Relating Building and Classroom Conditions with Student Achievement in Virginia's Elementary Schools

CHAPTER 1 THE PROBLEM

Across the country, increased accountability for public education has emerged over the last decade as a central theme in both the educational and political arenas. Calls for higher standards of learning, more rigorous testing of the country's school children, and greater degrees of accountability for both teachers and administrators have been heard from the White House, Congress, governors' mansions, and state legislatures. In his 1998 State of the Union address, President Bill Clinton expressed his desire to raise standards, expectations, and accountability in the nation's elementary and secondary schools. At the same time, political leaders and public bodies have also focused on our nation's crumbling infrastructure, particularly the sorry state of many of the nation's schools. Members of Congress have requested extensive reports from the General Accounting Office to document the state of the nation's school facilities.

The high level of political and public attention focused on Virginia's system of public education in recent years has mirrored this national interest. Increased accountability, high standards, and rigorous assessment have all been focal points

of an extensive overhaul of the state's public school system that has garnered national acclaim. The physical environments of individual schools, however, did not initially merit the same degree of attention. Despite a 1992 legislative study that identified over $6 billion dollars in school construction and maintenance needs, state lawmakers continued to reduce funds for school maintenance as part of the state funding formula and failed to provide funding for construction and renovation. However, recent actions by the state legislature indicate a radical change in policy. The 1998 Virginia General Assembly made history by allocating state revenues for school renovation and construction to localities as part of a larger restructuring of state finances linked to the phasing out of the personal property tax. Over the next two fiscal years local school divisions will share $110 million in construction funds. Divisions will receive a base allocation of $200,000 in each year of the biennium, with the balance of the funds allocated based on the local composite index (LCI) and average daily membership (Stapleton, 1998).

The links between financial inputs, including school construction and maintenance expenses, and educational outputs, most often student achievement, have been extensively studied. The relationship between expenditures and achievement has been debated since the 1960s. Hanushek (1981) reviewed numerous studies and found little connection between expenditures and achievement. Greenwald, Hedges, and Laine (1994) reviewed the same data and did find a link between expenditures and achievement when specific expenditure

categories were isolated. Wenglinsky (1997) attributed the lack of a clear causal relationship to inconsistency in data analysis, the lack of a standard measure for student achievement, the failure to account for differential spending among geographic regions, and the lack of a specific, consistent definition of what per pupil expenditures actually entailed.

When looking specifically at the physical environment of schools as a financial input, results have also been mixed. Weinstein (1979) failed to find clear causal relationships between the physical learning environment and student achievement. However, recent studies have shown different results. Stockard and Mayberry (1992) noted that the specific physical environment of the school could influence student achievement and found a strong tie exists between the physical condition of school buildings and expenditures. In Virginia, both Cash (1993) and Hines (1996) concluded that secondary students in both rural and urban areas performed better in higher quality school buildings. Lemasters' (1997) meta-analysis of studies since 1980 identified specific aspects of the physical environment that had a positive effect on student achievement.

Purpose

The purpose of this study is to explore the relationship between student achievement and the physical condition of school buildings and specific classrooms in Virginia's elementary schools. If specific physical factors are

found to have significant influence on achievement, these results can be used by architects and school leaders as they plan the school construction and renovation programs currently being considered across the state. Decisions regarding infrastructure improvements and deferred maintenance issues based on this study might also lead decision makers to request additional budgetary support for these projects if they are found to play a positive role in student achievement.

Significance of Study

The role of the physical environment must be considered by Virginia educators as they approach this era of increased accountability. Recent researchers have noted changes in the perceived role of the physical environment in the learning process. There has been a gradual acceptance of the notion that the common-sense assumption that a “sense of place” does influence what goes on there. Identification of specific building and classroom factors that have a significant relationship to student achievement can help architects, facility planners, administrators, principals and teachers make improvements in instructional spaces that would help foster increased student learning and thus allow them to achieve higher scores on the new assessment instruments.

Recent studies in Virginia have examined both rural and urban secondary schools. A study of the elementary school environment has been identified in recent research as an area in need of further inquiry (Cash, 1993; Lemasters,

1997). Moreover, considering the fact that elementary students spend most of their day in one single classroom, the results of this study could be utilized to influence the learning environment of a large number of Virginia students for the majority of their school day.

This study is also timely in its examination of building and classroom conditions as localities across the state receive new state funding designed to address specific building needs. The results, combined with those of Cash (1993) and Hines (1996), can provide Virginia lawmakers with additional information to consider as they debate whether or not to continue to provide state funds for school construction or renovation. Virginia's legislature has also allocated considerable portions of its educational budget to fund educational technology initiatives in recent years. This study of elementary schools can provide some preliminary data regarding the availability of technology in classrooms as well as student ability to use this technology as measured by the fifth grade Standards of Learning Assessment in Technology.

Research Question

What is the relationship between student achievement and the physical condition of school buildings and classrooms in Virginia elementary schools?

Theoretical Model

Cash (1993) developed a theoretical model to examine the relationship between school building condition and student achievement and behavior in Virginia's rural high schools. Hines (1996) applied this same model to urban high schools in Virginia. In her meta-analysis of research linking building conditions and student achievement, Lemasters (1997) refined the Cash model by incorporating the results of both the Cash and Hines studies. Building condition was clarified in this revision as having both structural and cosmetic components. In proposing this study, a model (Figure 1) was developed that extends the work of Cash, Hines, and Lemasters into the elementary school.

There are many similarities between the models as they were all based on recent research. The model illustrates how building and classroom conditions may directly and indirectly influence the achievement of the elementary students educated in those buildings. Indirect influences may exist through the building's influence on the attitudes and behaviors of parents and the community, the building's influence on the attitudes and behaviors of faculty and staff, and finally the building's influence on the attitudes and behaviors of students.

The model for this study differs from the work of Cash, Hines, and Lemasters in the identification of the antecedents to building and classroom condition. These antecedents are the variables of deferred maintenance, funding

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priorities and administrative decisions and are exogenous variables in this study (Pedhazur, 1982). These are variables that are influenced by factors outside of the model yet play a significant role in influencing building and classroom conditions. Deferred maintenance emerged as a significant factor in local school divisions as funds usually earmarked for maintenance and for upkeep were diverted to other educational reform measures. Such conditions were found by both the Education Writers Association (1989) and Hanson (1992). The Education Writers Association cited a $41 billion price tag for deferred maintenance in the nation's schools. Hanson put the price tag at $29 billion in 1983 and cited growth to over $100 billion in 1991. Both groups summarized that the nation's schools were old and small, were not structurally sound, were poorly maintained, were not properly heated or cooled, were not equipped with adequate electricity, were plagued by failing roofs, were contaminated by remnants of asbestos, and were not energy efficient.

Hanson (1992) pointed out that 31 per cent of schools in use today were built before World War II. An additional 43 per cent were built after the war to accommodate the baby boom, and often shoddy materials were used. Buildings were planned poorly and were built to last only 20 to 30 years. School problems have been exacerbated by the fact that school leaders cannot pass the higher costs encountered in recent years on to their clientele like businesses can. Decision makers often were forced instead to cut existing programs and services, and routine maintenance has been a frequent target as there were not immediate

visible results from this type of budget cut. Honeyman (1998) noted that postponed structural repairs such as roofing could lead to costly cosmetic repairs as roofs leaked and damaged ceilings, walls, floors, or carpeting had to be replaced. Lemer (1995) also discussed the issue of deferred maintenance. By postponing needed repairs into the future, administrators have allowed school buildings to deteriorate and have robbed future generations of both adequate facilities and needed funds. He also noted that even without deferred maintenance issues, the natural obsolescence of facilities would necessitate extensive spending on schools as programs changed, technology advanced, and school populations grew. Response to this obsolescence was not planned for by school officials.

Funding priorities are determined by the Governor, the Virginia General Assembly, and the State Department of Education to address the various goals they have identified as being most important. These priorities are often set in a highly-charged political climate and may be influenced by political rather than practical considerations. These priorities may also change with the election of new voting majorities or executive officials.

Local school boards and municipal governments have to make administrative decisions that make the most effective use possible of educational funding that often has not grown proportionally to meet the increasing demands of student growth, building needs, teacher salaries, and general inflation. Local officials must allocate funds for mandated programs and other expenditures necessary to meet accreditation standards even though these expenditures might

not address the division's most pressing needs. Administrative decision making refers to the choices made by state and local officials regarding custodial staffing, repair programs, and facilities construction that are within their locus of control.

The interplay of these three variables -- deferred maintenance, funding priorities, and administrative decision making -- combine with the existing school plant to produce building and classroom conditions. The structural and building characteristics and classroom characteristics are both components of overall building and individual classroom conditions. Structural factors include building age, roof condition, interior and exterior paint condition, quality of electrical service, general maintenance and overall building cleanliness. Also included would be the original purpose for the building when constructed and the amount of renovation completed in the building before its use as an elementary school. Classroom factors would include whether the class was in a permanent structure or mobile unit, whether the classroom had windows, the quality of classroom air-conditioning and heating, the quality of classroom lighting, classroom wall color, the material used in the classroom ceiling, classroom electrical service, the condition and functionality of classroom furniture, whether classrooms are self-contained or open-space structures, and the overall cosmetic effect of all of these factors combined. Certain technology characteristics, including network connections and internet access, would also be included as classroom characteristics. The continued interplay of deferred maintenance, of funding

decisions, and of administrative decisions in this model means that building and classroom conditions are dynamic and continue to change.

As illustrated in the model, the resulting building and classroom conditions have both direct and indirect effects on student achievement. Building conditions may be seen as a reflection of the value placed on education by community and school leaders. Parents and teachers may view poor facilities as indicators of low expectations for education, of a lack of concern for the education process, or as a symbolic representation of the low priority of education in the community. Conversely, well maintained and equipped facilities send the opposite message to parents and teachers, indicating that there are high expectations for students, that education is a community priority, and that there is concern for the educational process. Parents and teachers communicate these expectations to students, influencing their achievement. Student behaviors and attitudes are also indirectly affected by these same building and classroom factors. They too might be indirectly influenced by the quality of the facilities they attend and draw a message from the condition of these facilities about the importance of education in the community as well as what the community expects from them as students.

Student achievement may also be a direct function of some combination of factors found in the building including thermal conditions, acoustics, aesthetics, structural condition, or technological readiness. Socio-economic status (SES) as expressed by the percentage of students participating in the free and reduced-price lunch program is also a variable that should be considered when examining

student achievement. The net effect of these building and classroom factors as well as SES on student achievement across a variety of communities throughout Virginia might be determined by testing this model.

