for inclusion, 5 studies controlled for differences in student attendance. The remaining confounding variables discovered among research studies in this synthesis were the age of school buildings and the size of the school facilities.

12.) An analysis of the basic methodologies utilized in each study (Research Question #1
    – Sub Question #12)

This section highlights various methodological similarities and differences among studies that met the criteria for inclusion. The reason for this examination of methodologies is to identify trends and patterns among studies in an effort to inform educational stakeholders and future researchers.

One of the most recognizable methodologies among studies that investigated the relationship between the condition of school facilities and student academic achievement was the study conducted by Cash (1993). Her study spearheaded a direction for researchers to follow. From the building assessment instrument alone, which she created, 10 studies utilized the Commonwealth Assessment of Physical Environment (CAPE) or a hybrid thereof to measure the overall condition of school facilities. Out of the 30 studies that met the criteria for inclusion, 10 studies (33.3%) used the CAPE or a hybrid thereof as the instrument used to assess the overall condition of school facilities. The 10 studies that implemented the CAPE are; Cash (1993), Hines (1996), Lanham (1999), Syverson (2005), Crook (2006), O'Sullivan (2006), Bullock (2007), Geier (2007), Fuselier (2008), and Smith (2008).

Cash (1993)

Cash (1993) investigated the relationship between school facility condition, student academic achievement, and student behavior in small rural high schools in Virginia. In doing so, she collected data from high schools with a senior class of less than 100 students and schools that were not identified within metropolitan areas. In all, there were 47 schools in Virginia that met this criteria. Out of the 47 schools that met the criteria, 43 completed and returned the school facility assessment instrument.

Student academic achievement was determined using the scale score averages of schools on the Test of Academic Proficiency (TAP) given to 11th graders during the 1991-1992 school year. The condition of school facilities was measured using a facility assessment instrument designed by Cash called the Commonwealth Assessment of Physical Environment. This instrument was given to school division personnel to assess school facilities. These individuals did not work at the school they were assessing. Additionally, the socioeconomic status of the schools in the study were determined by free or reduced lunch percentages during the 1991-1992 school year.

The overall school facility score for each building was determined by the average of all 27 items of the CAPE. Once overall facility scores were calculated, schools were then identified as substandard, standard, or above standard. Using analysis of covariance as the statistical measure, Cash was then able to compare school facility ratings to student academic achievement using scale score means for each school on the TAP. Within her findings, Cash (1993) reported

that student academic achievement was higher in school facilities with higher building condition ratings as measured by the CAPE.

Earthman-Cash-Van Berkum (1995)

Earthman-Cash-Van Berkum (1995) focused their study around a research question that asked if a relationship between school facility condition, student academic achievement, and student behavior existed. To answer this question, the team of researchers conducted a study using all high schools in the state of North Dakota as the studies population. From a total of 199 high schools, the team received 120 responses from high school principals who completed and returned school facility conditions survey instrument.

To measure student academic achievement, Earthman et al. (1995) used results from the Comprehensive Test of Basic Skills given to all 11th grade students in North Dakota during the spring of the 1993-1994 school year. Each high school in North Dakota was sent a building assessment survey to be completed by the school principal. The survey consisted of 29 items related to building conditions where the principal recorded either the absence or presence of the building condition item. The survey results were used to categorize schools into quartiles. The top 25% of schools were identified as above standard, the middle 50% as standard, and the bottom 25% of schools in the study were identified as below standard. In terms of overall building conditions, all 29 items together were used and compared against student academic achievement. When academic achievement scores were compared, 11 of the 13 subsets were higher among students in above standard schools as compared to students in substandard schools. Therefore, based upon the findings, the research team declared a positive relationship existed between school facility condition and student academic achievement.

Hines (1996)

Underneath the same methodology umbrella is the Hines study. Whereas Cash (1993) researched rural high schools in Virginia, Hines (1996) investigated large high schools located in urban areas of Virginia. Schools in this study were located in metropolitan areas as defined by the Metropolitan Statistical Area with populations of over 100,000 and student enrollments of over 25,000. To determine the overall conditions of school facilities, Hines (1996) used the Commonwealth Assessment of Physical Environment. The collection of raw scores from this instrument allowed Hines (1996) to categorize schools based upon the overall condition scores. Like Cash (1993) and Earthman et al. (1995), Hines (1996) also sorted schools into quartiles as

determined by the average building condition scores on the CAPE. Schools in the bottom quartile according to overall building condition scores were identified as substandard and schools in top quartile according to overall building condition scores were identified as above standard schools. In order to measure student academic achievement, Hines (1996) used the Test of Academic Proficiency scores among 11th grade students during the 1992-1993 school year. Out of 88 schools identified as the population for this study, 66 completed and returned the building assessment instrument. Scale scores on all subtests of the TAP improved when substandard buildings were compared to above standard buildings as measured by the CAPE. The results of this study indicated that a strong relationship exists between school facility condition and student academic achievement.

Using a similar statistical methodological approach, Hines (1996) also employed ANCOVA as the preferred statistical analysis to compare adjusted mean achievement scores to the building ratings as determined by the CAPE. Hines (1996) adjusted for SES through the use of a measure of SES as a covariate.

Lanham (1999)

Using a similar approach as Cash (1993), Lanham (1999) conducted research at the elementary school level to determine if there was a relationship between student achievement, student behavior, and the condition of school facilities. He focused on gathering data from elementary schools that housed both 3rd and 5th grade students. Out of 989 elementary schools in Virginia that met this criteria, 300 schools were randomly selected from an alphabetical listing of schools where every third school was selected. From this population of schools, Lanham (1999) received responses from 191 schools. He assessed the condition of school facilities using a hybrid of the CAPE instrument completed by building principals and utilized the 3rd and 5th grade Math and English Virginia Standards of Learning assessments to measure student academic achievement. Lanham (1999) concluded that a relationship between school facility condition and student academic achievement does exist.

Five Similar Studies Conducted Between 2005-2008 That Reported a Positive Relationship Exists between School Facility Condition and Student Academic Achievement

Following a thorough analysis of the studies included within the meta-matrix chart, five studies emerged between 2005 and 2008 that encompassed many of the same methodological traits. The five studies with similar methodological traits were: Syverson (2005), Crook (2006),

O'Sullivan (2006), Bullock (2007), and Fuselier (2008). Each of these five studies used the CAPE or a hybrid thereof to rate the overall condition of school buildings, each study required the building principal to complete the CAPE, each study was conducted at the secondary level, and each of these five studies used the Virginia Standards of Learning standardized tests to measure student academic achievement.

