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

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Abstract

A meta-analytic synthesis of research studies was assembled upon the findings of research conducted within the last 40 years. Out of 81 studies that dealt with the relationship between school building condition and student achievement that were analyzed, 30 studies met the criteria and were included in the study in order to answer two research questions: What are the characteristics of the studies that investigated the relationship between school building condition and student achievement? What does research offer, in terms of informing educators about the relationship between the school building condition and student academic achievement? Following the completion of this analytic synthesis of studies, it was found that the condition of the school facility can either negatively or positively influence student academic achievement, according to the research findings. Students in school buildings assessed as being in poor condition scored lower on academic achievement tests than students in buildings assessed as being in good condition.

INTRODUCTION

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 of 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 the findings of these studies.

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. In such an attempt, Stewart (2010) completed a meta-analytic synthesis of sixteen studies that included the variables of school building condition and student learning. Sixteen studies represents 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 another 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 important to further analyze and synthesize the research findings in an effort to offer conclusions.

RESEARCH QUESTIONS

Two main research questions were used to guide this study: 1) What are the characteristics of the studies that investigated the relationship between school building condition and student achievement? 2) What does research offer, in terms of informing 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.

METHODOLOGY

Delimitations

This study was restricted to research studies performed within the United States that dealt solely with the relationship between the condition of school facilities and student academic achievement. Additionally, this study was 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 the development and use of the Commonwealth Assessment of Physical Environment (CAPE), which was created by Cash (1993). Her building

assessment instrument set a new standard, since there were no previously developed assessment instruments that matched this level before, and it provided a foundation for several studies to follow. Furthermore, in the later years of this time period, data pertaining to student academic achievement became more readily available because of state and federal mandated testing.

Limitations

This study served as an analysis of studies dealing with the relationship between school building condition and student achievement. For analytical purposes, the actual physical condition of the school building was measured by an instrument or survey tool designed to measure the overall condition of the school building, and student academic achievement was measured through 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 was believed the research community was provided a more accurate portrayal of the actual condition of school buildings.

By excluding all other variables, intense focus was devoted to compiling the findings of studies that include only the two variables of school building condition and student academic achievement. The aim was to determine whether a statement could be made about the findings of these studies regarding the influence of the physical environment, particularly the school building, on student learning without potential confusion caused by the inclusion of different variables.

Data Analysis

Four search strategies were implemented in an attempt to locate all research studies that dealt with the relationship between school facility condition and student academic achievement. First, related studies were discovered using the normative search engines available through the Virginia Tech Library. 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 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 several respected researchers 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. 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 peer reviewed journals or in unpublished dissertations from December 31, 1977 to January 31, 2017, (c) focused on public school facilities in the United States, (d) measured by the overall condition of the school by means of a building assessment instrument or survey completed by school personnel or professionals within the engineering or construction fields, and (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.

The purpose of all of the studies used in this analysis was the same. The researchers who completed the studies wanted to determine if there was a significant difference in academic test scores of students in school buildings assessed as being in either good or poor condition. This was an attempt to ascertain if the physical environment of the school building had an influence upon the academic performance of students. The basic methodology of all of the studies followed the same procedure. A population of school buildings was identified. Once identified, the school buildings were assessed by use of an instrument designed to identify the physical condition of the building. The assessment identified school buildings as being in either good or poor condition depending upon the final score of the assessment. The major buildings elements that determined if the building was in poor condition normally included poor Indoor Air Quality, lack of air conditioning, poor lighting, lack of noise abatement, science equipment that was either absent or not in good condition, poor student furniture, cleanliness of the building, and even graffiti. These building elements, and others, determined the condition of the building. The assessment of the building produced a total score for each building. Upon this basis the buildings were divided into two groups. Normally, the researcher would select the bottom and top quarter of the assessments to be the two groups of school buildings. Students in buildings assessed as being in poor condition were one identified group. The other group was the students in buildings assessed in good condition. The academic achievement test scores of the students in the two groups were compared by use of either multi-regression, a t-test, or some other statistical methodology. If a significant difference between the two sets of scores was evident, the researcher could report that the condition of the school building influenced the student achievement. In almost all studies the difference between the test scores of students in buildings assessed as being in either good or poor condition was 3-10 percentile points.

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, and/or (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, structural conditions, and cosmetic facility condition" (Cash, 1993, p. 12).

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, & 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).

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.

Within the early stages of this study, the researcher thoroughly reviewed all studies. This task required using a Research Review Template (Appendix A). 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 (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 significant difference between academic achievement of students in poor and good school buildings. (Research Question #1 – Sub-Question #4)
5) Average student population among studies where a significant difference was reported between academic achievement scores of the two groups of students. (Research Question #1 – Sub-Question #5)
6) Average student population among studies where no relationship was found between academic achievement of students in good or poor school buildings. (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 significant difference between academic achievement of students in school buildings assessed as in poor and good school condition. (Research Question #1 – Sub-Question #8)
9) Percentage breakdown of statistical analyses used among studies reporting no existence of a relationship between academic achievement scores of students in school buildings assessed as in poor or good condition. (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 significant difference between academic achievement of students in school buildings that were assessed as being in either poor or good condition. (Research Question #2)
14) Percent of synthesized studies indicating a significant difference between academic achievement scores among studies at the elementary school level (Kindergarten – Fifth Grade). (Research Question #2)
15) Percent of synthesized studies indicating a significant difference between student academic achievement among studies at the secondary school level (Sixth Grade – Twelfth Grade). (Research Question #2)

The study includes information organized and studied using the research review template (Appendix A) and the meta-matrix document (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.

