The Relationship Between School Building Condition and Student Achievement: A Critical Examination of the Literature

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Abstract

Research has produced a corpus of studies dealing with the relationship between school building condition and student achievement while reporting positive results. Yet, other studies have been completed that report no significant difference in achievement scores from students in buildings in poor and good condition. The differences in research findings may lie in the methodology employed. The most important difference is in how the building is assessed and the instrument utilized. An instrument that reports those building elements that have a direct research tie to student performance provides more accurate data on the actual learning condition of a school building, resulting in more significant findings.

INTRODUCTION

At a recent meeting of the Technical Writers Group of the new Educational Facilities Clearinghouse, the conversation eventually turned to the discussion of the relationship between school building conditions and student performance. The group seemed to be knowledgeable about the research that had been conducted investigating this possible relationship and agreed that there was evidence to indicate there was a positive correlation. This would mean that students in buildings rated as being in poor condition do not perform on standard measures of performance as well as students in buildings rated as being in good condition. One of the members, however, asked if there was a definitive statement to that effect, in which people could believe and understand. In other words, is there a statement that would, without any doubt, inform the reader that school buildings do influence student learning? The exact definition of a definitive statement was not asked, but the individual was told by the group that there was sufficient research evidence that school building conditions do in fact influence student performance.

It is probably a matter of personal preference, more than anything else, as to whether or not an individual accepts research findings as being illustrative of knowledge. Obviously, some people do not accept that research findings lead to knowledge, especially when a personal bias is evident. Nevertheless, research in all areas of human endeavor shed light on possible relationships, which eventually leads to a theory and an eventual knowledge base.

In most instances, a review of research, a synthesis of research, a meta-analysis of research findings, or even a meta analytic synthesis of research could be used to produce a definitive statement and/or highlight valid research results. At the very least, such efforts could produce conclusive statements and provide some basic knowledge of the subject area. Action or beliefs based upon such syntheses of findings occur through a secure foundation of knowledge. In the case of research on the subject of the relationship between school building conditions and student achievement, a corpus of studies have been completed in the past.

RESEARCH SYNTHESIS

This article reviews the differences in research findings in studies that examine the same phenomenon and ascertains why researchers have developed different conclusions, given the same basic methodology used across studies. For instance, some researchers who have examined the relationship between school building condition and student achievement have found significant differences in achievement scores of students in school buildings rated as being in good and poor condition, whereas other researchers have not found such differences. This brings the methodology used for these particular studies into question. If the premise of the study is to find out if the condition of the building influences student performance, then a measurement of both the condition of the school building and the achievement of the students in that building has to be made. Statistical analysis of the data generated by such measurements must be completed to determine if there are any differences. If the statistical analysis of the data produces differing results, there must be some reason for this, and it might well be in the source of the data utilized, the data that is gathered, and/or in the method(s) used in treating the data.

The synthesis of research findings in the area of school facilities began in the late 1970's when Weinstein (1979) reviewed completed research on school facilities. Her review of research covered a broad range of subjects relating to school facilities. The studies she included in her review, which were concerned with the relationship between facility conditions and student achievement, were limited due to a lack of available research during that time period. In the early 1980's, McGuffey (1982) reviewed a body of research in the same general knowledge area. He reviewed a total of 98 research studies, some of which dealt with the influence of classroom environments on student behavior, attitudes, and achievement. McGuffey's analysis of these studies led to the finding that certain elements of a building do influence student achievement. For instance, he found that, a "lack of proper control of the thermal environment results in inefficient [student] work patterns and discipline problems" (McGuffey, p. 285). His conclusion, which was based upon existing research, was that obsolete and inadequate facilities detract from student learning and that modern and efficient facilities enhance student performance (p. 287).

More recently, Lemasters (1997) worked to synthesize research findings in a way that supported McGuffey's work. Lemasters reviewed over 100 studies covering the years 1982 to 1997 to identify a pool of studies that addressed the relationship between school building condition and student achievement. This research was unique in that all of the studies included in the analysis dealt with the specific relationship between facility conditions and student achievement / behavior. Out of the 100 studies, Lemasters chose 53 studies that addressed the specific relationship. She included those studies that specifically dealt with the relationship between school building conditions and student / teacher health and productivity. A highlight of Lemasters' work is that she limited the studies analyzed to those that specifically dealt with the possible relationship between school building conditions and student achievement / behavior. This was a different approach taken - examining a more specific area of research within the general area of school facilities research. Lemasters' findings were more precise than the findings in the two previous reviews of research in that she had a pool of studies that dealt with a specific topic. She concluded that school facilities indeed have an influence upon student achievement. The majority of the studies analyzed reported significant differences in student scores when the students were housed in either adequate or inadequate school buildings. Students in inadequate buildings did not perform as well as students in adequate buildings, especially in math and English achievement tests.