Syverson (2005)

Syverson (2005) completed a study of Indiana high schools from a random sample of 50 high schools. From the 50 schools, 28 surveys were fully completed and used for the research study. The research question for this study focused on determining if there was a connection between the level of school facility conditions and the total scores on the qualifying exam in Indiana high schools. The research question lead Syverson (2005) to research and analyze the impact poor building conditions have upon student learning in Indiana. To collect data related to the school facility, Syverson (2005) utilized the CAPE which assess various features related to building condition, but ultimately lead to an overall school facility score. Information related to student achievement was obtained through the Indiana Department of Education where Syverson (2005) collected total battery score results from the Indiana statewide Test for Educational Progress in English and math. Syverson (2005) used a Spearman Correlation Coefficient designed to test the research question and rank the data sets. The findings of the study revealed "…significant results proving there is a relationship between building condition and student achievement" (Syverson, 2005, p. 56).

Crook (2006)

Crook (2006) observed the association between percentages of students' who passed the Standards of Learning (SOL) assessments, and current building conditions within high schools in the Commonwealth of Virginia. This study was built upon three data components. First, Crook (2006) collected the percentages of student pass rates on SOL assessments in grades nine through twelve within the Commonwealth of Virginia. Information was obtained from the Virginia Department of Education website. Here, information was inputted from Harcourt Testing Services which collected and stored assessment results for all students in the Commonwealth (Crook, 2006). Second, along with help from administrators throughout the Commonwealth, building condition data was collected using the Commonwealth Assessment of Physical Environment (CAPE) as the assessment tool. Crook (2006) issued out letters to high school

administrators who housed 11th grade students and asked them to complete the assessment instrument. Out of the possible 198 high schools that were given permission to participate from division superintendents, 142 principals responded agreeing to participate in the study by completing the CAPE. Thirdly, the percentage of students taking part in the free and or reduced lunch program was collected using information from the Virginia Department of Education (Crook, 2006). These data allowed Crook (2006) to control for socioeconomic status of children by using free and reduced lunch percentages as a covariant.

The first research question looked at the relationship between the percentage of students passing their SOL assessments in schools that were assessed using the CAPE as either substandard or standard. The second question investigated the disparity between the percentage of students passing the SOL assessments in school buildings that underwent a structural assessment and were labeled as either substandard or standard on the CAPE. The third question that guided this study was the difference between the percentage of students passing SOL assessments in buildings assessed cosmetically using the CAPE and identified as either substandard or standard (Crook, 2006).

In determining the condition of school facilities, Crook (2006) used the CAPE; an assessment instrument designed by Cash (1993) and has been implemented by other researchers. The CAPE is made up of 27 items pertaining mostly to the structural or cosmetic conditions of school facilities. The results of the assessment allowed the researcher to categorize schools into bottom and top quartiles, which ultimately labeled the condition of these schools. The top quartile of schools was identified as standard and the bottom quartile of schools were identified as substandard (Crook, 2006).

Following the determination of standard and substandard schools, Crook (2006) statistically compared the percent of students passing the SOL assessments to the quartile groups by using an ANCOVA. The pass rates of students in English reading and writing, Algebra I, Algebra II and Geometry for each school were averaged for both standard and substandard schools. This allowed Crook (2006) to statistically compare each respective group.

As a result of the findings, Crook (2006) reported that a significant relationship existed between building condition and the percentage of students passing English writing and reading SOL assessments. This determination was made using a significance level measured at the $> .05$ level. Strong differences were also needed when analyzing SOL pass rates in Algebra II and

Geometry among standard and substandard buildings. However, though differences were positive, they were not statistically significant. Crook (2006) also noted that percentages of students passing the Algebra I SOL assessment were higher in substandard schools when compared to standard schools, but not at a statistically significant level. The findings lead Crook (2006) to assert that "...a positive difference exists between building condition and student achievement, but in a limited number of subtests" (Crook, 2006, p. 119). Therefore, Crook (2006) recommended that school boards review the available research on school building condition and the influence it has on student achievement.

O'Sullivan (2006)

O'Sullivan (2006) conducted a study using 251 randomly selected high schools in the state of Pennsylvania. Student academic achievement was measured utilizing state standardized assessment results from the Pennsylvania System of School Assessment (PSSA) tests. The results from these assessments were used to compare scores from substandard school buildings to schools in standard buildings.   To conclude his study, O'Sullivan (2006) stated that as Pennsylvania high school building conditions improved, an increase in student academic achievement was observed. "This would indicate that a relationship exists between student academic achievement and school building conditions in Pennsylvania high schools" (O'Sullivan, 2006, p. 117).

Bullock (2007)

Bullock (2007) set out to investigate the relationship between school building condition and student achievement at the middle school level in the Commonwealth of Virginia. Specifically, Bullock (2007) targeted eighth grade students and defined middle school as any school serving students in grades not below fifth and no higher than eighth grade.

Three areas of data were collected. First, student achievement data was collected using the percentage of eighth grade students who passed the English, mathematics, and science Standards of Learning assessments in the spring 2006 (Bullock, 2007). Second, data on the socio-economic status (SES) of schools was obtained by the Virginia Department of Education website which used the Fall Membership Report dated September 30, 2005. SES information was determined by comparing the number of students participating in free and reduced lunch to the total school population and was used as a covariant investigating the relationship between student academic achievement and school facility conditions. Thirdly, data on school facility

condition was collected using the Commonwealth Assessment of Physical Environment (CAPE) as the school facility appraisal instrument. Schools in the bottom quartile, 29 schools, were labeled as being substandard while those in the top quartile, 27 schools, were identified as standard. As stated by Bullock (2007), data collected on school in the middle two quartiles, 50% of school in the study, were not used. The rationale for this was identified by Cash (1993) who determined that little variance existed among the two middle quartiles as compared to the variance see between the lower and upper quartiles. Once schools were appropriately categorized into their respective quartiles, they were compared using the percentage of student pass rates on SOL assessments to determine the relationship between school building and student academic achievement.

Bullock (2007) reported a positive relationship between school building condition and student achievement. This conclusion was made after students in standard schools outperformed students in substandard schools on all subtests. Due to the findings, Bullock (2007) suggested that substandard building conditions may cause schools not to meet state or federal requirements.

Fuselier (2008)

Fuselier (2009) focused her research on school facility condition and student academic achievement among middle schools in the state of Pennsylvania. The investigation was comprised of a population of approximately 75,000 male eighth grade students and approximately 70,000 female eighth grade students.   The purpose of the study was to investigate the relationship between student achievement with the variables of lighting, thermal comfort, and acoustics. To measure student academic achievement, the researcher retrieved data from the Pennsylvania System of School Assessment (PSSA) containing eighth grade scores in math and English. To measure school facility condition, data was collected from 104 completed and returned principal surveys from the School's Physical Environment Variables Assessment (SPEVA). This building assessment used components from both the CAPE, designed by Cash (1993), and assessment features from McGuffey (1982).