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)

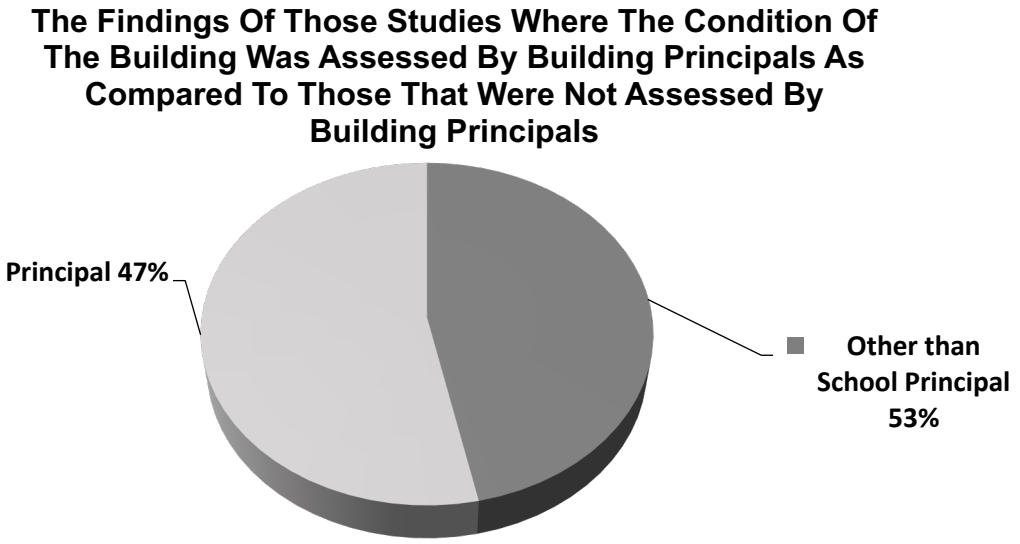

Figure 1. Building Assessment Personnel

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 central office personnel, teachers, architects, engineers, or a combination thereof to assess the overall condition of school facilities.

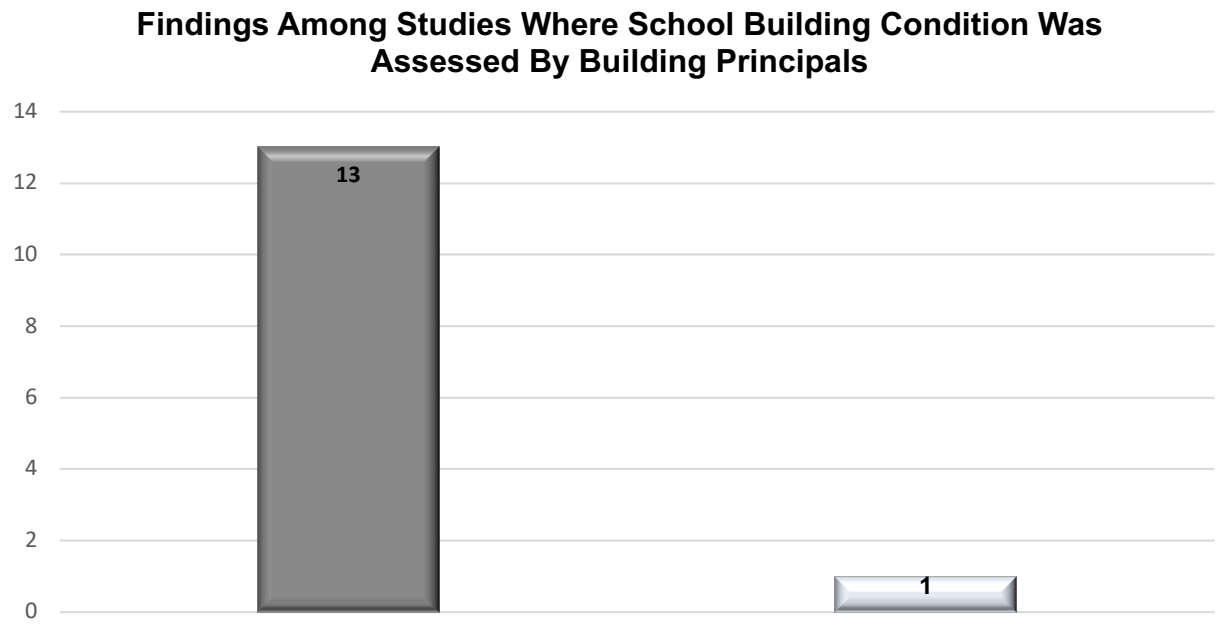

Figure 2. Findings among studies where school building condition was assessed by principals.

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 significant difference between the academic achievement tests of students in school buildings assessed as being in either poor or good condition. 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 significant difference in student achievement scores between the two groups of students are likely to be found.

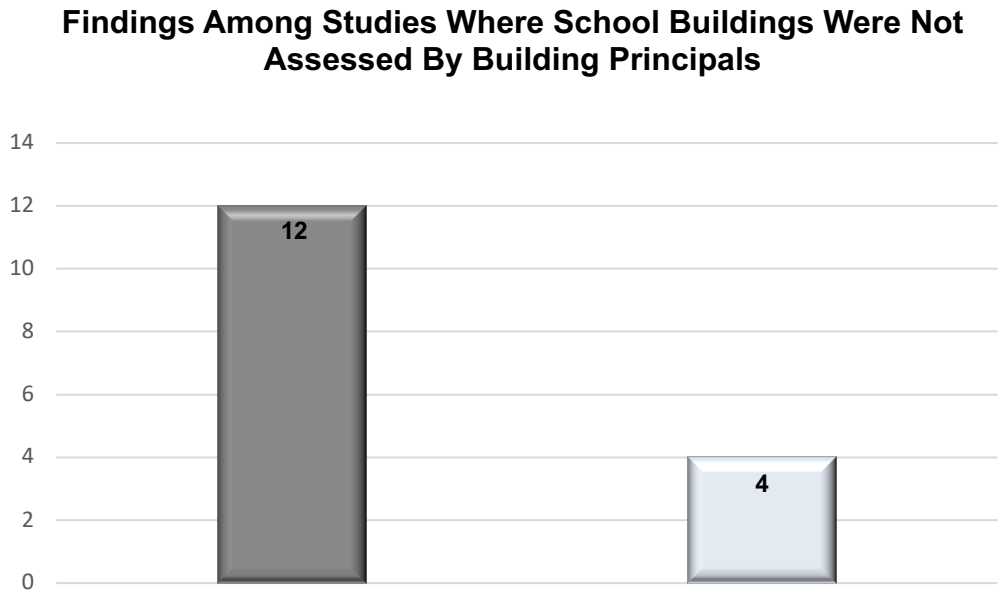

Figure 3. Findings from studies that did not use principals to assess the condition of schools