A more recent review of research by Bailey (2009) sheds additional light on the relationship between student / teacher health and performance and school buildings. This research supported the research of Lemasters (1997) and other previous work (Weinstein, 1979; McGuffey, 1982). Bailey (2009) analyzed studies on the same relationship between school building condition and student achievement between the years 1997 and 2008. Bailey reviewed 157 separate studies and selected 54 studies for analysis, which specifically considered the relationship between building condition and student achievement. Bailey asserted that the sum of the reviewed research indicated that a positive relationship exists between the condition of the school and the health and performance of students and teachers. This relationship was expressed in the difference in achievement scores of students in buildings assessed as being in either good or poor condition. The difference in student scores ranged from 3% to 17% (Edwards, 1993; Cash, 1993; Earthman, Cash & Van Berkum, 1996; Hines, 1996; Phillips, 1997; Lanham, 1999; Crook, 2006; Bullock, 2007, O'Sullivan, 2006; Fuselier, 2008; Taylor, 2009).

RESEARCH FINDINGS

The four research reviews that have been mentioned are important because the relevant research on this topic is compiled systematically and presented in a utilitarian form for other researchers and practitioners to use. Further, these studies are the only recognized studies that have reviewed research findings regarding the field of school facilities. The findings of the latter two researchers reflect a change in emphasis of research from the more generalized approach to an investigation of a specific topic or area of study within the general area of school facility research. The Weinstein (1979) and McGuffey (1982) studies addressed research studies in the general area of school facilities and, as part of that body of research, looked at a limited number of studies that addressed the relationship between school building conditions and student achievement. Lemasters (1997) and Bailey (2009) reviewed studies that mainly addressed that very relationship. These two research reviews highlight a trail of evidence that supports the notion that there is a measurable relationship between the condition of a school building and the health and productivity of students and teachers. Evidence of this relationship has progressed through each additional research review that has been conducted.

Still, doubts exist about the influence the condition of a school building may have upon student / teacher health and performance. In a meta-analytical synthesis of research studies dealing with the relationship between school building condition and student achievement, Stewart (2014) reviewed 42 studies and found only 38% of the studies (16) dealt with that relationship and reported a relationship that was significant in differences between student scores. But Stewart further reported:

> There was a positive relationship between the independent variable of building condition and the dependent variable student learning in 50% of the analyses found in the studies included in this meta-analysis. The researcher identified 16 specific analyses on the association between these two variables in the 42 studies that constituted the data set. Of these 16 analyses, eight revealed a positive relationship. Among the remaining analyses, six (38%) revealed no relationship between building condition while two of the analyses (12%) actually reported an inverse relationship (e.g. students in substandard buildings experienced higher achievement than students in standard or above standard buildings). It can be concluded that this meta-analysis suggests a weak association between building conditions and student learning (p. 56).

While this analysis of studies is correct, simply counting the number of studies that showed a significant relationship and comparing that number with the number of studies that did not report a significant relationship is not precise or revealing, especially when the researcher included only a limited number of studies. The number of studies that are available that actually deal with the relationship between school building conditions and student performance is far greater than the 42 studies in the data set that Stewart included and the further limited analysis of 16 studies done in the study. A simple review of the resources of any of the four major

clearinghouses on educational facilities or other reliable sources will reveal a much larger number of studies completed on this subject.