CHAPTER 2 REVIEW OF RELATED RESEARCH

In Chapter 2, the relevant theory linking architecture and education will be explored. A context for the study will be developed through an examination of research concerning financial inputs and student achievement. Specific studies relating building and classroom characteristics to student achievement will be examined to determine the significance of specific structural, cosmetic, and technological factors. Meta-analytical works relating to facilities research and student achievement will also be presented. Finally, specific variables identified as significant in the review of literature will be summarized.

The Role of Architecture in Education

There is an underlying, common sense assumption that the place where education occurs has an influence on the results. The design of early public schools in the 1900s provides evidence for this assumption. The adherence to the factory model of order and symmetry reflected the school's role in preparing the students for their roles as workers in an industrial society. Likewise, the placement of a teacher's desk at the front of the classroom as a symbol of authority and the orderly rows of desks also provided a strong cultural message as well, particularly to the children of recent immigrants.

Educators as influential as John Dewey found an important link between the appearance of the school and its work. Dewey felt the school's practical role and aesthetics had to be linked and saw the school building as offering security, self-assurance, and a measure of independence to its students. Schools served a symbolic role in their communities, and their architecture carried a strong message about community values and the importance of education. They provided an environment where students, teachers, parents, and the community at large interact (Uline, 1997).

Today's schools send similar messages. They are often poorly heated, dilapidated, unsafe, poorly equipped and furnished, and inadequate (Lackney, 1994). Today's citizens often are not proud of the schools in their communities despite their important roles in the lives of children (Meek, 1995). The abundance of trailers at schools across the nation sends a disturbing message about how much we value school today (Uline, 1997). The Carnegie Foundation concluded that quality education could not be accomplished in negative educational environments. Decaying school facilities send the wrong message to students, teachers, and community members (Carnegie Foundation for the Advancement of Teaching, 1988).

This image is in sharp contrast to the school's traditional image as well as with the image desired by modern architects and educators. Gaylaird (1991) stated that a quality school environment can enhance student achievement. Schools should be planned by a consortium of architects and educators to ensure

that the building structure contributes to student learning. Schools can be used to build a sense of community, encourage socialization among students and adults, and foster feelings of individual and civic pride. Likewise, Ortiz (1994) reflected that the "purpose of the [school] facility is loaded with symbolic overtones" (p. 6). Schools are the key to our survival and reflect the value we place on children. School construction also represents a major economic endeavor and a significant capital investment that must be protected (Castaldi, 1987; Ortiz, 1994).

Architecture and education are linked in both a symbolic and functional relationship. The edifice sends a strong cultural message to the citizens, and the building plays an active role in the day-to-day activities of students and teachers. Schools also represent significant financial investment. When the cultural message is negative and when the building impedes rather than fosters learning, architecture and education are in conflict.

Context for Study: Financial Inputs and Student Achievement

The links between specific financial inputs, including school construction and maintenance expenses, and educational outputs, most often student achievement, have been extensively studied. Hanushek (1981) reviewed multiple studies utilizing 130 different statistical analyses. He utilized a production-function equation designed for measuring inputs and outputs in an industrial setting to assess the impact of school spending (input) on student achievement

(output). While acknowledging that per pupil expenditures varied widely, he found no conclusive evidence tying higher expenditures with improvements in student achievement. Moreover, he stated that additional spending on education would not produce desired results because of the system's inability to make effective use of available resources. However, he did look at specific indicators common to most studies as measures of inputs into the educational process. Among those examined included teacher-student ratios, teacher education, teacher experience, teacher salary, total expenditures per pupil, quality of facilities, and quality of administrators. It should be noted that Hanushek often relied on data that had been generated for other purposes, and that he did not report the specific components that actually composed the various expenditures he reviewed.

In their study of Philadelphia schools, Summers and Wolfe (1975) concluded that family income and race largely accounted for school performance. They found little evidence to support that school facilities had any connection to student learning. They did express concern that using average achievement scores might mask the effects of specific inputs on specific types of students. In recent years, however, challenges to the school of thought articulated by Hanushek and his disciples have emerged.

Greenwald, Hedges, and Laine (1994) reviewed the same data as Hanushek and found links between expenditures and achievement when specific expenditure categories were isolated. They were critical of Hanushek's statistical analyses, specifically his vote-counting technique, and conducted a meta-analysis using the

same data. This vote-counting consisted of examining results from many regression studies and determining if the correlations found for various variables were positive, negative, or not reported. The highest number of votes counted determined whether or not the variable was significant. While the vote-counting technique appears to be valid on the surface, its key flaw is that the magnitude of significance is not accounted for. Thus, positive correlations of both high and low significance are given the same weight (Greenwald, Hedges & Laine, 1994).

Greenwald, Hedges and Laine also stated that the types of analyses used by Hanushek were subject to Type II errors, and that in many cases he failed to reject null hypotheses when they should have been rejected. Often, this occurred because of the small sample size of the studies reviewed and because of the inappropriate use of selected variables, particularly those measuring per-pupil expenditures and community wealth. In some cases, per-pupil expenditures in one study would include debt service and other capital costs while other studies excluded these costs. Community wealth was estimated from census data and might represent the wealth of an entire community, yet would be applied as a variable in school districts serving poorer areas (Greenwald, Hedges and Laine, 1994).

In their re-analysis, Greenwald, Hedges, and Laine used combined significance tests to group data from small studies with similar but not identical designs. In their reanalysis, they found a much larger number of educational input factors were found to be significant at $p = .05$. In the reanalysis, resource

inputs of teacher education, teacher salary, and teacher/pupil ratio would increase student achievement. Interestingly, facilities were one category where evidence in the reanalysis was inconclusive. These results challenged the accepted conventional wisdom that money did not matter in improving educational outcomes (Greenwald, Hedges and Laine, 1994). However, the difficulty with defining variables succinctly and clarifying what is included in expenditure categories remains a weakness in both Hanushek's and Greenwald, Hedges and Laine's work. Since both studies were meta-analytical in nature, there was a reliance on the research design of the prior studies. The results of the meta-analyses are only as reliable as the original studies on which they were based, and this factor is not fully taken into account in the two studies.

Alexander and Salmon (1995) also questioned the suitability of Hanushek's input-output model when analyzing educational outcomes. This model, usually used in the business sector, equates the value of the output of a process relative to the value of the inputs used for production. In an educational setting, Hanushek theorized that increasing expenditures for teacher salaries and instructional materials should produce a corresponding increase in student achievement. However, applying this model to a non-industrial activity such as learning was not appropriate because of the lack of exacting definitions for the variables being studied. Often, educational performance is the result of the cumulative effect of a variety of experiences that cannot be captured in this type of equation. At best,

each school situation would require a separate production function equation that fits its particular community and student body (Alexander & Salmon, 1995).

Wenglinsky (1997) also attributed the lack of a clear causal relationship between educational inputs and expected results to inconsistency in data analysis, the lack of a standard measure for student achievement, the failure to account for differential spending among geographic regions, and the lack of a specific, consistent definition of what per pupil expenditures actually entailed. These weaknesses occurred because the studies used were not national in scope and often studied only a single school division. Further, by looking at expenditures as an aggregate number rather than examining specific expenditure categories, the role of specific expenditure levels could not be tracked. In measuring student achievement, some studies used actual test scores while others relied on graduation and drop-out rates. Stockard and Mayberry (1992) also pointed out that the existence of curvilinear relationships among variables could account for the lack of significant findings. For example, a reduction in class size might not show significance until a particular threshold, such as 15 students, was reached.

Facilities Research

A different perspective concerning building factors as educational inputs and their role in student achievement has emerged in the last 25 years. The context for understanding building characteristics has changed as significant new

data have been collected concerning building condition across the country. These findings challenge the conventional wisdom that buildings play a passive role in the education of the nation's students, that "educational facilities simply provide the container in which learning occurs" (Bingler, 1975, p.23).

Individual Research Studies

Among the first studies in this period was a doctoral study that examined the relationship between school building age and student achievement, a topic that has been revisited by numerous other researchers. Chan (1980) studied standard public schools across Georgia that housed eighth grade students during the 1975-76 school year. He divided the schools in the study into three categories based on age and type -- older buildings that had not been renovated, partially renovated buildings, and new, modern buildings. School principals were surveyed to ascertain building data as well as achievement scores from the 1975-76 administration of the Iowa Tests of Basic Skills. Building age and socio-economic status were used as independent variables in the study, while mean test scores in vocabulary, reading, language, work-study, mathematics, and school composite were used as the dependent variables. Both multiple regression analysis and analysis of covariance were employed to examine the relationships among these variables. When controlling for socio-economic status, building age was statistically significant for vocabulary, mathematics, and composite test

scores (p .05). Building age was found to account for 1.92 per cent of the variance in the vocabulary score, 1.13 per cent of the variance in the mathematics score, and .98 per cent of the variance in the composite score. Chan concluded that building age played a statistically significant role in the achievement of the eighth grade students included in this study. While the percentages of variance influenced by building age are relatively small, they need to be considered in conjunction with other factors influencing student achievement that can be controlled and influenced by educators.

Lezotte and Passalacqua (1978) examined student achievement data from a large urban school division. Twenty elementary schools from Detroit, Michigan, were included. These schools had a total population exceeding 10,000 students and were predominantly poor and black. A random sample totaling 2500 students was obtained by selecting students from each classroom as participants. Scores from the Iowa Tests of Basic Skills were used as achievement data, with scores from 1972 used as the measure of prior achievement and scores from 1973 used as the measure of current achievement. Total reading and total math scores were used for these purposes. Prior achievement and school building attended were used as independent variables, and multiple linear regression was employed to examine the data. The researchers reported that prior academic performance proved to be a significant predictor of future performance. Reading and math achievement in 1972 accounted for 25 per cent of the variance in reading achievement and 23 per cent of the variance in math achievement on the 1973

assessments. When school building attended was added as a variable, an additional 16 per cent of the variance in both reading and math was accounted for. While the researchers did not identify any specific building features and did not attribute any measured differences in achievement to specific building characteristics, they did conclude that the individual building students attended did influence their achievement. They recommended future research to identify other specific factors that could contribute to such variances (Lezotte & Passalacqua, 1978). Additional information regarding school climate, the type of community served, the experience and leadership style of the building principal, pupil-teacher ratios, relative building age, class size, and a multitude of other factors is needed to place the results of this study in an appropriate context. Without this data, the applicability of the results to other schools and communities is limited.