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%) 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 significant difference between academic achievement score of students in the two types of school building. The remaining 4 studies (25%) reported that no relationship existed between student academic achievement test scores. 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 significant difference between these two sets of student scores 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)

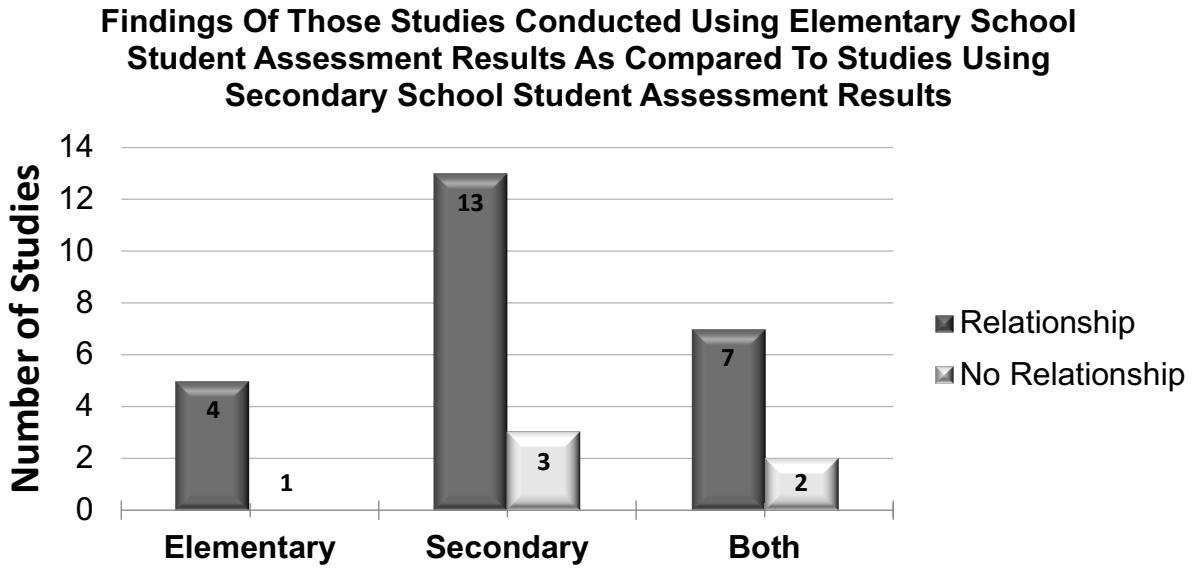

Figure 4. Comparison of results from elementary and secondary schools

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 student academic achievement test scores among elementary school students. Among these 5 studies, all but one (80%) resulted in a significant difference between academic achievement test scores of the two groups of students.

The majority of the studies that met the criteria for inclusion were conducted at the secondary level. This means that test data of secondary students were compared between the two groups of students. Out of the 16 studies conducted from data at the secondary level, 13 (81%) reported a significant difference between student academic achievement test results of the two groups of students.

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 significant difference between academic achievement of the two groups of students.

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)

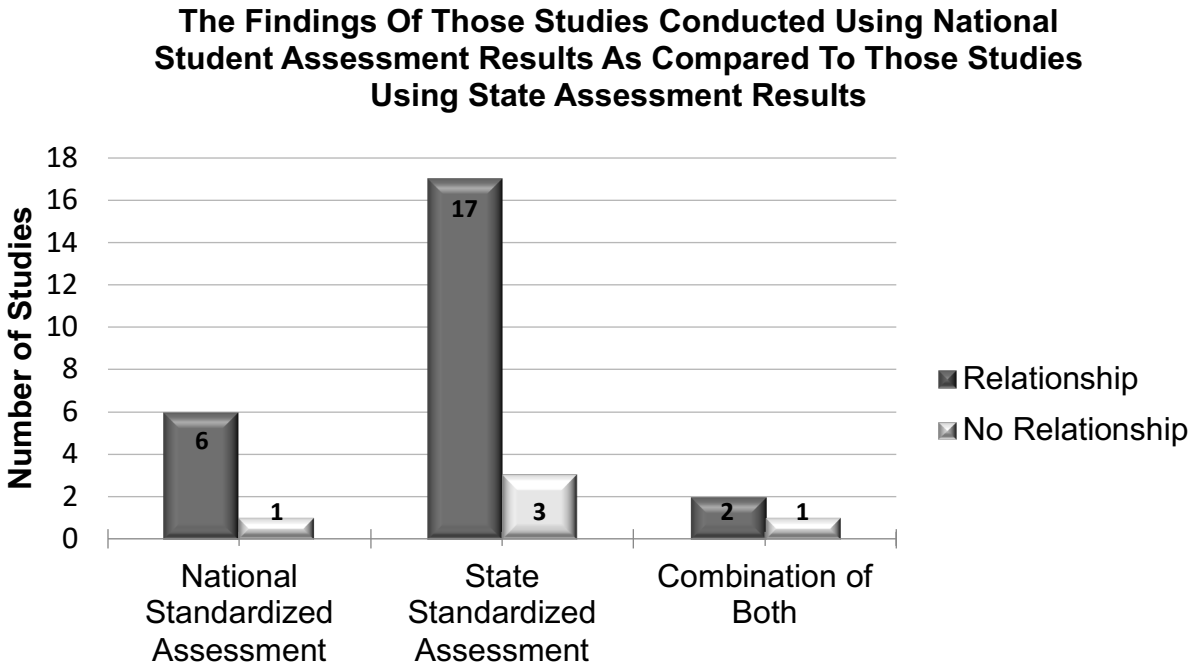

Figure 5. National standardized assessments and state standardized assessments

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 significant difference between academic achievement test results of the two groups of students.

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 significant difference between academic achievement test scores of the two groups of students.

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 significant difference between academic achievement test results of the two groups of students.