Yet the 50% of studies reported by Stewart (2014) that did not reveal a significant difference in student scores causes some people to believe there might not be a relationship between the two variables, or at very best, a weak association. In essence, these studies tend to make readers believe that the physical environment does not have any influence upon student health or performance or else they cannot find a difference in student scores. When such studies report that there is no relationship between school building condition and student achievement, readers tend to believe what they read or at least doubt existing research that report the reverse. The studies reporting no evidence of differences in scores are completed by competent researchers using exact methodology to obtain their findings (O'Neill, 2000; Lewis, 2001; Picus, Marion, Calvo & Glenn, 2005). As a result, the reader gives credence to what the researcher reports. The Picus et al. (2005) study is an example of a well-executed investigation that did not show a significant relationship between the academic scores of students in school buildings with ratings as being in either good or poor condition. Although not necessarily identified as such, it is surmised by some researchers that methodological differences in the studies that do not report any significant difference in student scores and those that do demonstrate a difference in student scores might be the reason for not finding any significant differences in student scores when they are enrolled in school buildings assessed as being in either good or poor condition.

Building Assessment Instruments

One interesting finding that Bailey (2009) identified was that the researchers who utilized a building assessment instrument that was designed to evaluate those building conditions that were directly related to student achievement found higher differences in student test scores between the two groups of students than in the studies where a maintenance or engineering type of evaluative instrument was used to assess the school building condition.

In many research studies, the condition of a school building is determined by using an engineering or maintenance type of assessment scale. These technical or engineering evaluation tools measure all parts of the building to determine what building components or items need to be repaired to keep the building in good condition. These instruments provide data on the condition of various parts or components of the building, which in turn, can be listed on a maintenance schedule for remedy. A large majority of the items needing repair or replacement identified in such instruments do not necessarily relate to student learning, or, at least there is no research to indicate that these items have a bearing or influence on student learning.

For example, the worn carpeting in the classroom that needs replacing does not have a direct affect upon the academic achievement of students. At least there is no research to indicate such is the case. Other maintenance items, such as the broken door latch, the window that needs replacing, and the chalkboard or whiteboard that is worn or not working does not have a direct influence upon the performance of students and teachers (at least there is no research to indicate this). Yet, such items may be given equal weight in the final score for the building – the same weight as the control of the thermal environment in the classroom, proper lighting, and daylight within the classroom. But the latter building features have a corpus of research to back up the

claim that these building features or elements indeed directly influence the performance of students and teachers (Lowe, 1990; Schneider, 2003; Earthman, 2004).

In measuring the condition of the school building when the physical condition of the building is being compared to student / teacher health and performance, there needs to be a direct tie to that relationship. Superfluous building maintenance needs that do not directly relate to student achievement tend to marginalize those building components that do have a direct relationship. Therefore, researchers that use such maintenance instruments may not be able to find a difference in student scores because the items of comparison do not directly relate to student and teacher health and performance. Roberts (2013) calls these assessment instruments engineering-based evaluation instruments. Roberts suggests that such types of instruments, while useful for the maintenance program, do not provide the necessary data needed to determine if the building condition has an influence upon student performance. In contrast, Roberts identified building evaluation instruments that are designed to evaluate those building components and elements that do influence student learning as mission-based instruments (2013). He further suggested that a mission-based instrument should be employed when conducting a study on how school building conditions influence student achievement. The maintenance or engineering based instruments Roberts referred to include the Council of Educational Facility Planners, International (CEFPI) Guide to the Evaluation of School Buildings (CEFPI, 1998); The Effective Learning Environment Assessment, (Dorris, 2011); and the Facility Condition Index (FCI) (Roberts, 2013). These instruments are designed for purposes other than research regarding how the school building influences student performance and behavior. Therefore, to use such instruments for research purposes is not in line with proper research protocol.

To further put into question the effectiveness of using an educator's type of assessment instrument, Roberts (2009) measured the quality of school buildings using two different types of assessment instruments in the school divisions of Canada. He established the Quality of Teaching and Learning Environment Scale (QTLE) based upon those factors that directly relate to the educational efficiency of school buildings. He measured school divisions in Canada based upon the QTLE and then used both an engineering and educators' assessment instrument to measure the same buildings. He found that the engineering assessment instrument did not directly relate to the quality of the teaching and learning environment of a school. He did find a relationship between the educators' assessment instrument and the quality of the teaching and learning environment of a school building. Roberts reasoned there is little evidence supporting the idea that an engineering building assessment instrument can adequately assess the educational usefulness of school buildings, especially for research purposes.