The SPEVA assessment instrument was completed by school building principals and assessed various components of school building condition, including lighting, thermal elements, and acoustic measures. The assessment was used to identify middle schools as being in poor condition, average condition, or excellent condition. To answer the research questions, Fuselier

(2009) used descriptive statistics, independent t-tests, linear regression and an analysis of variance (ANOVA).

The results of the study, as indicated by the school facility assessment instrument revealed that principals perceived their schools as adequate or excellent condition. The statistical analysis revealed a small, but positive correlation between student academic achievement among math and English scores as compared to the dependent variables of school lighting, thermal conditions, and acoustics. Ultimately, Fuselier (2008) determined that a positive relationship existed between overall school facility condition and student academic achievement.

Though these studies shared many of the same methodological components, it is important to note that many of these studies compared schools identified as above standard school in terms of school facility condition to schools identified as below standard. For example, Cash (1993), Earthman et al. (1995), Hines (1996), Crook (2006), O'Sullivan (2006), and Bullock (2007) all divided schools into quartiles following the determination of the overall building condition. Researches then used a statistical analysis to compare the top quartile schools to the bottom quartile schools. Using a similar method, Fuselier (2008) divided schools into three categories instead of four. In his study, school facility assessment results were used to divide schools into categories identified as poor, average, or excellent condition before comparisons were made. From a methodology analysis, when researchers compared schools identified as having top rated facilities to schools rated among the bottom, results yielded a positive relationship between school facility condition and student academic achievement.

Study Methodologies that Reported No Relationship between School Facility Conditions and Student Academic Achievement

Picus, Marion, Calvo & Glenn (2005)

Among all the researchers in this study, perhaps the one who is the most critical of other methodologies related to this topic is Picus, Marion, Calvo and Glenn (2005). Picus et al. (2005) investigated the relationship on school facility quality and student achievement using state assessment data in Wyoming. The data used to complete this study came from two sources. First, information on the condition of school facilities was composed by the consulting firm, MGT of America, Inc. (MGT). The consulting agency was employed by the state of Wyoming in

response to the Wyoming Supreme Court case, Campbell v. Wyoming. Their responsibility was to assess the "condition, educational suitability, and technological readiness of each school in Wyoming" (Picus, Marion, Calvo, & Glenn, 2005, p. 80). Upon creating an assessment instrument intended to be objective, the agency began assessing school facilities, evaluating 22 separate subsystems that included such things as building foundations, ceilings and floors. Second, student achievement was measured using the Wyoming Comprehensive Assessment System, (WyCAS), which assesses all "4th, 8th and 11th grade students in all Wyoming public schools, accredited institutions, and accredited private schools" (Picus et al. 2005, p. 81).

When analyzing the Pearson correlation coefficients of the 1999-2001 WyCAS average and composite scale scores along with the building condition scores, the research team found no statistically significant correlation. Additionally, similar results occurred when researchers only analyzed the percentage of students achieving proficient or above in each of the three subject areas, in place of scale score averages and composites. Therefore, upon studying the correlation coefficients, the team verified that no relationship existed between building condition scores and multiyear and multi-grade WyCAS scores. Accordingly, their research suggested that as building condition scores increase, there is no likelihood that student achievement will improve or decline (Picus et al. 2005).

Picus et al. (2005) also reviewed the correlation between building condition scores and improvement in WyCAS average composite scale scores. It could be assumed that higher quality school facilities produce higher scores on achievement tests. However, the research results in this study indicate otherwise. The team reports basically zero correlation between the full sample and any of the individual grade levels (Picus et al. 2005).

Within their study, this team of researchers stated that "Very little empirical evidence supports this common belief that high-quality school facilities are a positive factor in student achievement" (Picus et al. 2005, p. 72). Moreover, the team also proclaimed that researchers have limited knowledge concerning the condition of schools in the United States and that most states "lack sophisticated student testing systems..." needed to conduct research on student academic achievement (Picus et al. 2005, p. 72). As a follow-up to this statement, and to support their own efforts, Picus et al. (2005) declared that Wyoming had a system in place that had the ability to collect data on building condition and student achievement.

Despite the fact that numerous studies have been conducted on how school buildings affect student achievement, Picus et al. proclaimed that there are no conclusive findings. Additionally, Picus et al. (2005) stated that many of the studies conducted on the topic of school facility condition and student academic achievement were "...plagued with methodological problems…" (p. 73).

Cervantes (1999)

Cervantes (1999) conducted a study that investigated the relationship between school facility condition, student academic achievement, and the behavior of students in the 4th, 7th, and 11th grades attending public schools in Alabama. The overall condition of schools were conducted by doctoral students using the Guide for School Facility Assessment (created by Hawkins & Lilley, 1992). All 15 of the students completed 21 classroom hours along with 44 hours of on-site training before completing the Guide for School Facility Appraisal Instrument reports. Cervantes (1999) used the Stanford Achievement Test (SAT) 9th edition scores in reading and math for students in grades 4, 7, and 11 to measure academic achievement. The study was conducted using a total of 19 schools: 8 unit schools, 4 elementary schools, 2 middle schools, and 5 high schools. Cervantes explained that unit schools contained students from grade levels kindergarten through the 12th grade. In all, scores from 3,011 students (804 4th grade students, 1027 7th grade students, and 1180 11th grade students) in grades 4, 7, and 11 were used to compare student achievement to building condition scores. The building assessment instrument itself identified 6 areas of the building as being "nonexistent, very inadequate, poor, borderline, satisfactory, or excellent" (Cervantes, 1999, p. 48). The sum score for each of the 6 areas was used to develop the overall assessment score of the buildings condition. Cervantes (1999) used the scores from the 6 areas of the building and the overall condition score compared to the Stanford Achievement Test (9th edition) in reading and math. A Pearson correlation analysis was employed to analyze the results between building condition ratings and student academic achievement results. The statistical analysis conducted revealed that there was not a statistically significant relationship between the overall building condition of schools and student achievement based on reading and math scores on the SAT – 9th edition.

Morris (2003)

Morris (2003) conducted a study that investigated whether relationships exists between the physical characteristics of schools, student achievement, student behavior, and teacher

satisfaction levels. The study employed a teacher perception survey where results were averaged to determine the total quality of a school facility. Following the completion of the teacher perception survey, a composite score for the total quality of each school was calculated by averaging the means from each physical component surveyed. Morris (2003) randomly selected 164 teachers from 28 Georgia high schools to participate in the study. The teachers selected were e-mailed a survey questionnaire of 30 questions intended to measure the overall quality of the school building, student behavior, and the job satisfaction of teachers. In terms of building quality, the questionnaire asked teachers to rate their perception of the physical aspects of the school, such as; cleanliness, temperature, lighting, existence of windows, and noise levels. Student achievement data were collected from the Georgia Department of Education website using mean score results of schools from the following assessments: ACT, SAT, and Georgia High School Graduation Test. Additionally, the socio-economic status of students was used as a control by using percentages of free and reduced lunch students at participating schools. Data was compiled and entered into SPSS to conduct a number of correlations for Pearson's r aimed at determining relationships between variables (Morris, 2003).