4) Percent of synthesized studies utilizing the CAPE or a hybrid thereof, reporting a significant difference between student academic achievement of students in school buildings assessed as being in either poor or good condition. (Research Question #1 – Sub-Question #4)

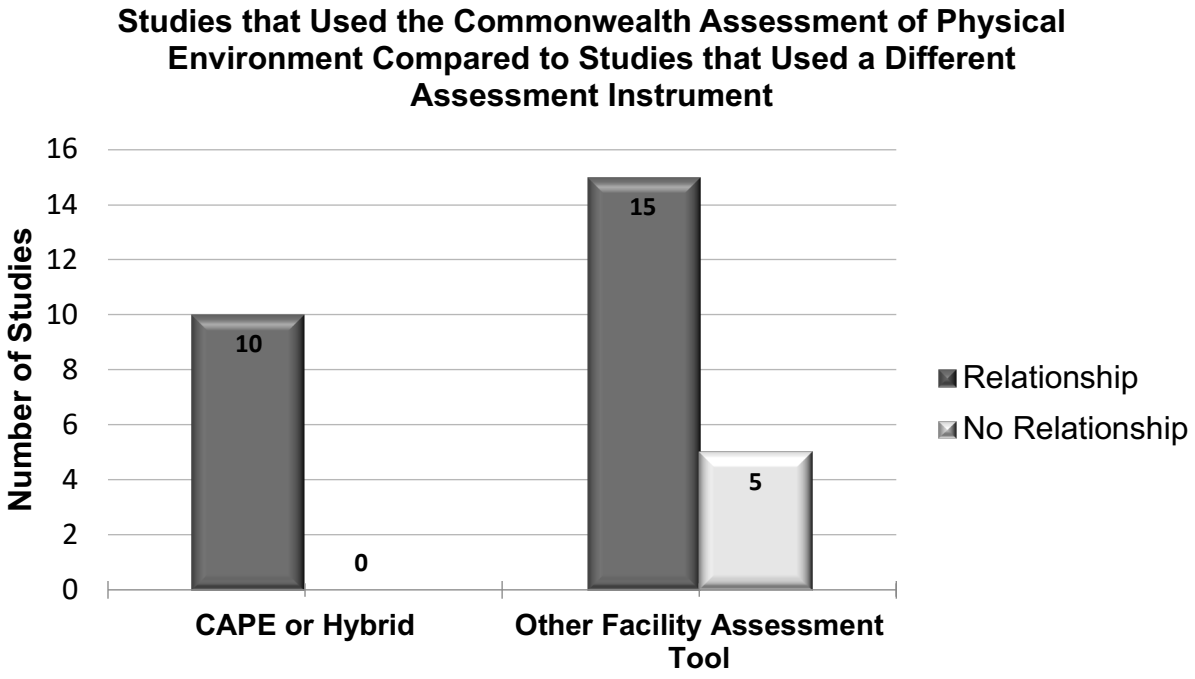

Figure 6. Facility assessment instruments

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 significant difference between 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 significant difference between the academic achievement of students in school buildings assessed as being in either poor or good condition results.

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 significant difference between the student academic achievement scores of the two groups of students.

5) Average student population among studies where a significant difference between student academic achievement of the two groups of students was found. (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, however, 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 building population among studies where a significant difference was reported between academic achievement test scores of the two groups of students?

Through a careful analysis of the 25 studies that reported a significant difference between student academic achievement of the two groups of students, 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 student academic achievement test scores of students in school buildings assessed as being in either poor or good condition. (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 academic achievement test scores of students in school building assessed as being in either poor or good condition?

Through a careful analysis of the 5 studies that reported no relationship between student academic achievement of the two groups of students, the total population of schools averages out to be approximately 106 schools. This average contains a combination of both elementary and secondary schools.

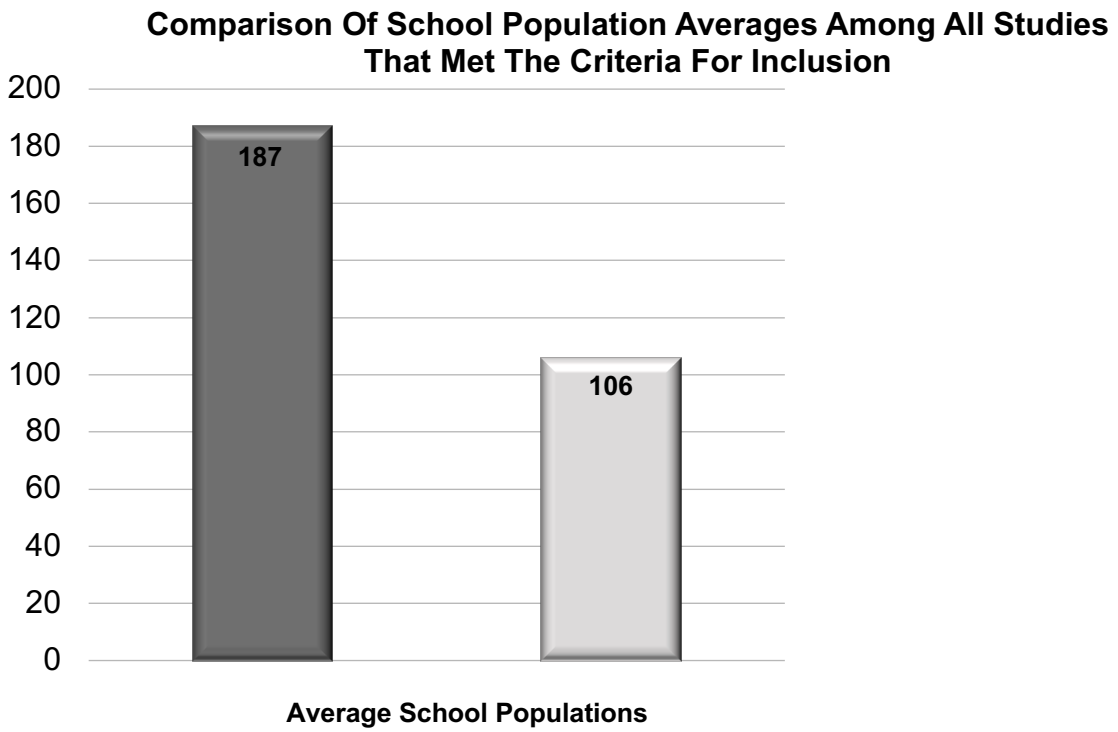

Figure 7. School population averages

Figure 7 offers a visual representation of the comparison of the average school populations among studies that reported a significant difference between the academic achievement test scores of the two groups of students to the average school populations among studies that reported no relationship. 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 academic achievement of the two groups of students 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)