School Building Categorization

Another reason for not finding a relationship between building condition and student achievement might reside in how the researchers establish the school building populations for comparison purposes. Normally, the achievement test scores of students in buildings assessed as being in poor condition are compared with test scores of students in satisfactory schools to determine any significant differences. Therefore, all of the school buildings in the population need to be assessed to determine their condition, as far as being either good or poor. The school buildings assessed in each study normally contain a numerical score that is assigned to each

building as a result of the rating instrument. This might be a composite score of the assessment instrument or a summative score of the condition of the school building. The score of each building is then arrayed in an ordinal scale numbering from 0 to 100 or whatever the top number is. The assessment rating number of each school building is normally a rank ordinal number in a scale. The building numbers are the key to determining good and poor buildings for determining the two groups of schools to be used in the analysis of student scores. The researcher must then divide the schools in the list into two categories depending upon the score of the building. This determines whether the building is considered in poor or good condition. This presents a problem for the researcher as to where to draw the line between the two types of buildings. By dividing the group of school buildings into two equal parts, bottom and top, there might not be enough of a difference in building condition to produce significant differences in student scores. There is undoubtedly very little difference in the condition of a building that is numbered 49 and a building that is numbered 50 on an ordinal scale.

There might, however, be a difference in the condition of buildings that are listed in the top quartile and the bottom quartile of the pool. This difference might produce more of a significant difference in student scores than if the researcher used the top half of all school buildings in the list and compared the student scores with the student scores in the bottom half of the total number of school buildings. In other words, comparing the scores of students in similar buildings might not produce the same results as comparing scores of students in dissimilar school buildings. The gradation of the condition of the schools in the middle portion of the list of buildings might be too similar to produce fruitful results. Some researchers do not report how the school building population is divided for comparison purposes. In these cases, it is difficult to determine what the researcher was using to develop dissimilar groups of school buildings for comparison purposes. But the method of division might be an explainable reason some researchers do not find any significant differences in student scores.

Building Assessment Responsibility

The third methodological variation might be in the individual who assesses the school building. In some of the recent studies the researchers have used superintendents, maintenance directors, engineers, or outside consultants to evaluate a building for educational worthiness. Picus et al. (2005) used the superintendent of schools to determine the educational value of the school buildings in his study plus outside consultants to assess the building using a maintenance needs instrument. Research has indicated the principal is probably the most knowledgeable person about the real condition of the building. Brannon (2000) found that the knowledge principals had about the condition of the school building far exceeded that of anyone else in the school system, including the superintendent. In Brannon's study, the superintendent of schools, director of maintenance, an outside consultant, and the principal of the school building each assessed the condition of the school building. The results of these data sources were compared with an independent educational consultant assessment of the building. The assessments of the principals correlated highly with the assessments of the independent educational consultant to a greater degree than the rest of the individuals. Principals of a school building are knowledgeable about the condition of the school building because they live within it each day.

In addition, Cash (1993) and Hines (1996) used a system of double rating of the building by the principal and the researcher. They found a very high inter-rater agreement on the items contained in the Commonwealth Assessment of Physical Environments (CAPE). This gives credence to the practice of having principals rate their buildings using the CAPE. These educators seem to realize the importance of those building elements or components that make a difference in student learning better than anyone else and can know if the building element or feature is present or absent. The results of studies in which a school principal has provided the assessment with an instrument that is related to research on student achievement have resulted in much more productive findings than studies where an outside evaluator or superintendent has been employed to evaluate the school buildings. Bailey (2009) reported as much in his synthesis of research studies related to building condition and student performance.

Student Achievement Scores

The fourth reason some of the latter research on school building condition and student performance has not been able to report a significant relationship or have found a diminished difference between student academic scores might be the use of a percentage of students passing a performance assessment or standardized test. The studies that showed the most robust difference in student achievement scores were completed in the decade 1990-2000. Such studies as Edwards (1993), Cash (1993), Hines (1996), and Earthman et al. (1996) indicated differences of student scores from 3% to over 10%. Whereas other studies, such as O'Neill (2000), Crook (2006), and Bullock (2009), which were completed in the next decade after the passage of the 2001 No Child Left Behind Act (NCLB), indicated a smaller difference in student scores. The reason for these diminished differences in student scores may be the result of the change in reporting student scores. Additionally, many of the tests are directly aligned to the state curriculum and the teaching/learning is more intentionally focused on the test, which may influence results of comparison.