The study controlled for the socio-economic status of students, the experience levels of teachers, and teacher education levels. However, the researcher found no positive correlations between mean scores for each characteristic of the physical environment surveyed and student achievement mean scores, nor did the researcher discover a relationship between the composite score for the total quality of the school facilities and student achievement mean scores. Morris (2003) identified multiple concerns with the study that could have influenced the results. For instance, he stated "…teacher's perceptions of the school as a whole are subject to their experiences in the classrooms." (Morris, 2003, p. 59-60). He goes onto explain that the presence of noise or fumes would not be consistent throughout all classrooms. Additionally, it should be noted that noise levels and the presence of fumes in classrooms can be interpreted differently by teachers. The subjectivity of these factors may have influenced the validity of the school assessment survey, and therefore brings the findings of this study into question.

McGowen (2007)

McGowen (2007) used both school size and the socioeconomic statue of students as confounding variables to better investigate the relationship between the condition of school facilities and student performance. The researcher focused on Texas public high schools

consisting of grades 9-12 with enrollments between 1,000 and 2,000 students. By staying within this range of student enrollment, McGowen (2007) hoped to avoid possible measurement error with schools being either too large or too small. The population consisted of 101 high schools. Data concerning facility condition was acquired using the Total Learning Environment Assessment (TLEA), the same measurement instrument implemented by (O'Neill, 2000) with building level principals conducting the assessment (McGowen, 2017). Data on student achievement was determined by the percentage of students passing the Texas Assessment of Knowledge and Skills (TAKS) tests as obtained from the Texas Education Agency's website and the Texas Education Association Division of Communication and Public Information (McGowen, 2007). Of the five research questions investigated by McGowen (2007), the first question dealt with school facilities and student achievement. This study utilized results from two sections of the TLEA. The two sections were Educational Adequacy and Environment for Education. A positive correlation (not significant) was discovered between TAKS scores along with the TLEA section Educational Adequacy and a negative correlation between TAKS scores along with the TLEA section Environment for Education (McGowen, 2007).

Sheets (2009)

Sheets (2009) investigated the relationship between the school facility condition and various educational outcomes within rural high school in Texas. Sheets (2009) defined educational outcomes as student achievement, teacher turnover rate, and student attendance. To measure student academic achievement, he used the average score of 11th grade students for all assessments taken on the Texas Assessment of Knowledge and Skills. Additionally, Sheets (2009) controlled for the wealth of the student population by using the percent of economically disadvantaged students, school division wealth by using property values, as well as percent of minority students from high schools in the study.

As Earthman and Lemasters (2011) suggested, controlling for the socio-economic status of students is the most common confounding variable among studies within this meta-analytic synthesis. Out of the 30 studies that met the criteria for inclusion, 17 reported they controlled for the socio-economic status of students. At the secondary level, this is most challenging due to the potential social stigmatism of a student being identified as a free and reduced lunch student. Perhaps the embarrassment of other students discovering this reduces the participation rate in this program at the secondary level, thus producing invalid data.

13.) Percent of synthesized studies indicating a positive relationship between school facility condition and student academic achievement (Research Question #2)

Percent Of Synthesized Studies Indicating A Positive Relationship Between School Facility Condition And Student Academic Achievement
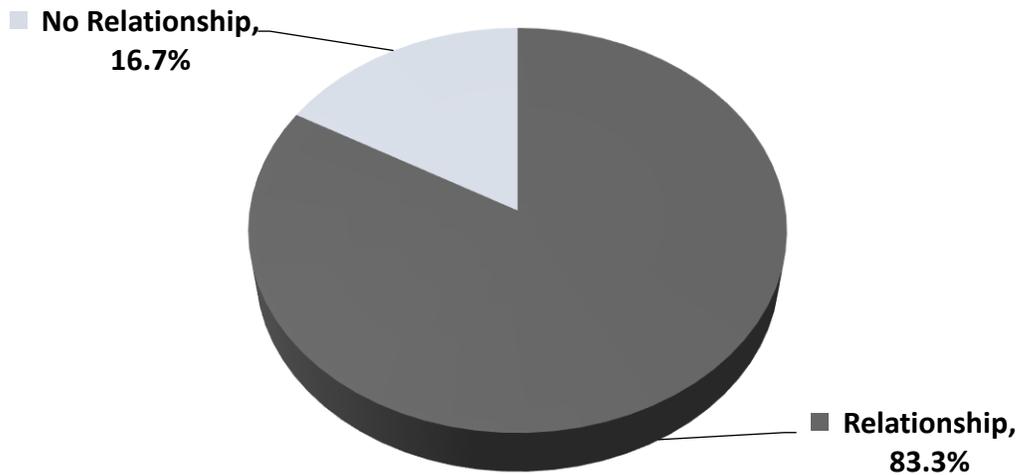
Figure 13. Comparison of all studies that met the criteria for inclusion

Figure 13 indicates that out of 30 studies conducted that met the criteria for inclusion, 25 studies (83.3%) reported a positive relationship between school facility condition and student academic achievement. Additionally, Figure 13 also shows that 5 studies (16.7%) reported no relationship between school facility condition and student academic achievement.

14.) Percent of synthesized studies indicating a positive relationship between school facility condition and student academic achievement among studies at the elementary school level (Kindergarten – Fifth Grade) (Research Question #2)

Percent Of Synthesized Studies Indicating A Positive Relationship Between School Facility Condition And Student Academic Achievement Among Studies At The Elementary School Level

Reported A
Positive
Relationship, 100%

Reported No
Relationship, 0%
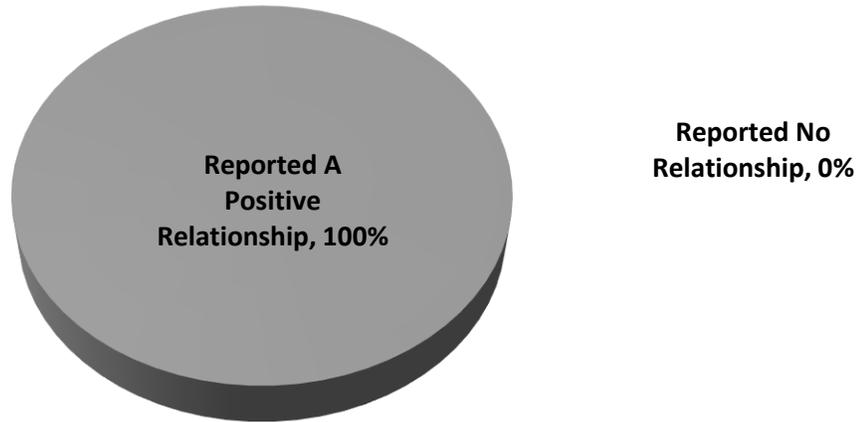
Figure 14. Findings from studies using data from elementary schools.