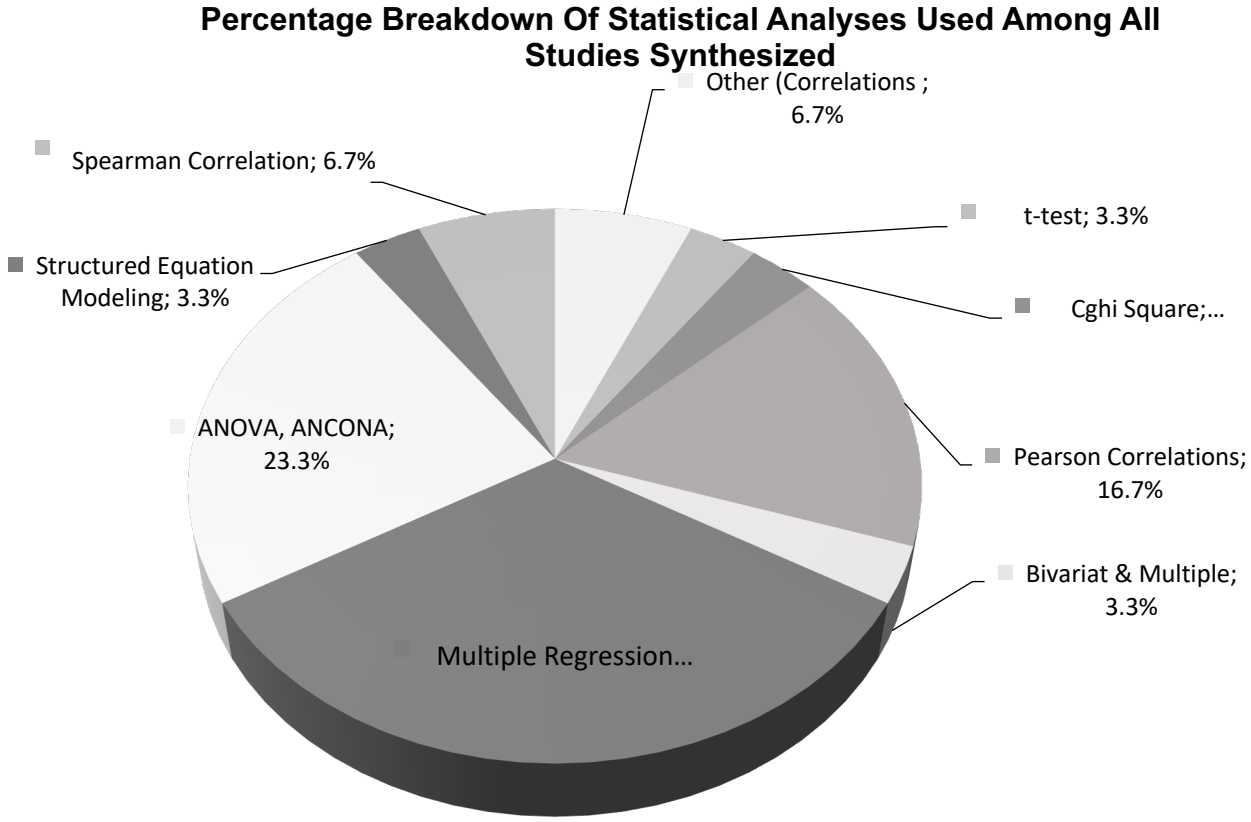

Figure 8. Statistical analyses used among all studies in the criteria for inclusion

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 the two sets of student achievement test scores. 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 or ANCOVA. This category of statistical measures represents 23.3% of the 30 synthesized studies.

8) Percentage breakdown of statistical analyses used among studies reporting a significant difference between academic achievement test scores of the two groups of students. (Research Question #1 – Sub-Question #8)