East Tennessee State University Professors J. H. Bowers and C.W. Burkett (1987) studied the relationship between school facility characteristics and student achievement in two schools in a rural Tennessee county. The schools included in their study were the division's newest school which had opened for the 1983-84 school year and the division's oldest school which had been completed in 1939 and also included a 1950 addition. The newer school had a student population of 758 with a capacity of 825. They noted that the newer school was well-equipped with modern amenities and systems, and included modern heating and air conditioning systems, fluorescent lighting, acoustical controls, and appropriate

furniture and color schemes. The older plant had a capacity of 650, and featured a coal-fired furnace and some window air conditioning units. They noted that furniture was outdated, color schemes were not uniform, and acoustical controls were not utilized. The sample for their study included fourth and sixth grade students from the 1986-87 school year who were randomly selected from the two buildings, 132 from the new building and 127 from the older structure . Since both schools served similar socio-economic areas, this factor was not controlled in this study (Bowers & Burkett, 1987).

Their data were analyzed using analysis of variance, t-tests, and chi-square. The null hypothesis tested was that a school's physical environment would not produce statistically significant achievement results. Test results are reported in Table 1. The null hypothesis was rejected as the study did indicate statistically significant differences in achievement scores between the old and new educational environments. Students at the new school also had fewer discipline incidents, fewer health problems, and fewer days absent from school. This data is reported in Tables 2 and 3. In all areas of the study, the researchers concluded that those attending the newer school building had significantly better educational achievement than those attending the older school. They urged those responsible for making decisions regarding school buildings to carefully consider the benefits of being educated in a modern school facility (Bowers & Burkett, 1987).

Table 1

Comparison of Grades 4 and 6 Student Achievement Between Students in a Modern School (1) and an Older School (2)

Subject	School	N	M	SD	F	Sig. of F
Reading	1 [Modern]	132	88.54	15.43	13.19	.00
	2 [Older]	127	80.94	18.40		
Listening	1 [Modern]	132	61.70	8.06	49.93	.00
	2 [Older]	127	53.59	10.66		
Language	1 [Modern]	132	77.89	13.49	12.53	.00
	2 [Older]	126	71.63	15.21		
Math	1 [Modern]	132	91.32	18.26	35.76	.00
	2 [Older]	127	96.46	21.81		

Note. Adapted from Relationship of student achievement and characteristics in two selected school facility environmental settings (p.8), by J.H. Bowers and C.W. Burkett, 1987, October. Paper presented at the 64th Council of Educational Facility Planners, International Conference in Edmonton, Alberta, Canada.
p .01

Table 2

Chi-Square Measure of Differences in Occurrences of Major Discipline Problems and Student Health Problems in a Modern School Compared to an Older School

Label	Discipline data	Health data
Number of Observations	280.00	280.00
Chi-square	138.70	10.41
Degrees of freedom	1.00	1.00
Significance level	.00	.00
Contingency coefficient	.58	.19

Note. Adapted from Relationship of student achievement and characteristics in two selected school facility environmental settings (p.9-10), by J.H. Bowers and C.W. Burkett, 1987, October. Paper presented at the 64th Council of Educational Facility Planners, International Conference in Edmonton, Alberta, Canada.
p .01

Table 3

Comparison of Student Attendance in a Modern School (1) Compared to an Older School (2)

School	N	M	SD	t	p
1 [Modern]	115	175.63	4.00	3.48	.00
2 [Older]	115	173.63	5.18		

Note. Adapted from Relationship of student achievement and characteristics in two selected school facility environmental settings (p.9-10), by J.H. Bowers and C.W. Burkett, 1987, October. Paper presented at the 64th Council of Educational Facility Planners, International Conference in Edmonton, Alberta, Canada.
p .01

Overbaugh (1990) examined the role school facilities played in the professional performance of teachers. The population for the study consisted of elementary and secondary teachers honored as State Teachers of the Year by the Council of Chief State School Officers. Of the 53 invited to participate, 43 completed a questionnaire concerning twenty aspects of the physical environment of their school and classroom. The respondents included 22 secondary and 16 elementary teachers. Teaching experience ranged from 5 to 41 years with a median experience of 15. The number of buildings individual teachers had worked in ranged from 1 to 11, with 2 buildings the mode. Most respondents taught in self-contained classrooms (27), with laboratory settings (6) and open space classrooms (5) completing the list. Extensive descriptive data were gleaned from the survey and are reported in Table 4. Respondents found 13 of the 20 environmental factors in their workplace satisfactory or better. Included in these factors were class locations, windows, floors, furniture, instructional equipment, storage areas, electrical access, restrooms, and parking. Seven factors were not found to be satisfactory, including utilization of space, access to a telephone, available conference space, professional libraries, planning spaces, and lounge or dining facilities (Overbaugh, 1990)

The researcher also examined the data by gender, teaching level, and experience using chi-square and found gender and teaching level to produce the most significant variances. These results are shown in Table 5.

Table 4

Most Frequent Responses to Environmental Aspects of School Facilities

Environmental Aspect	Most Frequent Response
Instructional Area:	
Location	6
Space Utilization	1
Ambient Features	7
Windows	7
Floor Coverings	7
Classroom Furnishings	7
Classroom Equipment	6
Teacher Storage	7
Electrical Outlets	7
Summary (overall response to instructional area)	6
Noninstructional Features:	
Telephones for Teacher Use	1
Conference Areas:	
Parent and Student	7-1[a]
Teacher to Teacher	1
Teacher Restrooms	7
Teacher Parking	7
Teacher Professional Library	1
Equipment for Teacher Use	7
Special Areas:	
Teacher Planning Area	1
Teacher Lounge Area	2
Teacher Dining Area	2
Combination Area	7
Other Areas	-[b]

Note. Adapted from School facilities: The relationship of the physical environment to teacher professionalism (p.50), by B.L. Overbaugh, B.L.,1990. Unpublished doctoral dissertation, Texas A&M University.
Scores 1-3 = negative (lowest to low satisfaction); Score 4 = neutral/average (no strong feelings); Scores 5-7 = positive (high to highest satisfaction).
a - Both 7 and 1 had an equal number of responses. b - only two responses given.

Table 5

Significant Differences by Gender, Teaching Level, and Years Experience in Responses to Environmental Aspects of School Facilities

Environmental Aspect	Chi-square probability		
	Gender	Teaching level	Yrs. experience
Instructional area:			
Ambient features	.03*	.04*	
Windows			.01*
Floor coverings	.00*		
Classroom furnishings	.00*	.00*	.03*
Classroom equipment	.02*	.03*	
Teacher storage	.04*	.03*	.00*
Electrical outlets	.02*		
Noninstructional features:			
Telephones for teacher use	.00*		
Conference areas			
Parent and student	.00*	.02*	
Teacher to teacher	.00*	.02*	
Equipment for teacher use	.02*	.00*	
Special areas			
Teacher planning area			.00*
Teacher lounge area	.00*	.05*	
Teacher dining area	.00*	.05*	

Note. Adapted from School facilities: The relationship of the physical environment to teacher professionalism (p.52), by B.L. Overbaugh, B.L.,1990. Unpublished doctoral dissertation, Texas A&M University.
*p .05

Several conclusions were drawn from the study. Space utilization in instructional areas received the lowest rating, and most non-instructional areas also were rated low. In individual classrooms, size, acoustics, and thermal conditions were identified as negative features. Respondents were asked to rank the environmental factors that most influenced their professional behavior. Classroom furnishings, equipment, and ambient features received the highest rankings. Factors teachers identified as being important in the design of new facilities included space utilization, classroom size, thermal conditions, and acoustics. Elementary teachers also included storage and conference areas as being important features for new facilities, while secondary teachers cited the importance of separate lounge and dining areas with telephone access in new construction (Overbaugh, 1990).

Kovol (1991) examined the relationship of classroom physical features to the learning environment. The population for the study included principals of all 1,120 K-6 schools in Indiana during the 1990-91 school year. A random sample of 300 principals was selected using a random numbers table to complete a survey instrument, and 232 completed surveys (77 per cent) were returned. The survey examined numerous classroom features for both kindergarten and elementary classrooms including location within the building, space, walls, storage areas, availability of restrooms and running water, and technology. Also included were a number of aesthetic features including floor covering, wall surface, color, windows, and classroom equipment. Environmental factors including acoustics,

thermal conditions, presence of a classroom listening center, proximity to the media center, and proximity to the music area were also examined. Health and safety features surveyed included classroom lighting, restroom location, ventilation, electric outlets, science labs, classroom wet areas, classroom drinking fountains, nearness to outside exits, and window size. One-way chi square analysis was employed (p .05)(Koval, 1991).

Kovol found statistical significance for every factor examined. The researcher concluded that the factors identified as significant should be included in the design for renovated or replacement instructional facilities. He also recommended further study to compare the results gained from principals with those of the teachers who must work in these same schools and classrooms (Kovol, 1991).

The results of Kovol's (1991) study must be viewed with caution, as finding significance in every factor is unusual. This may be indicative of a problem with the study's methodology and data collection instrument. While the study presented a comprehensive survey of physical features of instructional facilities, its reliance on principals' perceptions alone without any correlation with student achievement or behaviors limited its usefulness. The survey also failed to assess the opinions of the teachers who used the facilities every day.

Berner (1991) conducted a study relating school building condition and parental involvement to student achievement in the Washington, DC, public school system. This widely quoted study was completed as her masters thesis at

Georgetown University. She outlined the deplorable conditions found in the DC public school system and hypothesized that parental involvement and student achievement were both significantly affected by poor building condition. Included in her sample were 41 of the 52 schools in the district for which she could obtain complete data. However, in her research design she decided to conduct two sets of analyses for each hypothesis -- one including the schools for which she had complete data, another for all schools in the division. She developed two multiple regression models to test her hypotheses (Berner, 1993).

The first model identified school building condition as measured by the DC Committee on Public Education (COPE) as the dependent variable. Independent variables included building type (elementary or other), PTA membership per student, PTA budget per student, building age, percentage of the school census tract that was Caucasian, mean neighborhood income, and enrollment. Results for the first model are shown in Table 6.

The first group of results was for the sample group. School age was found to be a significant predictor ($p<.10$) of building condition. Overall school enrollment was also a significant predictor ($p< .05$) of building condition, and she noted that building condition improved as student populations grew, possibly because larger schools had more resources. PTA budget was also found to predict building condition ($p<.10$).