Figure 14 indicates that out of all 30 studies that met the criteria for inclusion, 5 studies (16.6%) were conducted using only data concerning elementary school facilities and elementary school students. Of the 5 studies that investigated the relationship between school facility condition of elementary schools and student academic achievement of elementary school students, all 5 studies (100%) reported a positive relationship between the two variables.

15.) Percent of synthesized studies indicating a positive relationship between school facility condition and student academic achievement among studies at the secondary school level (Sixth Grade – Twelfth Grade) (Research Question #2)

**Percent Of Synthesized Studies Indicating A Positive Relationship Between School Facility Condition And Student Academic Achievement Among Studies At The Secondary School Level**


Reported No Relationship , 19%

Reported A Positive Relationship, 81%
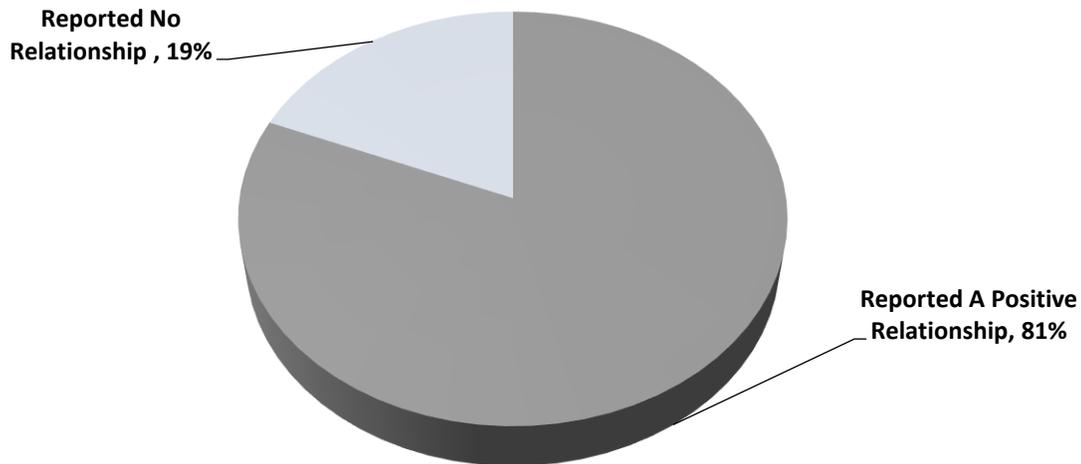
Figure 15. Findings from studies using data from secondary schools.

Figure 15 indicates that out of all 30 studies that met the criteria for inclusion, 16 studies (53.3%) were conducted using only data concerning secondary school facilities and secondary school students. Of the 16 studies that investigated the relationship between school facility condition of secondary schools and student academic achievement of secondary school students, 13 studies (81.3%) reported a positive relationship between the two variables. It is interesting to note that the overwhelming majority of studies that found a positive relationship between overall building condition and student achievement were conducted using data from secondary schools. Out of the 25 studies where a positive relationship was discovered, five studies investigated data solely from the elementary school level. Lanham (1999), Osborne (2007), Geier (2007), Duran-Narucki (2008), and Brooks (2015) all were conducted using elementary school data and all utilized state standardized assessments to measure student academic achievement. Therefore, all studies conducted solely at the elementary school level, reported a positive relationship between school building condition and academic achievement.

CHAPTER 4

RESULTS

This meta-analytic synthesis is a compilation of the findings from an extensive list of research studies conducted on the relationship between school facility condition and student academic achievement. In all, 81 research studies were identified, analyzed, and then compared against the criteria for inclusion in this meta-analytic synthesis. All studies included in this synthesis were completed after January 1, 1977, were conducted in the United States, used a measurement tool or instrument to assess the overall condition of a school facility, and used state or national standardized assessments to measure student academic achievement. Out of the 81 studies analyzed, 30 studies were identified as meeting the criteria for inclusion and were included in this meta-analytic synthesis. The purpose of this study was to synthesize existing research in an effort to make a definitive statement concerning the relationship between school building condition and student academic achievement and to determine whether a relationship among these two variables exists. When the aforementioned studies are merged into one body of thought, it is difficult to deny that school building condition has a positive impact on student achievement.

Researchers have stated that numerous factors influence student academic achievement, with the condition of school facilities being one such factor. This is without question a true statement and any logical person can begin an endless list of possible factors at play. Certain researchers in this field have denied the existence of a relationship between school facility condition and student academic achievement, likely due to weaknesses in their methodologies. With the literature possibly being questioned by readers, this meta-analytic synthesis of studies has focused solely on compiling research limited to the variables of school facility condition and student academic achievement, in an effort to condense the results of research and create a greater understanding of the overall results of previous research studies.

Findings

The purpose of this study was to complete a comprehensive analytic synthesis of studies conducted on the topic of school facility condition and the relationship these conditions have on student academic achievement in an effort to better understand specific characteristics of these studies and to better inform educators regarding this relationship. Additionally, this meta-

analytic synthesis reported and quantitatively combined results from studies that have not been included within previously completed synthesis studies. Through the careful analysis of the meta-matrix document along with the research questions and sub-questions, the following findings have been identified:

1) **When the Commonwealth Assessment of Physical Environment, or a hybrid thereof, is used to assess the overall condition of school facilities, and the results are compared to student academic achievement results, a positive relationship between these two variables is likely to exist.** In fact, out of 10 studies that utilized the CAPE, all studies reported a positive relationship between the two variables. It is also important to note that the Commonwealth Assessment of Physical Environment is an assessment instrument that included school building elements such as "lighting, acoustics, climate control, color, density, science lab quality, and aesthetics" (Cash, 1993, p. 34). Many researchers in this field have found these elements to impact student learning. Additionally, the CAPE is a validated instrument as Cash (1993) had the instrument field tested by experienced personnel in the facilities field to ensure the instrument's high "interrater reliability" (Cash, 1993, p. 34-35).

2) **When school facility measurement instruments are completed by school building principals, it is likely that a relationship between school facility condition and student academic achievement will be found.** Among the 14 studies that utilized school building principals to complete the facility assessment instrument, 13 (93%) reported a positive relationship between school facility condition and student academic achievement**.**

3) **The majority of studies included in this meta-analytic synthesis used state standardized assessments to measure student academic achievement.** Out of the 30 studies that met the criteria for inclusion, 20 studies were conducted using state standardized assessments.