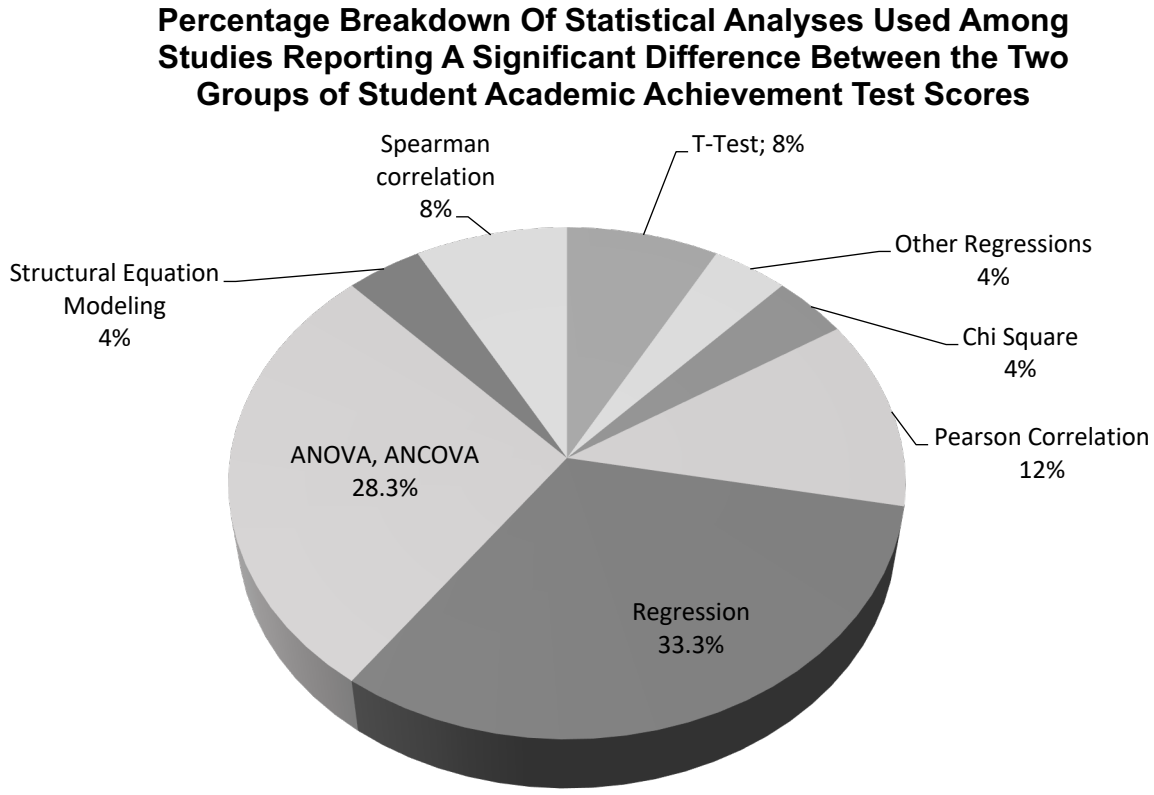

Figure 9. Statistical analyses among studies that met the criteria for inclusion reporting a significant difference between the academic achievement test scores of the two groups of students.

Figure 9 represents only those studies that reported a significant difference between student academic achievement of the two groups of students. Out of the 30 studies that met the criteria for inclusion, 25 studies (83.3%) reported a significant difference between student academic achievement of the two groups of students. Of these 25 studies, 8 studies (33.3%) used multiple regression analysis as the preferred statistical measure to investigate the relationship. The second most recognized statistical measure that resulted in a significant difference in test scores used a combination of either ANOVA or ANCOVA. Of the 25 studies that resulted in a significant difference between student academic achievement test scores, 7 studies (28.3%) fit this category.

9) Percentage breakdown of statistical analyses used among studies reporting no existence of a relationship between student academic achievement scores for students in school buildings assessed as being in either poor or good condition. (Research Question #1 – Sub-Question #9)

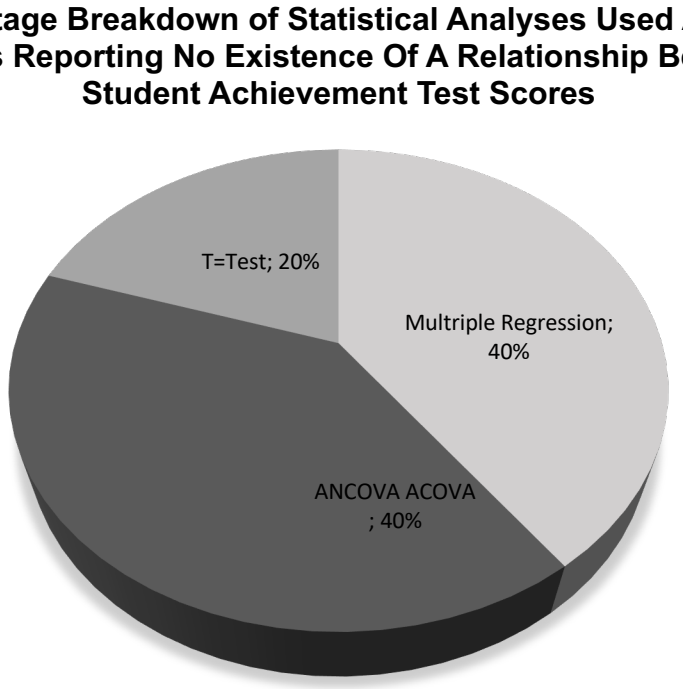

Figure 10. Statistical analyses among studies that met the criteria for inclusion reporting no significant difference in student scores

There were 5 out of 30 synthesized studies that reported no existence of a significant difference between the student academic achievement test scores of the two groups of students. 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)

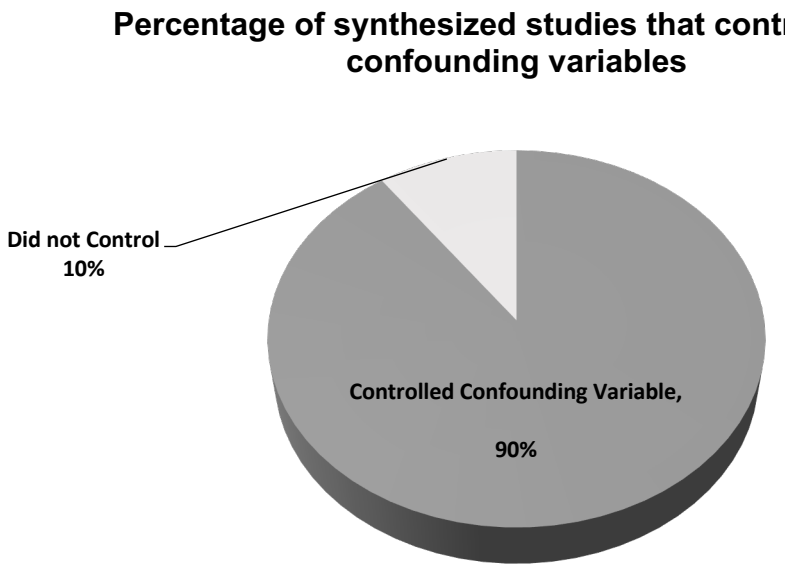

Figure 11. Confounding variables among all studies

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)