The percent of students passing is a gross measure that does not accurately measure student achievement as such. Rather, it is simply a measure indicating how many students achieved a certain score on the assessment instrument. In addition, some states permit students to re-take the examination or assessment if they do not pass it on the first administration. Of course, this practice is very sound educationally, because the student is given repeated opportunities to achieve a passing score. Such practices, however, do not provide accurate data for the researcher, but on the contrary, produces contaminated data for the researcher. Some students score well above the passing mark on the assessment instrument, and other students just meet the passing mark, yet all are considered as passing the examination at the minimal level. Such test reporting practices may represent sound pedagogical practice, but do not provide the researcher with data that can be precisely compared.

The good measure for judging student performance is the actual score of students on a standardized achievement test that is norm referenced. Such scores are normally given for each sub-test of the instrument and a composite score is provided for the entire instrument. As can be seen, the percent of students passing an examination does not provide an accurate measure in comparison to actual student scores on a standardized test. Researchers often have to be content, however, with using the percent of students passing as a measure of achievement for the entire

school because the school system may not publish other data. Some of the research studies that have been completed in the latter part of the past decade have used the percent of students passing as the measure of achievement because that is the only student achievement measure available (Crook, 2006; Bullock, 2007) Such studies have found a difference in the percent of students passing when comparing student achievement in schools assessed as being in either poor or good condition, but the differences have diminished in comparison to research findings prior to 1997. Using the percent of students passing may contribute to the diminishing differences in student achievement scores and result in finding no statistically significant difference among schools.

Uniform Student Achievement Measures

In almost every research study that has examined the relationship between the school building condition and student academic achievement, there has been a recommendation to conduct a study dealing with this subject on a regional or national level. While this may be necessary, there is a seemingly insurmountable problem in implementing such a study. Since the enactment of NCLB in 2001, states have been required to implement a statewide student assessment program to qualify for federal funds. This has resulted in each state either formulating a new assessment system or at least unifying an assessment program that is statewide to measure the progress of every student. This has resulted in almost 50 different assessments that measure student progress in the states. With a plethora of measures reported, the researcher has a problem in compiling comparable data from each state. Some studies have been able to use the results of the National Assessment of Educational Programs (NAEP) as a measure of student achievement. The NAEP samples students across the nation and the results represent the sample rather than the complete population. Nevertheless, this data sample serves as a viable substitute for a complete data set of the entire student population.

Statistical Procedures

For the most part, the studies dealing with the relationship between school building condition or age and student achievement have used the same statistical analysis procedures. The process includes identifying the independent variable, which is the condition of the school building or the age of the structure. An analysis of the condition of the school building is obtained through an assessment instrument, which may vary from study to study.

The dependent variable is either student performance or particular academic outcomes. The measuring devices vary considerably from nationally normed instruments to state normed instruments, and in some cases, teacher grades. The measurements can be supported through student attendance data. For example, in a study comparing school building condition with student attendance and student achievement in New York City, Duran-Nurwicki (2008) found a high correlation between the two dependent variables. In addition, she found a statistically significant difference with both student attendance and achievement in buildings that were in good and poor condition. This indicated that the attendance rate could be a predictable substitute for student achievement. The rationale is that students learn while attending school and do not learn when absent.

Normally, in studies dealing with the relationship between building condition and student achievement, the dependent variable of student scores on academic measures are compared using either a t-test of independent samples or an ANOVA to determine significant differences in scores of students enrolled in good or poor school buildings. These two statistical procedures seem to be the appropriate ones to use where two variables are compared to one another (Roval, Baker, Ponton, 2013). In at least one study, the researcher used a different method of comparing scores and could not find a significant difference in student scores (Lewis, 2001).

In studies dealing with the relationship between school building condition and student academic achievement that have not controlled for such confounding variables as student minority status, percent of students in poverty, quality of the teaching staff, community factors or similar variables, the findings have been slightly different. The findings of studies that did not control confounding variables are not considered as robust as the findings of studies that did control confounding variables. Nevertheless, many of these studies found significant differences in student achievement scores.

If the preponderance of the studies dealing with the relationship between school building conditions and student achievement have used the same or similar statistical methodology to determine differences in student scores, it would seem that the statistical methodology does not contribute to differences in research findings of studies that did and did not find a significant relationship in student scores. Something other than the statistical methodology would be the contributing factor. This factor could well be in the manner in which the school building is assessed and categorized.