4) **All studies conducted using elementary school facility assessment results compared to elementary school student academic achievement results reported a positive relationship.**

5) **Two noticeable differences can be observed among studies reporting that no relationship exists between school facility condition and student academic achievement.**

   a. **First, the average student/school populations were far less among these studies than those reporting a positive relationship between the variables.** Three of the five studies that reported no relationship between the two variables of school facility condition and student academic achievement did so with school populations of less than 75 schools. The number of school buildings in the studies that discovered a positive relationship is 187 schools, which is significantly greater.

   b. **Second, four out of the five studies utilized someone other than the school building principal to complete the school facility assessment instrument.**

6) **There is a positive relationship between school facility condition and student academic achievement.** This statement is based upon data collected from 30 studies that met a specific criteria. This analytic synthesis was to report and quantitatively combine the results of previous studies, in a condensed organized manner, to assist future researchers and better educate public school stakeholders.

Diversity of School Facility Assessment Instruments

There are multiple factors that potentially influenced the findings of studies included within this meta-analytic synthesis. The studies identified within this study used an assortment of assessment methods to measure the overall condition of school buildings. In no particular order, the building assessment instruments used were: State Assessment of Facilities in Education (SAFE), Commonwealth Assessment of Physical Environment (CAPE), Facility Condition Index (FCI), Total Learning Environment Assessment (TLEA), survey conducted by the D.C. Committee on Public Education (COPE), general building condition surveys developed by individual researchers, school facilities survey developed by the Texas Comptroller's Office, and the school facilities survey developed by The United States General Accounting Office. Additionally, studies within this meta-analytic synthesis also used school facility assessment results from engineering or architectural firms. One question educational stakeholders may have is, are some building assessment instruments better than others? The answer to this question is

dependent on what the intended purpose of the assessment is. Roberts (2009) characterizes some assessment instruments as being "engineering" or "property management" driven, and not taking educational factors into account (p. 369.) Whereas other assessment instruments, namely the CAPE, utilized objective questions, based on previous research, upon factors that impact student achievement (Cash, 1993). Therefore, it is important to understand that some facility assessment instruments may or may not provide the data necessary for determining an accurate correlation to student achievement results.

Implications for Practice

The findings of this meta-analytic synthesis contribute to the overall body of existing research dedicated to school facility condition and the relationship these conditions have on student academic achievement. In doing so, this study supports the claim made by many researchers that there is a positive relationship between the condition of school facilities and student academic achievement. This indicates that as school facility conditions improve, so too does the academic achievement of students. Therefore, based upon the overall findings within this analysis, decision makers, school administrators, parents, and community stakeholders can better understand that addressing maintenance issues, renovating outdated and substandard school facilities, and building new school facilities improves the academic environment and plays a part in the degree to which students perform academically. Additionally, when opportunities arise, the information contained in Chapter 3 of this study can assist these key players in their pursuit to influence public policy, in an effort to improve the condition of schools, as well as the learning that takes place within.

Discussion

Each day, a significant number of American public school students attend school facilities that are less than adequate. All schools are shaped in part by the political landscape at the local, state, and federal levels. As mentioned previously, our public school population represents the United States' commitment to education as observed through rankings provided by the Trends in International Mathematics and Science Study (TIMSS) (Mullis, I.V.S., Martin, M.O., Foy, P., and Hooper, M., 2016). The rankings speak to the fact that American students are in direct competition with students from other nations. As we consider this, many of our schools

are not equipped to meet the basic needs of our students, which includes the technological needs to maintain relevancy in the academic setting. The results of this meta-analytic synthesis provides the research establishment, as well as educational stakeholders with a greater understanding concerning the relationship between school facility condition and student academic achievement. The knowledge gained by understanding the research questions and the overall findings of this study will assist those with a desire to improve upon school facilities and also positively influence student learning.

This meta-analytic synthesis validates the findings of previous researchers within this field, which support the idea that the physical condition of a learning environment impacts the academic achievement of students. It is believed that schools in poor condition exude a perception that learning, and the students and teachers within these schools, are not important. Therefore, schools identified as substandard, outdated, not properly maintained, and those in need of renovation or replacement, creates a negative learning environment and thereby effects student academic achievement. This study supports the previous research and provides added confirmation concerning this relationship. By condensing a large number of studies across a specific set of criteria, the researcher was able to make comparisons and determine trends among all studies related to this topic.

Given that students spend a great deal of time inside school buildings, it is reasonable to assume that the condition of the school building has an impact on learning outcomes. Though research has attempted to give credibility to this assumption by providing concrete data in support of this belief, some researchers have provided contrary results, thus stalling the progress towards a consensus. However, the findings as outlined in this study provide the research establishment with a definitive statement surrounding the relationship between school building condition and student academic achievement. In total, 83% of the studies that met the criteria for inclusion, found a positive relationship between the overall condition of school facilities and student academic achievement. After carefully and comprehensively reviewing and synthesizing relevant studies that met the criteria set forth for this study, it can be concluded that a relationship exists between the condition of school facilities and student academic achievement. The evidence in this study is definitive. The results are based upon the findings of a large group of studies spanning the last 40 years.

Leading up to this study, and though many studies discovered positive correlations among the two variables, the research community still had not reached an overall consensus of understanding due to a mix of findings. In an effort to unite the existing literature within the last 40 years, this meta-analytic study reviewed 81 studies that dealt with school facilities and student achievement. The review of these studies revealed a narrower group of studies that investigated the relationship of the overall condition of school facilities to student academic achievement. As a result, the findings of this meta-analytic synthesis reveals that school building condition impacts student academic achievement.

Recommendations for Further Inquiry

This analytic synthesis is noteworthy as it compared a large group of studies dealing with the relationship between school facility condition and student academic achievement against a very specific criteria for inclusion. Until this study, no synthesis of research has completely limited itself to the relationship between the condition of school facilities and the academic achievement of students. Stewart (2005) analyzed a small percentage of studies related to this topic, but neglected to include studies considered valuable for researchers. This analytic synthesis merged the existing body of research into one document that enabled the researcher compare a large number of studies that met a specific criteria in order to make a definitive statement on behalf of the research community. By creating a thorough analytic synthesis of studies related to the condition of school facilities and student academic achievement, the body of existing research has been merged along with a shared conclusion to assist future researchers. Following this analytic synthesis of studies and data gathering process, the researcher is convinced that school facility condition influences student academic achievement. Based upon the patterns and trends discovered throughout this investigation, the following recommendations are made to future researchers on this topic:

1.) Among the 30 studies that met the criteria for inclusion, only five were conducted solely at the elementary school level. Of these five studies, all five (100%) used state standardized assessments to measure student academic achievement. Future researchers may want to consider conducting studies at the elementary level using national standardized assessments to measure student academic achievement.