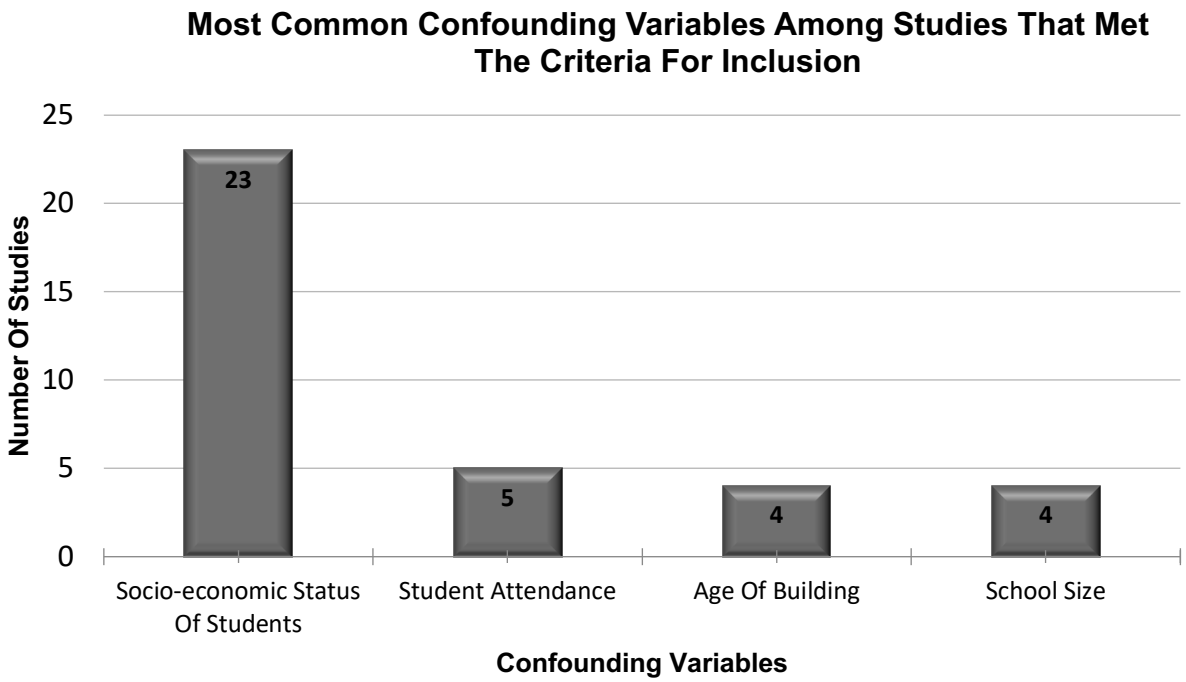

Figure 12. Most common confounding variables

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 a significant difference between academic achievement test scores of students enrolled in school buildings assessed as being in either poor or good condition. 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 academic achievement test scores 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). The Earthman, Cash and Van Berkum (1995) study also used a variation of the CAPE called the State Assessment of the Physical Environment and found similar results.

As Earthman and Lemasters (2010) 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 significant difference between academic achievement of students in school buildings assessed as being in either poor or good condition. (Research Question #2)

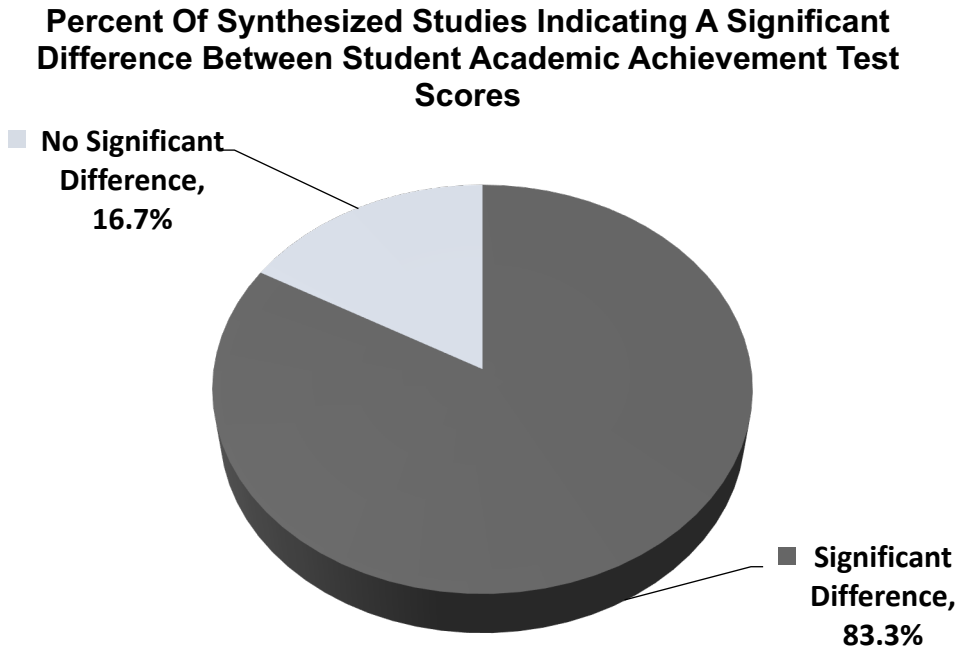

Figure 13. Comparison of all studies that met the criteria for inclusion

Figure 13 indicates that out of 30 studies conducted that met the criteria for inclusion, 25 studies (83.3%) reported a significant difference between student academic achievement. Additionally, Figure 13 also shows that 5 studies (16.7%) reported no relationship between student academic achievement of the two groups of students.

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

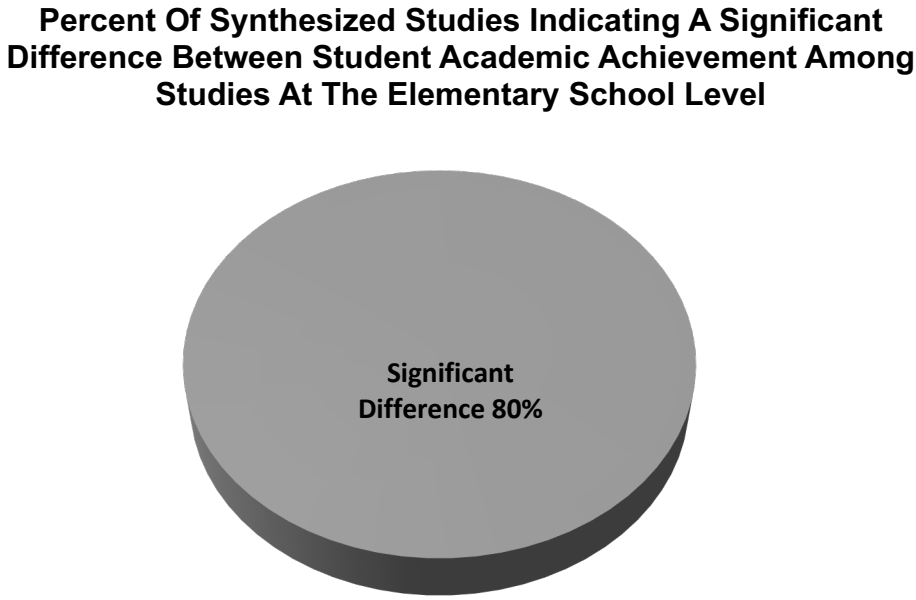

Figure 14. Findings from studies using data from elementary schools

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 student academic achievement of elementary school students, all but one study (8 0%) reported a significant difference between the two sets of academic test scores.