Slightly different results were obtained when the division as a whole was examined. Since complete PTA data were not available division-wide, that

Table 6

Multiple Regression for Predicting Building Condition from School Type, School Age, Caucasian Population, Mean Income, School Enrollment, PTA Membership, and PTA Budget in Washington, DC Public Schools

Predictor	All schools est.[a] (t-statistic)	Surveyed schools est.[a] (t-statistic)
Type of school (1 - elementary, 0 all others)	-.359 (-2.77)***	-.368 (-1.38)
School age	.00 (1.74)*	.00 (1.78)*
Caucasian percentage in the school's census tract	.00 (.80)	.00 (.96)
Mean income for the school's census tract	-.00 (-1.89)*	.00 (1.4)
School enrollment	-.00 (-2.86)**	-.00 (-2.38)**
PTA membership per school		-.308 (-.915)
PTA budget per student		-.00 (-1.92)*
Intercept	2.69 (11.40)***	1.89 (3.90)***
Adj. R^2	.10	.28
F Value	3.991***	3.286***

Note. Adapted from "Building condition, parental involvement, and student achievement in the District of Columbia Public School System" by M.M. Berner, 1993. Urban Education, 28 (1), p.18.

[a]Unstandarized regression coefficient

*p<.10; **p<.05; *** p<.01

variable was not included in the second analysis. Four other variables, however, were found to be significant at the division level. Building type (elementary or secondary) had significance ($p<.01$) with elementary schools found to be in better condition than secondary schools. Building age was again significant ($p<.10$) as was school enrollment ($p<.05$). The new variable showing significance in the division-wide analysis was mean income ($p<.10$). As neighborhood incomes increased, building conditions improved. The R^2 for the first model ranged was .10 for all schools and .28 for the sample, accounting for 10 per cent to 28 per cent of the variance in building condition. (Berner, 1993).

The second model used student achievement as measured on the Comprehensive Tests of Basic Skills (CTBS). Composite test scores were utilized. Independent variables for the second model included type of school (elementary or secondary), school age, percentage of the school census tract that was Caucasian, mean neighborhood income, school enrollment, PTA membership per student, PTA budget per student, and building condition. The results of the second regression model are shown in Table 7. For the identified sample, only building condition was found to be a significant predictor of student achievement ($p<.05$). In the division-wide analysis, four factors were found to be significant. The percentage of Caucasians in the census tract was significant ($p<.05$) as was mean neighborhood income. School enrollment was significant ($p<.10$) as was building condition ($p<.05$). A move from one category to another in building

Table 7

Multiple Regression for Predicting Student Achievement (CTBS Scores) from School Type, School Age, Caucasian Population, Mean Income, School Enrollment, PTA Membership, PTA Budget, and Building Condition in DC Public Schools

Predictor	All schools est.[a] (t-statistic)	Surveyed schools est.[a] (t-statistic)
Type of school (1 - elementary, 0 all others)	5.72 (1.659)	-.337 (-.04)
School age	.06 (1.322)	.08 (.951)
Caucasian percentage in the school's census tract	.16 (2.61)**	.17 (1.34)
Mean income for the school's census tract	-.01 (-1.98)**	-.00 (-.91)
School enrollment	-.00 (-1.91)*	-.00 (-.36)
PTA membership per school		13.86
PTA budget per student		.03 (.639)
Condition of School (1-excellent, 2-fair, 3-poor)	-5.46 (-2.55)**	-10.85 (-2.331)**
Intercept	47.70 (5.83)***	55.70 (3.22)**
Adj. R^2	.34	.28
F Value	10.06***	2.88***

Note. Adapted from "Building condition, parental involvement, and student achievement in the District of Columbia Public School System" by M.M. Berner, 1993. Urban Education, 28 (1), p.18.

[a] Unstandardized regression coefficient
*p<.10; **p<.05; *** p<.01

condition was found to account for a 5.46 point increase in average achievement scores. The researcher recalculated the regression omitting schools found to be in excellent condition. Poor school condition continued to be a significant predictor of student achievement (p<.10). Division-wide, school type was significant (p<.10), percentage of Caucasians in the census tract was significant (p<.01), mean neighborhood income was significant (p<.10), school enrollment was significant (p<.05), and poor school condition was significant (p<.05). Students attending schools in poor condition were found to score 8.49 points lower than those attended schools found in excellent condition. The R^2 for the second model was .34 for all schools and .28 for the sample, accounting for 28 per cent to 34 per cent of the variance in student achievement (Berner, 1993).

Berner recognized the small sample size as a limitation in the study. She also acknowledged that many other factors had a role in determining student achievement, among them intelligence, health, and school attendance. It should also be noted that the factors used to determine parental involvement in this study were not particularly reliable. PTA membership and budget data may vary widely based on the way the PTA is organized, how cooperative the school administration is in working with the PTA, and the quality and experience of PTA officers. Using this information as the sole source of information regarding parental involvement limits the usefulness of some results. Berner's coding also made her results difficult to understand. Codes were not shown in tables, making

interpretation of statistics more complicated. When coding school condition, Berner coded the best rating as a 1 and the worst rating as a 3. Her unstandardized beta weights appeared in her results as negative numbers, making the interpretation of the table somewhat confusing without the codes. Berner's use of a predetermined alpha of .10 was not consistent with other research in this field, and any conclusions drawn based on this level of significance would not be useful. However, there was evidence that a student's environment, both school and community, were factors in academic performance (Berner, 1993).

Cash (1993) developed a model to examine the relationship between building condition and student achievement and student behavior. The model is shown in Figure 2. Cash identified the antecedents to building condition as school and division leadership, financial ability, maintenance staff, and custodial staff. These four antecedents provide a context for understanding the influences on overall building condition. Through their decisions and personal beliefs school division leaders influence multiple factors in school divisions including decisions regarding facilities and expenditures. Leaders who see value in facilities will give them a high priority. Leadership decisions are also tempered by local financial ability. The continuing pressure to control governmental spending while meeting rising costs influences all areas of school spending, including facilities. Leadership and financial ability in turn influence the work of maintenance and custodial staffs in school. Maintenance and custodial staffs must work with the resources they have been given and carry out the priorities set by

See CashModelp37.pdf

school leaders. Their work in turn influences building condition as well, based on the quality of their work and the tasks that they are able to accomplish with the resources at their disposal. The resulting building condition flows from the interplay of these factors (Cash, 1993).

Cash (1993) goes on to explain that this resulting building condition in turn influences student outcomes both indirectly and directly. Indirect influences include building conditions influence on both faculty and parental attitudes which in turn influence student attitude. Student attitudes then influence student achievement and behavior. Cash also shows building condition having direct influence on student achievement and behavior. Such direct effects might evolve from structural or environmental factors.

The model was tested in small, rural high schools in the Commonwealth of Virginia. Small schools were defined as schools with senior class membership of 100 or less, and rural schools were identified as those not found in Virginia's eight Metropolitan Statistical Areas (MSAs). Several others were included or excluded based on local population variances. Three schools were included as rural schools based on local population even though they were within an urban MSA. Schools that had fewer than 100 seniors but served in an area with more than 2500 were excluded from the population. Forty-seven schools were identified as the population, and all were included in the study. A total of 39 schools elected to participate in the study. Division superintendents were asked to identify a central office staff member who would provide achievement data in the

form of scale scores from the 1991-92 administration of the eleventh grade Tests of Academic Proficiency (TAP). Socio-economic data were gathered in the form the number of students not participating in the free and reduced-price lunch program for the 1991-92 school year. Each participating school was also asked to complete the Commonwealth Assessment of Physical Environment (CAPE) developed by the researcher. This survey gathered data on a number of building factors and was used to categorize buildings as above standard, standard, or below standard. Categories included in the survey were lighting, acoustics, thermal controls, color, classroom density, science lab quality, and aesthetic features, and included 16 structural features and ten cosmetic features. A document inserted in the survey gathered additional descriptive data including TAP scale scores, incidents of school violence, the number of school suspensions and expulsions, and the number of students approved for free or reduced-price lunch (Cash, 1993).

Analysis of covariance was used to compare mean achievement scores with mean building ratings and also employed to compare mean behavior ratings and mean building ratings. In all cases, SES was used as the covariant. Regression analysis was also employed to compare achievement score means to behavior rating means and achievement score means to building age. Demographic data on the schools were also provided. Mean achievement scores were analyzed across three building conditions -- below standard, standard, and above standard. For each of the eight scores analyzed, scores were higher or stable for each step of

improvement in building condition with one exception. These scores are shown in Table 8. Writing scores were lower for standard building condition than substandard. In all cases, the highest scores were found in buildings rated as above standard, with the greatest differences in science scores at 50 per cent in substandard buildings and 55 per cent in both standard and above standard buildings (Cash, 1993)

The same achievement scores were compared for two categories of cosmetic feature ratings -- the 21 highest rated schools against the 20 lowest rated schools. These results are shown in Table 9. In all but one case, social studies, students in the highest rated buildings achieved higher tests scores. The greatest difference in these rankings was a 4 per cent difference in mathematics percentile ranks between lower-rated buildings and higher-rated buildings (Cash, 1993)

Structural building conditions were also related to achievement scores. The results of this analysis are shown in Table 10. In five of the eight sub-tests, scores were actually lower in schools with higher structural ratings (Cash, 1993).

When reviewing the data on individual building factors, Cash noted higher achievement in buildings that were newer, in buildings with adjacent athletic facilities, in buildings with better lockers, in classrooms with more windows, in classrooms with air conditioning, in classrooms with more recent interior painting, and in classrooms with better furniture. No relationship was found regarding classroom heating, exterior painting, roofs, floor condition, acoustics,

Table 8

A Comparison of Achievement Scale Score Means and Percentile Ranks on the Subtests of the Tests of Academic Proficiency for Grade 11 During the School Year 1991-92 and Building Condition Ratings

	Overall building condition					
	Substandard N=10		Standard N=21		Above standard N=10	
Achievement:	M	PR	M	PR	M	PR
Reading comp.	185	47	185	47	188	51
Mathematics	179	43	180	45	181	47
Written exp.	191	57	186	51	193	59
Sources	189	48	191	50	193	52
Basic composite	186	49	186	49	189	53
Social studies	190	48	190	48	192	51
Science	190	50	193	55	193	55
Compete comp.	187	47	188	49	190	52

Note. Scale score means have been adjusted for socioeconomic status. Percentile ranks have been derived from scale score means which have been adjusted for socioeconomic status. Adapted from Building condition and student achievement and behavior (p.46) by C. Cash. Unpublished doctoral dissertation, Virginia Polytechnic Institute and State University.