2.) Based upon the data collected, there is a noticeable lack of studies conducted at the elementary school level. Perhaps this is because there is an abundance of data concerning secondary students. Future researchers could potentially begin replicating studies within this analysis, but could begin incorporating reading scores at the elementary level as the measure of student achievement rather than standardized assessment results. The Virginia Department of Education uses the Phonological Awareness Literacy Screening (PALS) to assess kindergarten-third grade students in participating school divisions in Virginia. Screening results could be used to measure student academic achievement of early elementary school age students in the Commonwealth of Virginia.

3.) Further inquiry may include an attempt to quantify the relationship between school facility condition and student academic achievement across a specific region of the United States. Researchers could increase the size and scope of study populations using a large distribution of a building assessment instrument along with a national measurement of academic achievement; such as the SAT or ACT.

4.) Though the majority of studies discovered a relationship between the two variables of school facility condition and student academic achievement, they did so using a wide range of building assessment instruments and methods of determining student achievement. Among studies analyzed, overall condition of schools were determined through the use of an assessment instrument or survey which some researchers mentioned in their limitations sections as having user bias. If the condition of school facilities throughout our country is of concern, perhaps a national standardized assessment tool should be created and mandated by the United States Department of Education. The assessment tool could be created as part of a collaborative effort among prominent researchers in this field.

5.) With the availability of digital technology, data concerning student academic achievement continues to increase. Each year, students participate in standardized assessments and large amounts of data is compiled to measure student academic achievement. However, the availability of data concerning school facility condition is far less in comparison to that of student academic achievement. Within this analytic synthesis, often researchers began their investigation with a large population

only to settle on a much narrower focus due to lack of participation on the part of schools or principals. For example, Hines (1996) conducted a study that investigated the relationship between school facility condition, student academic achievement, and student behavior among certain urban high schools in Virginia. Following the identification of eighty-eight high schools that met this description, sixty-six (75%) schools returned completed surveys after repeated attempts by the researcher to secure this information (Hines, 1996, p.43). In this case, data on school facility condition from 22 schools were not available to assist the researcher in this investigation. Future researchers should work to develop a software program designed using federal/state guidelines in an effort to standardize the evaluation of school facility conditions.

6.) Future researchers might consider conducting additional research in Wyoming, the state where Picus et al. (2005) conducted an investigation and reported findings that suggested no relationship exists between school facility condition and student academic achievement. Though this team of researchers strongly pronounces the methodological weaknesses of other studies, additional studies conducted in this state may shed light on methodological concerns of any study that suggests that no relationship exists. By doing so, future researchers could ask the questions, how could a relationship not exist between these two variables? If this were the case, why would communities ever build or renovate schools? From a fiscally responsible perspective, why would taxpayers ever allow money to be spent rebuilding or renovating schools if no relationship between school building condition and student academic achievement existed?

7.) As technology continues to advance and these advancements are implemented into our nation's schools, future researchers should continuously make the necessary adaptations to school facility assessment instruments to reflect technological progress and how this will impact the overall condition of school facilities. Once teams of researchers, educators, architects, and engineers collaborate and design a shared school facility assessment instrument, regular evaluations of the instrument itself should be scheduled. Just as building construction methods advance and components

of curriculum will change, the overall school facility assessment instrument will also need to be overhauled periodically to reflect future innovation.

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APPENDIX A

DISSERTATION REVIEW TEMPLATE

Name of Researcher(s)

Title of Document:

> ☐ Completed between 12/31/1977 and 1/31/2017
> ☐ Focused on public school facilities and public school students in the U.S.
> ☐ Used a measurement instrument to assess the overall condition of schools
> ☐ Used state standardized achievement tests or national norm reference exams to measure student academic achievement

1.) Was the condition of the building assessed by building principals as compared to those that were not assessed by building principals? (Research Question #1 – Sub-Question #1)

2.) Was the study conducted using elementary school student assessment results or secondary school student assessment results? (Research Question #1 – Sub-Question #1)

3.) Was the study conducted using national assessment results as compared to those studies using state assessment results? (Research Question #1 – Sub-Question #1)

4.) Did the study utilize the CAPE or a hybrid thereof to assess the overall condition of the building? (Research Question #1 – Sub-Question #2)

5.) What was the average student population within the study? (Research Question #1 – Sub-Question #3)

6.) Average student population among studies where no relationship was found between school facility condition and student academic achievement (Research Question #1 – Sub-Question #3)

7.) What statistical analyses' were used to conduct the study? (Research Question #1 – Sub-Question #4)

8.) Percentage breakdown of statistical analyses used among studies reporting a positive relationship between school facility condition and student academic achievement (Research Question #1 – Sub-Question #4)

9.) Percentage breakdown of statistical analyses used among studies reporting no existence of a relationship between school facility condition and student academic achievement (Research Question #1 – Sub-Question #4)

10.) What were the confounding variables identified within the study? (Research Question #1 – Sub-Question #5)

11.) Percentage breakdown of specific confounding variables as compared to the total number of synthesized studies (Research Question #1 – Sub-Question #5)

12.) What was the basic methodology used in the study? (Research Question #1 – Sub Question #6)

13.) Was there a positive relationship between school facility condition and student academic achievement? (Research Question #2)

14.) Percent of synthesized studies indicating a positive relationship between school facility condition and student academic achievement among studies at the elementary school level (Kindergarten – Fifth Grade) (Research Question #2)

15.) Percent of synthesized studies indicating a positive relationship between school facility condition and student academic achievement among studies at the secondary school level (Sixth Grade – Twelfth Grade) (Research Question #2)

APPENDIX B

META-MATRIX DOCUMENT

Study	Assessed by Principal	Conducted at the Elementary level, Secondary level, or Both	Student Academic Achievement Measured Using National Assessment, State Assessment, or Both	School Facility Condition Measured Using the CAPE	Study Resulted in Positive Relationship or No Relationship Between Student Achievement and Facility Conditions
Berner (1993)	No	Both	National	No	Positive
Blincoe (2008)	Yes	Secondary	State	No	Positive
Boese-Shaw (2005)	No	Both	State	No	Positive
Brooks (2015)	No	Elementary	State	No	Positive
Buckley (2014)	No	Both	Both	No	Positive
Bullock (2007)	Yes	Secondary	State	Yes	Positive
Cash (1993)	No	Secondary	National	Yes	Positive
Cervantes (1999)	No	Both	National	No	No
Crook (2006)	Yes	Secondary	State	Yes	Positive
Duran-Narucki (2008)	No	Elementary	State	No	Positive
Earthman-Cash-Van Berkum (1995)	Yes	Secondary	National	No	Positive
Fuselier (2008)	Yes	Secondary	State	Yes	Positive
Geier (2007)	Yes	Elementary	State	Yes	Positive
Guy (2001)	No	Secondary	National	No	Positive