15) Percent of synthesized studies indicating a significant difference between academic achievement of students at the secondary school level (Sixth Grade – Twelfth Grade). (Research Question #2)

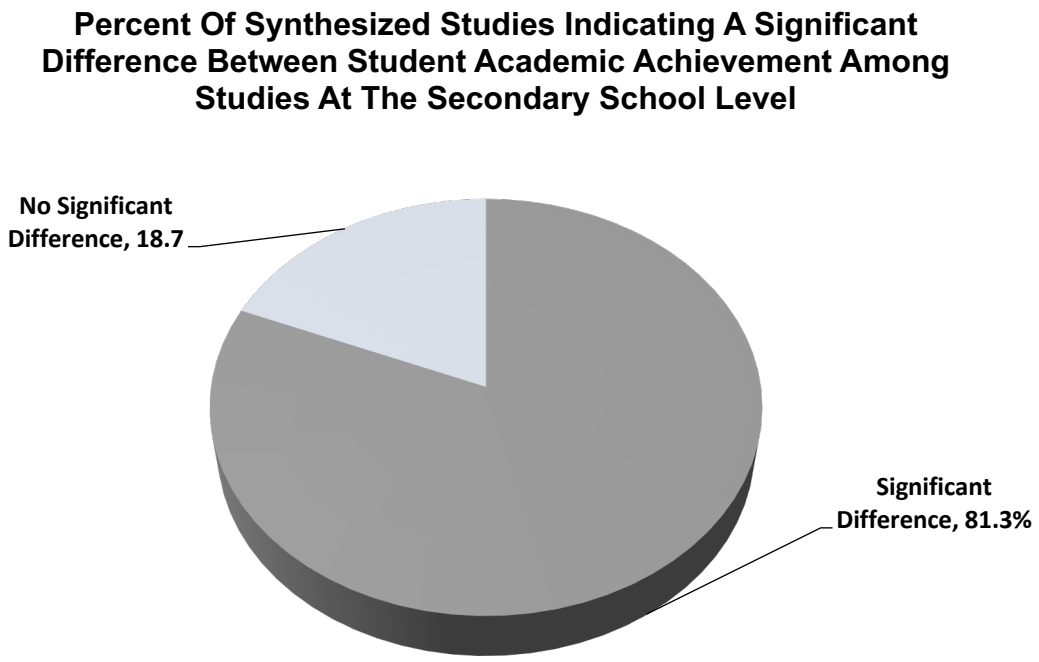

Figure 15. Findings from studies using data from secondary schools

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 academic achievement of secondary school students, 13 studies (81.3%) reported a significant difference between two sets of student data. It is interesting to note that the overwhelming majority of studies that found a significant difference between student achievement test scores were conducted using data from secondary schools. Out of the 25 studies where a significant difference in test scores was discovered, four studies investigated data solely from the elementary school level. Studies by Lanham (1999), Osborne (2007), Geier (2007), Duran-Narucki (2008) were all conducted using elementary school data and all utilized state standardized assessments to measure student academic achievement. Therefore, almost all studies conducted solely at the elementary school level, reported a significant difference between academic achievement. Brooks (2015) used data from elementary schools, but did not find a positive relationship between the two sets of data.

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 variable of academic achievement of students in school buildings assessed as being either poor or good condition, 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 (CAPE), or a hybrid thereof, is used to assess the overall condition of school facilities, and the results are used to identify students in buildings assessed as being in either poor or good condition, a significant difference is likely to exist.** In fact, out of 10 studies that utilized the CAPE, all studies reported a significant difference between the test scores of students in school building assessed as being either poor or good condition. 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.

2) **When school facility measurement instruments are completed by school building principals, it is likely that a significant difference exists between 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 significant difference between the academic achievement test scores of students in school buildings assessed as being in either poor or good condition**.**

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 but one study conducted using elementary school facility assessment results compared to elementary school student academic achievement results reported a significant difference between the two sets of student test data**

5) **Two noticeable differences can be observed among studies reporting that no significant difference exists between academic achievement score of students in school buildings assessed as being in either poor or good.**

    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 student academic achievement scores did so with school populations of less than 75 schools. The average school population among studies that discovered a significant difference 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 significant difference between the academic achievement of students in school buildings assessed as being in either poor or good condition.** This statement is based upon data collected from 30 studies that met 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 depends upon the intended purpose of the assessment. Roberts (2009) characterized 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, with a focus on the 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.

DISCUSSION

Many of the schools in the United States are not equipped to meet the basic needs of students, which includes the technological needs to maintain relevancy in the academic setting. The results of this meta-analytic synthesis provide 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 as important as other school problems. 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 significant difference between the academic achievement scores of students in school buildings assessed as being in either poor or good condition. After careful 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.

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APPENDIX A

RESEARCH 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 a significant difference or No Significant Difference Between Student Achievement Test Scores
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

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

AUTHOR BIOGRAPHIES

Dr. Chris D. Hewitt is Dean of Christiansburg High School in Montgomery County Public Schools in Virginia. He formerly was an elementary school principal in the Floyd county Public Schools.

Dr. Glen I. Earthman possesses forty years' experience in the field of education at all levels and thirty years of specialized experience in the educational facilities planning arena at Virginia Polytechnic Institute and State University. He has authored six books on the subject of educational facilities and served as the first Director of the National Clearinghouse for Educational Facilities. He continues a schedule of teaching and research in the field of school facilities specializing in the relationship between school building condition and student achievement and student and teacher attitudes.

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