Table 9

A Comparison of Achievement Scale Score Means and Percentile Ranks on the Subtests of the Tests of Academic Proficiency for Grade 11 During School Year 1991-92 With Cosmetic Building Condition Ratings

	Cosmetic building condition			
	Lower scores N=20		Upper scores N=21	
Achievement:	M	PR	M	PR
Reading comprehension	185	47	187	50
Mathematics	179	43	181	47
Written expression	188	54	190	56
Sources	190	49	192	51
Basic composite	186	49	187	50
Social studies	191	50	190	48
Science	191	52	193	55
Complete composite	187	47	189	50

Note. All standard score means have been adjusted for socioeconomic status. All percentile ranks have been derived from standard score means which have been adjusted for socioeconomic status. Adapted from Building condition and student achievement and behavior (p.49) by C. Cash. Unpublished doctoral dissertation, Virginia Polytechnic Institute and State University.

lighting, school grounds maintenance, density, or site acreage and student achievement. Regression analysis was employed to examine the relationship between building age and building condition. The adjusted $R^2 = .18$, indicating that 18 per cent of the variance in building condition could be attributed to its age.

Improvement of certain building conditions was seen as a way of improving student achievement. More windows, air conditioning, interior painting, improved lockers, and improved furniture had a positive influence on student achievement. Factors with little or no influence were floor condition, heating, exterior painting, roof condition, frequency of mopping, graffiti removal, ceiling condition, science lab age, lighting, school grounds, wall color, noise, density, and school site acreage. Building age was identified as a primary predictor of building condition (Cash, 1993).

Ratios of behavior incidents per 100 students were also related to the three building condition ratings. In this case, a higher number of behavioral incidents was reported as building condition improved. Similar results were noted when behavior ratios were related to the school's cosmetic rating. When behavior ratings were related to the building's structural rating, suspensions were slightly lower at the highest rated buildings, while expulsions and incidents of violence and substance abuse were higher. Because of a lack of clarity on at least one question relating to discipline data, caution was urged when examining these results. However, the researcher suggested that higher behavioral expectations

Table 10

A Comparison of Achievement Scale Score Means and Percentile Ranks on the Subtests of the Tests of Academic Proficiency for Grade 11 During School Year 1991-92 With Structural Building Condition Ratings

	Structural building condition			
	Lower scores N=24		Upper scores N=17	
Achievement:	M	PR	M	PR
Reading comprehension	186	49	185	47
Mathematics	180	45	180	45
Written expression	189	55	190	56
Sources	191	50	191	50
Basic composite	187	50	186	49
Social studies	191	50	190	48
Science	193	55	192	53
Complete composite	189	50	188	49

Note. All standard score means have been adjusted for socioeconomic status. All percentile ranks have been derived from standard score means which have been adjusted for socioeconomic status. Adapted from Building condition and student achievement and behavior (p.51) by C. Cash. Unpublished doctoral dissertation, Virginia Polytechnic Institute and State University.

might be present in newer school buildings (Cash, 1993). Better record keeping or improved recording procedures might also help account for this result.

The Cash model was employed in two other subsequent studies. A North Dakota study again examined the relationship between school building condition and student achievement and behavior. North Dakota was selected for the study because of its record of high academic achievement and its relatively homogeneous population. The study included 199 high schools across the state. There was a 60 per cent return rate for the survey (n = 126). Results from the Comprehensive Tests of Basic Skills administered to 11th graders were used as measures of student achievement after adjusting for SES. Each principal was asked to determine the presence or absence of 29 specific building conditions that had been found significant in previous research. Again, buildings were categorized as above standard, standard, or below standard based on these results. Cosmetic and structural features were also rated either high or low (Earthman, Cash, & Van Berkum, 1996).

When comparing achievement scores across building conditions, student achievement was equal or higher in above standard buildings than below standard buildings in every sub-test area except total math. When compared across cosmetic building condition, achievement scores were higher in every category in above standard buildings. When compared across structural building condition, students in above standard buildings scored equal to or higher than students in

below standard buildings in nine subtests, and below those in below standard buildings in five subtests. Very little data were reported concerning student behavior making the results from those analyses questionable. However, it should be noted that behavioral incidents were again somewhat higher in the best buildings, although no conclusive explanation for this result was found. Results for individual building factors were also provided, with building age, air conditioning, and noise identified as being positively related to student achievement (Earthman, Cash, & Van Berkum, 1996).

Hines (1996) also employed the Cash model in an analysis of urban high schools across Virginia. A revised CAPE instrument was used to gather building data. Eleventh grade test scores from the 1992-93 administration of the TAP were used as measures of student achievement. A population of 88 urban schools was identified and included in the study. Sixty-six surveys (75 per cent) were returned. Data analysis was similar to that employed by earlier studies by Cash (1993) and Earthman, Cash, and Van Berkum (1996). Hines ran a second set of analysis using data only from Prince William County, Fairfax County, Arlington, Henrico County, and Virginia Beach as he perceived these school divisions as better systems due to facility quality and affluence.

Comparing student achievement across building condition for the entire sample, students in above standard schools scored between 9 and 17 percentile points higher than those attending substandard schools. Similar results were found comparing school achievement across cosmetic condition rating and

structural condition rating with one exception. Students in buildings with lower structural ratings scored slightly higher than those in buildings with higher structural ratings in one subtest, sources of information. Once again, more disciplinary actions were reported at better maintained buildings. When examining specific building and classroom features, factors associated with higher scores were building age, window condition, floor condition, heat and air conditioning quality, exterior paint, mopped floors, absence of graffiti, prompt removal of graffiti, school grounds condition, and wall color. Interior paint, roof condition, adjacent athletic facility, swept floors, locker condition, ceiling condition, lighting, noise, site size, and density were not found to be significant building features in relation to student achievement. In the analysis of the more affluent divisions identified by Hines had better overall building conditions as reported on the CAPE survey (Hines, 1996)

The importance of building condition as a factor in student achievement was again reinforced in the Hines study. It should be noted, however, that Hines offered no rationale for his identification of several systems for additional analysis.

Phillips (1997) examined the role facility age played in the academic achievement and attendance of upper elementary school pupils in Georgia. Three cohorts of 150 students each were identified in three rural Georgia elementary schools. The only criteria used for selection was that the students had to attend the same school for their third, fourth, and fifth grade year. The control group

attended a school that was thirty years old for third, fourth and fifth grades. The two test groups attended older schools for third and fourth grade but both were transferred to two newly constructed facilities for their fifth grade year. The two new schools were of identical design, and the entire school program was simply relocated from an old facility to a new one. All three student groups were similar in socio-economic status, had a similar gender mix, and attended fully accredited schools. Each school had the same principal for the duration of the study, and the instructional staff was also relatively stable during this period (Phillips, 1997).

Reading and math scores on the Iowa Tests of Basic Skills as well as number of days absent were the dependent variables in the study. Previous year's test scores and attendance were used as covariants. An alpha level of p .05 was used for all analyses conducted. Analyses of covariance were used to test the various hypotheses by comparing results from the control group with the two treatment groups (Phillips, 1997).

The relationship between school age and student attendance was found to be significant (p .05). The mean number of school days missed increased for the control group by 1.2 days when compared to their previous year's attendance. Treatment group 1 showed a decrease of 0.73 in the mean number of days missed (Sig. of F = .04), while treatment group 2 showed an increase of 0.42 in the mean number of days (Sig. of F = .01). Mixed results were found when student achievement scores were analyzed. For treatment group 1, a significance level of

.02 was found when comparing ITBS scores in reading to the control group. For treatment group 2, no significant difference was found in reading scores. When examining math achievement, both treatment groups scored significantly better than the control group, with significance for group 1 at .00 and significance for group 2 at .01. Phillips (1997) concluded that movement to a new school facility had a positive effect on student achievement and attendance (Phillips, 1997).

While a number of researchers have completed individual studies at the local or state level, there have also been several national reports issued by the United States General Accounting Office. At the request of a number of political leaders, including Senators Carol Moseley-Braun, Edward M. Kennedy, Claiborne Pell, Paul Simon and Paul Wellstone, a series of reports was completed concerning the state of the nation's school facilities. Published in 1995 and 1996, these five reports contain a summary of the results of an extensive survey conducted in all 50 states. There was a 78 per cent response rate to the survey. These surveys included a variety of questions concerning the physical condition of school buildings, the status of the environmental condition of school buildings, the presence of hazardous materials, their compliance with the Americans with Disabilities Act (ADA), the extent to which instructional technology was present in schools, and the amount of money that would be needed to raise the condition of school buildings to good condition. (United States General Accounting Office, 1995a). Building features analyzed included roof integrity, building structure, exterior walls and finishes, windows, interior finished, plumbing, HVAC systems,

electrical power, and compliance with life-safety codes. In examining these features, at least one inadequate building feature was found in 66.6 per cent of urban schools, 56.8 per cent of suburban or large town schools, and 51.7 per cent of rural or small town schools (United States General Accounting Office, 1996).

The results of this survey presents a detailed portrait of the condition of school plants across the nation and in the Commonwealth of Virginia. Over 60 per cent of the schools responding reported at least one major physical feature needing repair, and over half cited the need to correct at least one major environmental problem (United States General Accounting Office, 1995a). In Virginia, 60.1 per cent of the schools reported at least one inadequate building feature, with roofs, climate control and plumbing concerns most frequently cited. Insufficient technology was also found to exist in schools across the nation as well as in Virginia. The most frequently cited inadequacies for both the nation and Virginia were the lack of school network infrastructure, phone lines, and modems (United States General Accounting Office, 1995b).

Meta-Analytical and Summary Studies

A number of meta-analytical and summary studies in the field of facilities research also provide relevant information for future studies. Weinstein's (1979) analysis of studies prior to 1980 found no link between building condition and academic achievement. Her analysis examined specific environmental variables

including seating position, classroom design, furniture arrangement, density and crowding, privacy, and noise. She also examined nine studies involving classroom ecology and open space classrooms. Her analysis did show a link between building condition and non-academic behaviors. Among the non-academic behaviors identified were risk-taking, feelings of autonomy, self-concept, aggression, social interaction, attendance, class participation, attitude towards school, and spatial behaviors. Weinstein speculated that these behaviors, over time, could influence academic outcomes. She also noted that educational researchers had not sufficiently studied the relationship between the educational program and the physical environment in which the program was implemented.

McGuffey (1982) examined research related to the role facilities played in student learning, performance, and self-concept. He examined studies within three categories -- those dealing with the physical environment, those dealing with the configuration of the actual school building, and those dealing with programming and physical aspects of the structure. Specific variables were then analyzed within each category. He warned that the results of his analysis must be viewed with caution due to the shortage of data for some identified variables as well as the different methodologies employed in analysis in each given study. McGuffey used a combination approach to analyze the data. A counting approach was used to simply tally the number of studies where a variable was found to be significant. He also used his own judgment to identify significant findings, cautioning that reviewer bias was difficult to control. Building age, thermal

conditions, lighting, color and interior painting, acoustics, building maintenance, presence of lab facilities, and school size were identified as having an effect on achievement, while open space, lack of windows, underground location, site size, building utilization, and support facilities were not found to be significant factors. An important point made by McGuffey was that while the amount of variance in student achievement influenced by facilities might be small, the amount of variance in student achievement controlled by any combination of school factors as compared to outside influences is also small. In this light, the contribution of facilities or any other identifiable factor within the school's locus of control to improved achievement may be magnified and cannot be ignored.