Size of Findings

Some researchers have suggested that the differences between student achievement scores of students in good and poor buildings is insignificant. The findings of many researchers range from 3% to 17%. Even accounting for the outliers, many researchers (Edwards, 1993; Cash, 1993; Earthman et al., 1996; Hines, 1996; Lanham, 1999; Crook, 2006; O'Sullivan, 2006; Bullock; 2007; Taylor, 2009) have found differences ranging from 5% to 10%. Although these differences may seem small when compared to the overall variances by which student learn, one must realize that the school system can account for only a small percent of the variance. Berliner (2010) suggested the school can account for only about 20% of the variance in student achievement, while the parents, community, and other out-of-school factors account for more than 60% of the total variance (Berliner, 2010). If one accepts this ratio of variance, then the 5-10% variance accounted for by the building condition seems to be much more significant than initially thought. The 20% variance that can be attributed to the school accounts for not only school buildings, but also teacher quality and turnover, the financial stability of the school system, and the availability of a constellation of school programs and services for students.

Of course, the school building condition is something school authorities are responsible for and can improve. The 60% variance attributed to the family and community is almost impossible to modify by the school organization. The school system does not have much control over the 60% variance contributed by the parents, home environment, and the community in which the student lives. When all of the school related variances in student learning are

considered, perhaps 5%-10% of the student variances schools can account for seem more important.

In addition, the measures of differences in student scores that are reported in various research studies are simply a snap-shot of one year. When students spend more than one year in a school building rated as being in poor condition, the effect of the school building condition can be multiplied by every year. It is virtually impossible to measure the influence a school building in poor condition has upon students over a period of years because of the movement and maturation of students and possible changes in the building. Nevertheless, it can be assumed that the influence is cumulative.

SUMMARY

Human beings instinctively believe that the physical environment influences their behavior as well as their thinking. A building's physical structure can especially influence those residing within the building. As Hartenberger (2011) noted, Winston Churchill is reported to have said, "We shape our buildings; thereafter they shape us." However, trying to measure how our buildings influence their users is very difficult. Perhaps the reason is that the available data for researchers is variable and limited. This problem area illuminates the difficulty with social science research, which is less precise than the hard sciences. How individuals perceive the physical environment is both personal and malleable in nature. Yet, respectable research has indicated the condition of a school building can influence the performance of students and teachers. Both students and teachers spend significant time within the school building, and because of that, the building can be influential. In addition, students are young and impressionable, and therefore, the influence may be more pronounced.

For many decades, researchers have investigated the possible relationship between school building conditions and student and teacher health and productivity. A significant number of researchers have found a statistically significant difference in student achievement scores between students in buildings assessed as being in good and poor condition. These researchers report that there is a 3%-10% difference in student scores of students in buildings in good and poor condition. That percentage may seem small at the outset, but when compared with the variance in student learning that can be attributed to school influence, these percentages are of importance. At least these percentages represent an area in which school authorities have control.

There are some researchers who have not been able to find any significant difference in student scores when the students are enrolled in buildings assessed in good and poor condition. This does not mean there is no relationship between school building condition and student and teacher health and performance. It simply means that such data did not show any significant differences in student scores. The old saying that "absence of evidence is not necessarily evidence of absence" holds true in these cases (Burl, 2007, p.194).

The obvious reason for the difference in findings may reside in how data are gathered and treated in these various research studies. It would seem that methodological variations could explain why some researchers find significant difference in student scores in good and poor buildings while other researchers do not report any significant differences. These methodological differences may be found in a variety of data gathering instances. These differences seem to be related to how a school building is assessed, who assesses the school building, how the

researcher develops two pools of buildings that are in either good or poor condition, student achievement assessments, and the lack of uniformity in student assessments. These variations may not be exhaustive, but seem to explain why there are differences.

The use of an engineering-type instrument in assessing a school building for research purposes may not be the most appropriate, when considering other available research instruments. Assessment instruments that contain research-based items have produced more robust findings in comparison to engineering instruments. The reason given is that engineering-based instruments measure various elements that are not directly related to student learning, which may marginalize those items that do have a direct relationship on student learning.