Study	Assessed by Principal	Conducted at the Elementary level, Secondary level, or Both	Student Academic Achievement Measured Using National Assessment, State Assessment, or Both	School Facility Condition Measured Using the CAPE	Study Resulted in Positive Relationship or No Relationship Between Student Achievement and Facility Conditions
Hines (1996)	No	Secondary	National	Yes	Positive
Lair (2003)	Yes	Both	State	No	Positive
Lanham (1999)	Yes	Elementary	State	Yes	Positive
Lewis (2001)	No	Both	State	No	Positive
McGowen (2007)	Yes	Secondary	State	No	No
Morris (2003)	No	Secondary	Both	No	No
O'Neil (2000)	Yes	Secondary	State	No	Positive
Osborne	No	Elementary	State	No	Positive
O'Sullivan (2006)	Yes	Secondary	State	Yes	Positive
Picus-Marion-Calvo-Glenn (2005)	No	Both	State	No	No
Sheets (2009)	No	Secondary	State	No	No
Smith (2008)	Yes	Secondary	State	Yes	Positive
Stevenson (2001)	Yes	Both	Both	No	Positive
Syverson (2005)	Yes	Secondary	State	Yes	Positive
Taylor (2009)	No	Both	National	No	Positive
Uline-Tschannen-Moran (2008)	No	Secondary	State	No	Positive

LETTER OF INVITATION

Dear _____:

       I am a doctoral student at Virginia Tech, writing my dissertation under the direction of Dr. Glen Earthman. My dissertation will be an analytic synthesis of research studies dealing with the two variables of school building condition and student academic achievement. As such, this study is limited to the physical condition of public school buildings as measured by various instruments designed to calculate the overall condition of a school. By excluding all other variables, intense focus will be devoted to compiling the findings of studies that include only the two variables of school building condition and student academic achievement. In doing so, perhaps a statement can be made about the findings of these studies regarding the influence the physical environment, particularly the school building, has upon student learning without the confusing inclusion of different variables.

       I have developed a list of studies that deal with the two variables stated above. In an effort to make this list as complete as possible, I am requesting your assistance in identifying any research studies you believe are not included within the attached list. Once you have reviewed the attached list, I would appreciate your adding the title or author of any study you feel should be included.

       You may forward any suggestions via email to dhchris6@vt.edu. I feel this synthesis will serve as a focused endeavor to discover specific strands of research, add to the existing body of research, and will attempt to make a definitive statement concerning the relationship between the physical condition of a school facility and student academic achievement. It is also believed that this study will establish a platform for further inquiry. Thank you in advance for any assistance you provide.


Sincerely,

Chris D. Hewitt

APPENDIX D

STUDIES THAT DID NOT MEET THE CRITERIA FOR INCLUSION

Study	Reason
Anderson (1999)	Focused on design features
Ayres (1999)	Focused on design features
Bailey (2009)	Synthesis of studies
Battles (2006)	Focused on lighting
Bowers-Burkett (1988)	Focused on age of school facilities
Bowers-Urick (2011)	Did not assess the overall condition of schools
Broome (2003)	Focused on design features
Duyar (2010)	Focused on principal perception of instructional delivery
Edwards (2006)	Did not assess the overall condition of schools
Evans-Maxwell (1997)	Impact of aircraft noise on reading
Fletcher (1983)	Impact lighting has on student behavior
Gibson (2012)	Focused on age of school facilities
Hawkins-Lilley (1998)	Guide for appraising school facilities
Horswill (2011)	Study conducted in Canada
Hughes (2006)	Focused on design features
Hyatt (1982)	Focused on jet aircraft noise
Hygge (2003)	Impact of noise on recall of children
Jackson (2005)	Study conducted in Canada
Jago-Tanner (1999)	Examined 17 studies conducted on relationship lighting and color of classrooms has on student achievement
Johnston (2015)	Principal perceptions
Lemasters (1997)	Synthesis of studies
Leung-Fung (2006)	Conducted in China
Lowe (1990)	Did not use a facility assessment instrument
Lumpkin-Goodwin-Hope-Lutfi (2014)	Did not use a facility assessment instrument
Lundquist-Holmberg-Landstrom (2000)	Conducted in Sweden
Martorell-Strange-McFarlin (2016)	Dealt with school capital campaigns and student achievement
Maxwell (2016)	Focused on renovation of school buildings
Mayo (2012)	Did not assess the overall condition of schools
Monk (2006)	Did not use overall condition of schools or achievement as variables
O'Donnell (2016)	Did not assess the overall condition of schools
Peterson (2014)	Conducted a review of research

Study	Reason
Phillips (1997)	Focused on age of school facilities
Plympton-Conway-Epstein (2000)	Discussed daylighting in schools
Roberts (2009)	Conducted in Canada
Roberts-Edgerton-Peter (2008)	Conducted in Canada
Ruszala (2008)	Discussed teacher satisfaction
Shield-Dockrell (2008)	Conducted in England and focused on noise levels
Smedje-Norback (1999)	Focused on temperature
Tanner (2000)	Focused on design features
Tayyaba (2012)	Conducted in Pakistan
Teli-James-Jentsch (2013)	Conducted in England
Thompson (2014)	Did not assess the overall condition of schools
Wilson (2008)	Authors reflections only – not a study
Winterbottom-Wilkins (2009)	Conducted in England
Wyon (1970)	Conducted before 1977

APPENDIX E

IRB APPROVAL MEMO
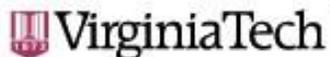
VirginiaTech

Office of Research Compliance

Institutional Review Board

North End Center, Suite 4120, Virginia

Tech 300 Turner Street NW

Blacksburg, Virginia

24061 540/231-4606

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email irb@vt.edu

website http://www.irb.vt.edu

MEMORANDUM

DATE: March 28, 2017

TO: Glen I Earthman, Chris Daniel Hewitt

FROM: Virginia Tech Institutional Review Board (FWA00000572, expires January 29, 2021)

PROTOCOL TITLE: AN ANALYTIC SYNTHESIS OF RESEARCH STUDIES DEALING WITH THE RELATIONSHIP BETWEEN PUBLIC SCHOOL BUILDING CONDITION AND STUDENT ACADEMIC ACHIEVEMENT

IRB NUMBER: 17-307

Effective March 27, 2017, 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.)

Invent the Future

PROTOCOL INFORMATION:

Approved As:	**Exempt, under 45 CFR 46.110 category(ies) 4**
Protocol Approval Date:	**March 27, 2017**
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.

Date*	OSP Number	Sponsor	Grant Comparison

* 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.