Lemasters (1997) completed a synthesis of research on facilities and achievement since 1980. This extensive review of 53 studies completed since Weinstein's (1979) analysis noted that noise, building age, room color, lighting condition, overall maintenance, density, climate, and classroom structure all influenced student achievement, with building age, lighting, and noise having the strongest significance. Lemasters also recommended modifications in the Cash model to reflect that building condition had both cosmetic and structural components. This revised model is shown in Figure 3.

See LemasterRevp53.pdf

Summary

Numerous individual and meta-analytical studies conducted since 1970 have found that various combinations of building age, building condition, and building characteristics have some degree of influence on student achievement. Chan (1980) found that building age accounted for between one and two per cent of the variance in mean student achievement test scores. Bowers and Burkett (1981) also found that attending a new school as opposed to an older school produced statistically significant differences in mean student achievement scores as measured by the Iowa Tests of Basic Skills at p .01. Lezotte and Passalaqua (1978) found that 16 per cent of the variance in mean student achievement as measured by the Iowa Tests of Basic Skills was attributable to the school building attended, although no specific building characteristics were identified.

McGuffey's (1982) meta-analysis identified building age, thermal conditions, lighting, color and interior painting, acoustics, building maintenance, lab facilities, and school size as being significant factors in determining student achievement.

Berner (1993) concluded that overall school condition was a significant factor in the variance of mean composite achievement scores on the Comprehensive Tests of Basic Skills. Combined with other demographic factors including mean income and percentage of Caucasians in the census tract, she

accounted for between 28 per cent and 34 per cent of the variance in student achievement.

Cash (1993) found high academic achievement in secondary schools with above standard building condition and above standard cosmetic condition. Building age was accounted for 18 per cent of the variance in building condition. Hines (1996) and Earthman, Cash, and Berkum (1996) found similar results. Although all three of these studies used a very similar survey instrument different specific factors were found to be significant influences on student achievement. Cash (1993) identified classroom windows, classroom air-conditioning, interior painting, locker condition, classroom furniture, and building age as significant in Virginia's rural secondary schools. Earthman, Cash, and Berkum (1996) identified building age, air conditioning, and noise as significant factors in North Dakota secondary schools. Hines (1996) identified building age, windows, floor condition, heat and air conditioning, exterior painting, cleanliness, wall color and the condition of school grounds as significant factors in Virginia's urban secondary schools. Phillips (1997) study also found school age a significant factor on student achievement and attendance.

The factors identified in these studies will be utilized when developing a survey instrument for this study of Virginia elementary schools.

CHAPTER 3 METHODOLOGY

In Chapter 3, the population and sample of this study are identified. The setting and context for the study are reviewed, including a discussion of the new Standards of Learning for Virginia and the related assessments. Methods of data collection, including plans to develop and administer a survey, are explained. Instrumentation for measuring student achievement is discussed. The survey response rate is provided. Finally, the data analysis for the study is discussed including the identification of variables and the types of statistical analyses to be used.

Population and Sample

Previous studies in this field have focused on both rural (Cash, 1993) and urban (Hines, 1996) high schools in Virginia. Virginia's elementary schools are the population for this study. During the 1997-98 school year, all Virginia elementary schools were assessed by the same new state testing program and were required to implement the same new standards of learning. Current research indicates that poor school building conditions exist in both urban and rural settings so schools from all areas of the state are included in the population (Virginia Department of Education, 1992). While restricting the population to Virginia's elementary schools may be seen as a limitation, the data from this

study when combined with the data from the work of Cash (1993) and Hines (1996) can be used to extend the information on school facilities in Virginia.

A random sample of elementary schools in the Commonwealth of Virginia that house both third and fifth grade students was included in this study. Since there was a population of 989 schools in this category, 300 schools were selected for the study based on the calculations of Krejcie and Morgan (1970). After developing an alphabetical list by division of all elementary schools that had both third and fifth grades in their buildings from the state school data base, every third school was selected for the sample. No replacement was used.

Survey Response Rate

Three hundred schools were selected as the sample for the study. Later, one of the selected schools was found to house a different grade configuration than that described in the Department of Education database. This factor decreased the actual sample by one to 299. Of the 299 school principals surveyed, 197 or 66 per cent returned surveys. An analysis of the returns is found in Table 11.

Table 11

Summary of Survey Responses

	N	%
Population[a]	989	100.00
Sample	299[b]	30.23
Returns	197	65.88
Usable returns		
First mailing (12/4/98-1/4/99)	150	
Second mailing (1/7/99 – 1/29/99)	41	
Total	191	
Unusable returns		
First mailing	4	
Second mailing	2	
Total	6	

[a]Includes Virginia elementary schools housing both third and fifth grades.
[b]300 schools were selected for the sample. However, one selected school was found to have a grade configuration that excluded it from the study.

Of the surveys deemed unusable, one was a duplicate, one was too incomplete to be used, and four were returned blank. In all, 191 usable surveys or 64 per cent were returned and used to provide data for analysis.

Setting

The Commonwealth of Virginia Department of Education oversees the operation of 134 county and city school divisions across the state responsible for educating 1,110,815 pupils, 550,522 of them in elementary schools (Virginia State Department of Education, 1997a). All public schools in Virginia are governed by the Standards of Quality promulgated by the Virginia Board of Education and approved by the Virginia General Assembly. These standards set clear objectives for the State Board of Education, the Virginia Department of Education, and local school boards in the educational process (Virginia Department of Education, 1996). This board has undertaken an extensive revision of the Standards of Quality as well as the Standards of Learning for Virginia Schools and Standards for Accrediting Public Schools in Virginia. Approved in September of 1997, these rigorous new accreditation standards provided a system of assessments for the Standards of Learning to be administered at grade 3, grade 5, grade 8, and at the completion of various high school courses each year, with the initial administration completed in the spring of 1998. Through new standards the Virginia Board of Education defined the student achievement benchmarks expected of each Virginia student, provided a mechanism for measuring student performance, and for the first time tied student performance on these assessments to school accreditation (Virginia State Board of Education, 1997c).

Data Collection and Instrumentation

Data relating to building and classroom conditions, student achievement, the socio-economic status of schools, and demographics of the schools was needed to complete this study. The data on building and classroom conditions, socio-economic information, and school demographics was collected from building principals using a survey developed specifically for this study. The data for student achievement was from the spring 1998 administration of the Virginia Standards of Learning Assessment Tests at grades three and five.

Instrument Development

Development of the Assessment of Building and Classroom Conditions in Elementary Schools in Virginia

To ascertain building and classroom conditions, a closed form survey was developed and distributed to all elementary building principals identified in the sample. The survey was based in large part on the Commonwealth Assessment of Physical Environment (CAPE) utilized by Cash (1993) and Hines (1996), and the North Dakota instrument used by Earthman, Cash, and Berkum (1995). However, certain modifications to these surveys have been made. Items more applicable to high schools, such as questions dealing with science labs and athletic

playing fields, have been eliminated. Items related strictly to the overall school complex have been separated from questions relating to specific classroom factors. In questions such as school age where the CAPE survey offered a range of numbers as choices, a free response question requesting a specific numerical answer was offered instead. Additional questions have been developed to update the survey concerning the building's readiness for technology. Inclusion of questions from the CAPE survey was based on the review of literature as well as the results of the Cash (1993) and Hines (1996) study.

Demographic information collected included March 30, 1998, enrollment and the percentage of students approved for the free and reduced-price lunch program on or about March 30, 1998. The approximate acreage of the school site was also included in this section.

Summary test data from the spring 1998 administration of the Standards of Learning Assessments in third grade English and math as well as fifth grade English, and math in the form of scaled scores were obtained from the Virginia Department of Education's homepage. A domain analysis for this survey can be found in Table 12. The survey can be found in Appendix 1.

Table 12

Domain Analysis for An Assessment of Building and Classroom Conditions in Elementary Schools in Virginia

Domain	Variables	Item number
Building conditions	Age of building	1 [a]
	Original purpose of building	2
	Years since last renovation	3
	Roof integrity	4
	Years since interior was painted	5
	Years since exterior was painted	6
	Adequacy of electrical service	7
	Type of flooring	8
	Location near noisy environment	9
	Overall maintenance	10
	Overall structural condition	11
Classroom conditions	Total number of classrooms	12
	No. classrooms - permanent structure	12
	No. classrooms - mobile units	12
	No. classrooms without windows	13
	Heating system quality	14
	Air conditioning quality	15
	Lighting type	16
	Wall color in classrooms	17
	Ceiling material type	18
	How often swept	19
	How often mopped	20
	No. of electrical outlets	21
	Connection to school network	22
	Connection to district network	23
	Connection to Internet	24
	Connection to cable TV	25
	Classroom furniture condition	26
	Overall structural cond.-classrooms	27
	Overall cosmetic cond.- classrooms	28
Summary and demographic information	Overall condition rating	29
	Enrollment, March 30, 1998	30
	% approved for free or reduced-price lunch program, March 30, 1998	31
	Total school site acreage	32

[a] Item numbers are from the survey in Appendix 1.

Principal Components Factor Analysis

The interrelationships among the various independent variables outlined in Table 14 were analyzed using principal components factor analysis with varimax rotation. The purpose of this analysis was to determine if there were any common, underlying factors within these variables. All factors with an eigenvalue greater than one are included in the analysis. The correlation matrix for the analysis is found in Table 13. The rotated component matrix is found in Table 14.

Thirteen separate factors with eigenvalues greater than one are identified through the factor analysis. Within each factor, any score of .40 or above was considered important. The thirteen factors are summarized below:

Factor 1 – Age/Size Factor – Variables included are building age (-.50), the total number of classrooms (.94), the number of classrooms in the permanent structure (.91) and total enrollment (.86).

Factor 2 – Overall Condition Factor – Variables included are roof integrity (.70), electrical system adequacy (.70), overall building maintenance (.45), heating system quality (.47), air conditioning quality (.64), overall cosmetic condition (.58) and overall combined condition (.63).

Factor 3 – Technology/Furniture Factor – Variables included are access to a local area network (.76), access to a wide area network (.83), access to the Internet (.83), furniture condition (.42) and overall combined condition (.44). Although overall combined condition did load on this factor, it had a stronger loading (.63) on factor two.