The individual who does the actual assessment of a school building condition is very important for accurate data results. Research has indicated that the principal is the individual who has the most knowledge of the educational adequacy of a building. This has been demonstrated by research findings and high inter-rater reliability (in comparison to other assessors).

The division of the assessed school buildings into two groups for comparing student scores is crucial in obtaining significant differences. Research has indicated that comparisons of student scores in buildings in the top and bottom quartiles of the list of school buildings produces better results than by comparing the top and bottom half of the total school building population. There apparently is little difference in the condition of schools in the middle of the building pool.

Finally, student achievement scores used in comparing students varies considerably. Many of the state assessments are state normed and the results cannot be used effectively in a meta-analysis. Many states record only the percent of students passing as the measure of student success. This is a gross measure that does not accurately measure student achievement. Because some states report only the percent of passing students, the actual achievement of students is marginalized and merged towards the mean. In addition, all states now use a state adopted assessment instrument, which makes it difficult for researchers to develop a regional analysis of the national school population. All of this diminishes the rigor of research studies concerning the relationship between school building condition and student achievement.

All in all, the differences in methodology, as far as assessing school buildings, that occurs across studies regarding the relationship between school building conditions and student achievement do lead to diverse findings. The method of assessing the school building is probably the most important measure of the study and will determine its findings. It is inevitable that if a school building is assessed in a way that marginalizes the differences between those elements of the school buildings that previous research has found to have a direct influence upon student learning, the researcher will have difficulty in finding significant differences in student achievement scores.

There is an ethical side to the reporting of research findings that needs to be observed by all researchers. Data obtained in a research study can demonstrate a difference in student test scores. This would indicate that the independent variable might have an influence upon the dependent variable. Conversely, a researcher might find no difference in student achievement scores. This does not indicate there is no difference in the student test score, simply that the set off data utilized by the researcher did not show a difference. The researcher must than state that the data did not show a difference. However, the research cannot say with any certainty that there is no difference in student scores. To state that is going beyond what the data indicates.

The concern regarding a definitive statement still remains in the minds of some. Yet, there have been definitive statements in the latest reviews of research that have been conducted by Lemasters (1997) and Bailey (2009). These researchers analyzed the available research and found that the majority of studies reported differences in scores between students in school buildings assessed as being in either poor or good condition. The findings reported in these syntheses cannot be ignored. The fact of the matter is that the school building has been shown to influence student learning to a significant extent, and therefore, poses a problem for school authorities to consider and work to ameliorate.

References

Bailey, J. (2009). *A synthesis of studies pertaining to school building condition, student achievement, student behavior, and student attitudes.* Blacksburg, VA: Unpublished doctoral dissertation, Virginia Polytechnic Institute & State University.

Berliner, D. C. (2010). Effects of inequity and poverty vs. teachers and schooling on America's youth, *Teachers College Record*, accessed 10/13/14 http://www.record.org/PrintContent.asp?ContentID=16889.

Brannon, W. L. (2000). *A study of the relationship between school leadership and the condition of school buildings.* Blacksburg, VA: Unpublished doctoral dissertation. Virginia Polytechnic Institute and State University.

Bullock, C. (2007). *The relationship between building condition and student achievement in Virginia middle schools,* Blacksburg, VA: Unpublished doctoral dissertation. Virginia Polytechnic Institute and State University.

Burl, A. (2007). *Stonehenge*. New York, New York: Carroll and Graf Publishers.

Cash, C. S. (1993). *The relationship between school condition and student achievement and behavior.* Blacksburg, VA: Unpublished doctoral dissertation. Virginia Polytechnic Institute & State University.

Crook, J. R. (2006). *The relationship between the percentage of students' passing the Standards of Learning examinations and the condition of the educational facilities in the high schools in the Commonwealth of Virginia.* Blacksburg, VA: Unpublished doctoral dissertation. Virginia Polytechnic Institute & State University.

Dorris, D. (December 2011). The effective learning environment assessment: A validation tool for assessing educational facilities. *ACEF Journal*, 2(1), 79-101.

Duran-Narucki, V. (2008). "School building condition, school attendance, and academic achievement in New York City public schools: A mediation model, *Journal of Environmental Psychology*, 29, 278-286.