Factor 4 – Paint Factor – Variables included are years since last interior painting (.78) and years since last exterior painting (.83).

See CorrelationMatrixp64.pdf

See CorrelationMatrixp65.pdf

See CorrelationMatrixp66.pdf

See RotatedMatrixp67.pdf

Factor 5 – Ceiling/Lunch Factor – Variables included are ceiling type (.81) and percentage of students participating in the free and reduced-price lunch program (.56).

Factor 6 – Renovation/Site Size Factor – Variables included are years since last renovation (-.40), wall color (.68) and site size (.46).

Factor 7 – Noise Control/TV Access Factor – Variables included are noise control adequacy (.80) and access to television antenna or cable system (.55).

Factor 8 – Windows Factor – Variables included are the number of classrooms without windows (.85) and access to television antenna or cable system (-.41). Television access loaded stronger on factor 7.

Factor 9 – Structural Factor – The only variable loading on this factor was overall structural condition (.84).

Factor 10 – Electrical Outlets/Room Structure Factor – Variables included are the number of electrical outlets (.75), and the structural design of individual classrooms (.72).

Factor 11 – Trailer Factor – The only variable loading on this factor was the total number of trailers in use (.84).

Factor 12 – Mopping/Shampooing Factor – The only variable loading on this factor was the frequency of floor mopping or shampooing of carpets (.88).

Factor 13 – Sweeping/Vacuuming Factor – Variables included are the frequency of sweeping or vacuuming (.80) and site size (.49). Size size also loaded on factor six.

Survey Administration

Procedures outlined by Dillman (1978) were followed when administering the survey instrument to ensure the highest possible return. Survey booklets were printed on off-white paper and had an appropriate cover page. Consistent answer types were employed throughout the survey, and demographic

information was collected after the substantive survey questions. An appropriate cover letter was developed to accompany the survey document. This cover letter explained what the survey was about, why it was important, and why each individual surveyed should respond. Respondent confidentiality was assured. Each cover letter and envelope was individually addressed using the mail-merge feature from the survey data base. A pre-addressed stamped return envelope was also included. Initial surveys were mailed on a Tuesday. A post card was mailed one week after the initial mailing. The message on this card thanked participants who had already returned the survey instrument and reminded others to do so. A follow-up mailing was sent to non-respondents three weeks after the initial mailing. Another personalized letter was included urging them to complete the survey instrument. A second survey and return envelope were included. A final mailing was sent to non-respondents seven weeks after the initial mailing making a final request for participation. This last mailing included a third copy of the survey and return envelope.

Scoring

Survey items are constructed to obtain either a specific numerical answer generated by the respondent or a selection from a list of responses. Where specific numerical responses were given, no coding was used. For some items, a rating scale was employed with clear explanations of the ratings provided. In all

cases the responses are structured to offer the most positive response first, followed by less positive responses in ascending order. The most positive response was coded as a “5”, the next response a “4”, and so on. For questions requiring a yes or no answer, yes was coded as “2” and no was coded as “1”. For all survey questions “0” was used if there is no response. These numerical responses were analyzed using the Statistical Package for the Social Sciences (SPSS). The survey concluded with an open-ended question regarding school facilities and the study. The responses to this question were analyzed thematically. A summary of questions and response types can be found in Table 15.

Table 15

Summary of Response Types, Survey Questions, and Coding

Response type	Coding	Survey questions of this type
Specific numerical response	N/A	1, 3, 5, 6, 12, 13, 30, 31, 32
Two-choice scale	A-2 B-1	16
Three-choice scale	A-3 B-2 C-1	4, 7, 8, 9, 14, 15, 17, 19, 20, 21, 26, 27,
Four-choice scale	A-4 B-3 C-2 D-1	2, 18,
Five-choice scale	A-5 B-4 C-3 D-2 E-1	10, 11, 28, 29
Yes-no response	Yes-2 No-1	22, 23, 24, 25,

Reliability and Validity

The majority of survey items were adapted from other survey instruments that have been utilized in prior research. The Commonwealth Assessment of Physical Environment was initially developed and administered by Cash (1993), and later used by Hines (1996) as well as by Earthman, Cash, and Berkum (1995) with only minor alterations. The General Accounting Office Survey was administered across the United States in 1994.

The Assessment of Building and Classroom Conditions in Elementary Schools in Virginia developed for this study was pretested with twelve members of the current Virginia Tech Educational Leadership Tidewater Cohort and one faculty member who had experience as a school principal. This pretest was designed to locate any survey construction defects. The pretest ascertained if individual questions measure what they are intended to measure; whether they are written in clear, understandable language; whether each reader has the same interpretation of the question; whether appropriate answer choices are provided; whether the overall impression made by the survey is positive; and whether any researcher bias is evidenced in the survey. Only minor adjustments were made after reviewing the results of this pretest and notes from a group discussion that followed the individual review of the survey.

A second content review was conducted using 20 randomly selected elementary school principals who were not included in the study sample. A total

of 12 responses (60 per cent) were received. Again, all responses regarding the survey were very positive and only minor adjustments in wording of responses were recommended. All respondents agreed that building principals had the knowledge necessary to complete a survey of this type.

Standards of Learning Assessments

The Standards of Learning Assessments for Virginia were administered to all third and fifth grade students beginning in late April, 1998. Individual raw scores were reported to individual schools at the end of the school year, and were compiled and released to individual schools in late August 1998. Parents will receive a summary of school scores in the Virginia State School Report Card after cut scores have been established.

Content and Structure

These assessment instruments were developed by content committees across Virginia in conjunction with Harcourt Brace Educational Measurement. Third grade students take SOL Assessment tests in English, mathematics, science and social studies. Fifth grade students take SOL Assessment tests in English reading, literature and research; English writing; mathematics, science; history and social science; and computers and technology. The fifth grade English writing test is a

writing prompt that students must respond to in paragraph form. All of the other assessments are four choice multiple choice tests (Virginia Department of Education, 1998a).

Reliability and Validity

Elementary grade test items were field tested in the spring of 1997, and the results of these field tests were used to develop final versions of the tests administered in the spring of 1998 (Virginia Department of Education, 1997b). Additional data regarding the reliability and validity of these assessment instruments was released by the Department of Education, Division of Assessment and Reporting prior to the October, 1998 meetings of the State Board of Education to set passing scores on the assessment tests. The Kuder-Richardson 20 (KR-20) was used by test developers to establish statistical reliability of the individual tests to repeatedly measure the same skills and information. KR-20 scores range from 0 to .99, and the higher the score, the higher the instrument reliability. Reliability coefficients for the grade 3 and grade 5 assessments are found in Table 16 (Virginia Department of Education, 1998b).

Table 16

Kuder-Richardson #20 Reliability Coefficients for Grade 3 and Grade 5 Virginia Standards of Learning Assessments, Spring 1998 Administration

SOL test	Number of test questions	KR#20
Grade 3 English	45	.90
Grade 3 Mathematics	50	.91
Grade 3 History and social science	40	.84
Grade 3 Science	40	.85
Grade 5 English	42	.89
Grade 5 Mathematics	50	.88
Grade 5 History and social science	40	.80
Grade 5 Science	49	.81
Grade 5 Computer/technology	30	.81
Grade 5 Writing[a]	21	.84

Note. Adapted from "New SOL Tests Score Well on Reliability" by the Virginia State Department of Education, September 21, 1998, p. 4.

[a]Twenty multiple-choice items and one writing prompt.

Reliance on the Standards of Learning Assessment instruments for student achievement data limits the comparability of these results to student achievement in other states. In addition, the results used were from the first administration of the Standards of Learning Assessments. Smaller divisions may have been at a disadvantage in preparing their students for these tests as they lacked the resources of larger divisions in the areas of staff development and curriculum development. However, the SOL test results provided a measure of comparison across the state of Virginia as the test was designed to be directly tied to the classroom curriculum.

Data Analysis

The Statistical Program for the Social Sciences (SPSS, 1997) was employed to conduct a Pearson's product moment correlation matrix and a step-wise multiple regression analysis. Multiple regression analysis was utilized as it allowed the researcher to determine the relationship between the identified dependent or criterion variables and two or more independent or predictor variables. A pre-determined alpha of .05 was used for all tests as this significance has been used throughout most studies in this field.

Average scaled scores on the SOL Assessment tests were used as the criterion variable for each multiple regression. Multiple regression analysis

were completed for each criterion variable: third grade English, third grade math, fifth grade English, and fifth grade math. The predictor variables influencing building condition and classroom condition are identified in Table 12. The research question studied was: To what extent can student achievement on a specific SOL assessment test be explained by socio-economic condition, school size, building age, original purpose, roof integrity, interior painting, exterior painting, electrical service, overall cleanliness, overall maintenance, overall structural condition, percentage of classes in trailers, percentage of classes with windows, heating quality, air conditioning quality, lighting quality, wall color, ceiling material, classroom outlets, classroom furniture, and classroom structure, and overall classroom cosmetic condition?

CHAPTER 4 FINDINGS

In Chapter 4, the findings from the survey of elementary school principals are reported. Specific survey responses and demographic information about the schools in the sample are summarized. Finally, the survey data are analyzed using step-wise multiple regression.

Survey Responses

The survey administered to building principals asked them to complete 32 questions rating specific features of their school buildings and classrooms. Part 1 of the survey included general questions (1-11) regarding the school building. Part 2 of the survey included questions (12-28) relating the school's classrooms. Finally, Part 3 included questions (29-32) aimed at obtaining general information regarding the schools. Principals were asked to use their own judgement and experience as a building administrator to respond. Their responses are summarized in the next three sections.

Questions Relating to School Buildings

Building Age

The first question asked principals the age of their school building in years, using their best estimate of the age of the space used by students. Buildings ranged in age from new complexes to 92 years old, with a mean building age of 34.48 years. An analysis of these results can be found in Table 17.

Table 17

Building Age of Survey Respondents

Age in years	N	%	M	SD
10 years or less	25	13.08		
11 to 20 years	22	11.51		
21 to 30 years	34	17.80		
31 to 40 years	45	23.56		
41 to 50 years	36	18.87		
51 to 60 years	8	4.19		
Over 60 years	21	10.99		
Total	191	100.00	34.48	19.06

Original Purpose of Building

The second question concerned whether the school building was originally built as an elementary or secondary school. For those built as secondary schools, principals were asked if their buildings had undergone major renovations, some renovations, or no renovations before conversion to an elementary school complex. The vast majority of the respondents (82.2 per cent) stated their buildings were originally designed and built as elementary schools. A summary of responses is found in Table 18.