Earthman, G. I., Cash, C. S., & Van Berkum, D. (June, 1996). Student achievement and behavior and school building condition, *Journal of School Business Management*, *8*(3), 26-37.

Earthman, G. I. (2004). *Priortization of 31 criteria for an adequate school.* Baltimore, MD: American Civil Liberties Union of Maryland.

Edwards, M. (1993). Building conditions: Parental involvement and student achievement in the DC public school system, *Urban Education* 28(1), 6-39.

Fuselier, C. (2008). *A study of the relationship between selected school building facility components and student achievement in Pennsylvania middle schools.* Pittsburgh, PA: Unpublished doctoral dissertation. Duquesne University. Retrieved from: http://cdm256101.cdmhost.com/cdm4/document.php?CISOROOT=/p256101coll31&CISOPTR=3942&REC=1.

Guide to the Evaluation of School Buildings (1998). Scottsdale, AZ: Council of Educational Facility Planners, International.

Hartenberger, U. (2011). Why buildings matter. *The Guardian.* Retrieved From: https://www.theguardian.com/sustainable-business/sustainable-building

Hines, E. W. (1996). *Building condition and student achievement and behavior*, Blacksburg, VA: Unpublished doctoral dissertation. Virginia Polytechnic Institute & State University.

Lanham, J. W. (1999). *Relating building and classroom conditions to student achievement in Virginia's elementary schools*. Blacksburg, VA: Unpublished doctoral dissertation. Virginia Polytechnic Institute & State University.

Lemasters, L.K. (1997). *A synthesis of studies pertaining to facilities, student achievement, and student behavior*. Blacksburg, VA: Unpublished doctoral dissertation, Virginia Polytechnic Institute & State University.

Lewis, M. (2001). Where children learn: Facilities conditions and student test performance in Milwaukee public schools. *CEFPI Issue Trak*, 1-4. www.cefpi.org.

Lowe, J.M. (1990). *The interface between educational facilities and learning climate.* College Station, TX: Unpublished doctoral dissertation. Texas A&M University.

McGuffey, C.W. (1982). Facilities, In H. J. Walberg (ED) *Improving educational standards and productivity: The research basis for policy.* (pp. 237-288). Berkeley, CA: McCutchan.

No Child Left Behind (2001), (Public Law 107-110).

O'Neill, D. J. (2000). *The impact of school facilities on student achievement, behavior, attendance, and teacher turnover rate at selected Texas middle schools in Region XIII ESC*. Unpublished doctoral dissertation, Texas A&M University. Retrieved from Dissertations & Theses: Full Text database. (Publication No. AAT 9980195)

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

Phillips, R. W. (1997). *Educational facility age and the academic achievement and attendance of upper elementary school students.* Athens, GA: Unpublished doctoral dissertation, University of Georgia.

Picus, L. O., Mario, S. F., Calvo, N., & Glenn, W. J. (2005). Understanding the relationship between student achievement and the quality of educational facilities: Evidence from Wyoming, *Peabody Journal of Education*, 80(3), 71-95.

Roberts, L. W. (May, 2009). Measuring school facility condition: An illustration of the importance of purpose, *Journal of Educational Administration.* 47(3), 368-380.

Roberts, L. W., (July 11, 2013). *Do school facilities impact educational outcomes?* Vancouver, British Columbia: Supreme Court of British Columbia, Vancouver Registry, Matter No. S103975.

Roval, A.P., Baker, J.D., & Ponton, M.K. (2013). *Social science research design and statistics*, Virginia Beach, VA: Watertree Press.

Schneider, M. (2003). *Linking school facility conditions to teacher satisfaction and success*. Washington, DC: National Clearinghouse for Educational Facilities, http://www.edfacilitiesw.org/pubs.

Stewart, R. L. (2014). *A meta-analytical synthesis of studies on the effect that building conditons, building age, artificial lighting, and natural lighting in schools has on student learning and behavior.* Spokane, WA: Unpublished doctoral dissertation, George Fox University

Taylor, R. G. (2009). *School facilities in the nation's capital: An analysis of student achievement, attendance, and truancy*. Washington, DC: Unpublished doctoral dissertation, The George Washington University. 1-169.

Weinstein, C. S. (1979). The physical environment of the school: A review of the research, *Journal of Educational Research,* 49 (4) 577-610.

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