Table 18

Original Purpose of Building

Status	N	%
Designed as elementary school	157	82.20
Secondary design/major renovations	9	4.70
Secondary design/some renovations	17	8.90
Secondary design/no renovations	7	3.70
No response	1	0.05
Total	191	100.00

Years Since Last Renovation

The third question asked principals when the last major renovation of the school had been completed. A total of 63 schools or 33 per cent had never been renovated. A summary of these responses is found in Table 19.

Table 19

Years Since Last Renovation

Years	N	%
Never renovated	63	33.00
Renovated in last 5 years	38	19.90
Renovated 6 to 10 years ago	35	18.30
Renovated 11 to 20 years ago	26	13.60
Renovated 21 to 30 years ago	11	5.75
Renovated more than 30 years ago	10	5.25
No response	8	4.20
Total	191	100.00

Roof Integrity

The fourth question concerned roof integrity. Principals were asked to indicate if their buildings had no visible roof leaks, had only minor leaks, or had roofs that were badly deteriorating due to water damage or had areas of the building where water fell inside and had to be collected in buckets. While approximately half reported no leaks, over 47 per cent of those responding reported some type of roof leak. Responses are summarized in Table 20.

Table 20

Roof Integrity

Roof condition	N	%
No visible leaks	99	51.80
Minor leaks	63	33.00
Deteriorating	27	14.20
No response	2	1.00
Total	191	100.00

Years Since Last Interior Painting

Question five asked principals to state, in years, when their building had undergone its last interior painting. Over 40 per cent reported interior painting within the last two years, and the mean was 4.38 years since the last interior painting. Responses are summarized in Table 21.

Table 21

Years Since Last Interior Painting

Years	N	%	M	SD
1 year or less	54	28.30		
2 years ago	25	13.10		
3 to 5 years ago	57	29.90		
6 to 10 years ago	35	18.30		
More than 11 years ago	11	5.70		
No response	9	4.70		
Total	191	100.00	4.38	4.10

Years Since Last Exterior Painting

Question five asked principals to state, in years, when their building had undergone its last exterior painting. Over 30 per cent reported exterior painting within the last two years, and the mean was 4.54 years since the last exterior painting. Over 17 percent of principals did not respond to this question. Responses are summarized in Table 22.

Table 22

Years Since Last Exterior Painting

Years	N	%	M	SD
Never painted	6	3.10		
1 to 2 years ago	59	30.90		
3 to 5 years ago	53	27.75		
6 to 10 years ago	30	15.70		
More than 10 years ago	10	5.25		
No response	33	17.30		
Total	191	100.00	4.54	4.48

Electrical System Adequacy

Question seven asked principals to rate the adequacy of the electrical service in their buildings as sufficient for current needs with room for expansion, sufficient for current needs with no room for expansion, or insufficient for current needs. Over half of the respondents (58.10 per cent) reported their school's electrical service was either inadequate or at capacity with no room for expansion. Responses are summarized in Table 23.

Table 23

Electrical System Adequacy

Description	N	%
Sufficient with room for expansion	75	39.30
Sufficient with no room for expansion	71	37.20
Insufficient	40	20.90
No response	5	2.60
Total	191	100.00

Flooring Type

Principals were asked to indicate what flooring type was found in the majority of their school building in question eight. Tile or terrazzo were found in about 53 per cent of schools, with an additional 43.50 per cent reporting carpet. Responses are summarized in Table 24.

Table 24

Flooring Type

Description	N	%
Carpet	83	43.50
Tile or terrazzo	101	52.90
Wood	5	2.60
No response	2	1.00
Total	191	100.00

Noise Producing Environment

Question nine asked principals if their schools were located near a major highway, frequently used rail line, area where aircraft passed frequently overhead, or in any other noise producing environment. If schools were in these areas, principals were also asked whether measures had been taken to reduce noise within their school. Over 75 per cent of those responding did not identify a noise-producing environment. Responses are summarized in Table 25.

Table 25

Noise Producing Environment

Building status	N	%
Not in noise-producing environment	149	78.00
In noise-producing environment, but control measures taken	22	11.50
In noise-producing environment and no control measures taken	19	10.00
No response	1	0.50
Total	191	100.00

Overall Building Maintenance

Question ten asked principals to consider general repairs, light bulb replacement, and maintenance of plumbing and similar systems and provide a summary rating of outstanding, very good, satisfactory, needs improvement, or poor. Almost 70 per cent of respondents rated their school's maintenance as

outstanding or very good, and none reported a poor rating. A summary of responses is found in Table 26.

Table 26

Overall Building Maintenance

Rating	N	%
Outstanding	38	19.90
Very good	95	49.70
Satisfactory	46	24.10
Needs improvement	11	5.80
Poor	0	0.00
No response	1	0.50
Total	191	100.00

Overall Structural Condition

Question eleven asked principals to rate the structural condition of their school building as outstanding, very good, satisfactory, needs improvement, or poor. Over 70 per cent of respondents rated their school's structural condition as outstanding or very good. A summary of responses is found in Table 27.

Table 27

Overall Structural Condition

Rating	N	%
Outstanding	39	20.40
Very good	99	51.90
Satisfactory	40	20.95
Needs improvement	10	5.25
Poor	2	1.00
No response	1	0.50
Total	191	100.00

Questions Relating to School Classrooms

Classrooms in Trailers

Question 12 was a multi-part question to determine the total number of trailers at the school. Almost half of the respondents (47.60 per cent) had no trailers used as classrooms. A summary of responses is found in Tables 28.

Table 28

Classrooms in Trailers

Trailers	N	%	M
No classrooms in trailers	91	47.60	
1 or 2 classrooms in trailers	39	20.40	
3 or 4 classrooms in trailers	23	12.10	
5 to 10 classrooms in trailers	31	16.30	
More than 10 classrooms in trailers	4	2.00	
No response	3	1.60	
Total	191	100.00	2.26

Classrooms Without Windows

Question 13 asked principals how many classrooms in their building were without windows. Approximately 60 per cent of respondents had no rooms without windows, with an additional 21 per cent reporting having one to three classrooms with no windows. Responses are summarized in Table 29.

Table 29

Classrooms Without Windows

Windows	N	%	M
No classrooms without windows	113	59.20	
1 to 3 classrooms without windows	41	21.40	
4 to 10 classrooms without windows	19	10.00	
11 or more classrooms without windows	16	8.40	
No response	2	1.00	
Total	191	100.00	2.59

Heating System

Question 14 asked principals to rate the characteristics of their school's heating system. Choices included even heat/able to control in each room, even heat/unable to control in each room, or uneven heat/unable to control in each room. Over 68 per cent reported difficulty in controlling heat in individual classrooms. Responses are summarized in Table 30.

Table 30

Heating System

Description	N	%
Even heat/able to control	59	30.90
Even heat/unable to control	47	24.60
Uneven/unable to control	83	43.50
No response	2	1.00
Total	191	100.00

Air Conditioning System

Question 15 asked principals to rate the characteristics of the air conditioning system in their schools. Choices were well-regulated air conditioning in all instructional areas, air conditioning in some instructional areas or in all areas not well-regulated, or no air conditioning in instructional areas. Approximately 15 per cent of respondents reported no air conditioning in

classrooms, while an additional 42.40 per cent reported difficulty regulating classroom air conditioning. Responses are summarized in Table 31.

Table 31

Air Conditioning System

Description	N	%
AC in all instructional areas/well-regulated	81	42.40
AC in some instructional areas or in all areas but not well-regulated	81	42.40
No AC in instructional areas	28	14.70
No response	1	0.50
Total	191	100.00

Lighting Type

Question 16 asked principals if classroom lighting was flourescent or incandescent. A total of 133 schools (69.6 per cent) had flourescent lighting, while 51 schools (26.7 per cent) had incandescent lighting. Seven principals (3.7 per cent) did not respond to this question.

Wall Color

Question 17 concerned wall color in the majority of classrooms. Principals reported 144 schools (75.40 per cent) had white or off-white walls, while 44

schools (23 per cent) had pastel walls and 1 school (0.5 per cent) had dark walls. Two principals (1.00 per cent) did not respond to this question.

Ceiling Material

Question 18 concerned the ceiling material found in most classrooms. The majority of classrooms (87.40 per cent) had acoustical tile ceilings. A summary of responses is shown in Table 32.

Table 32

Ceiling Type

Description	N	%
Acoustical tile	167	87.50
Plaster	18	9.50
Wood	2	1.00
Metal	1	0.50
No response	3	1.50
Total	191	100.00

Floor Maintenance

Questions 19 and 20 asked principals how often classroom floors were swept or vacuumed as well as how often classroom floors were mopped or shampooed. The vast majority of respondents (97.40 per cent) reported that floors were swept or vacuumed daily or more frequently. Daily or weekly

mopping or shampooing was reported by 67.50 per cent of the respondents. A summary of all responses are reported in Tables 33 and 34.

Table 33

Floor Maintenance: Sweeping or Vacuuming

Description	N	%
Daily or more frequently	186	97.40
Weekly	4	2.10
Monthly	0	0.00
No response	1	0.50
Total	191	100.00

Table 34

Floor Maintenance: Mopping or Shampooing

Description	N	%
Daily or weekly	129	67.50
Monthly	32	16.80
Annually	28	14.70
No response	2	1.00
Total	191	100.00

Electrical Outlets

Question 31 asked principals to describe electrical service available in classrooms as measured by the number of electrical outlets in the room. The majority of classrooms (56 per cent) had two or three electrical outlets, while

42.50 per cent had 4 or more electrical outlets. Responses are summarized in Table 35.

Table 35

Electrical Outlets

Description	N	%
4 or more electrical outlets	81	42.50
2 or 3 electrical outlets	107	56.00
1 electrical outlet	2	1.00
No response	1	0.50
Total	191	100.00

Technology Access

Questions 22 through 25 asked if classrooms had access to a local-area computer network, a wide-area computer network, internet service, and television service through a central antenna system or cable connection. In each case, the majority of respondents had access to the identified technologies in their classrooms. Responses to these questions are summarized in Table 36.

Table 36

Technology Access

Description	Yes	%	No	%	No response	%
Access to local-area network	156	81.70	34	17.8	1	0.50
Access to wide-area network	122	63.90	68	35.6	1	0.50
Access to internet	135	70.70	55	28.8	1	0.50
Access to central antenna or cable TV	166	86.90	24	12.6	1	0.50

Condition of Classroom Furniture

Question 26 asked principals to indicate the best description of classroom furniture. Choices included furniture being functionally sound and facially attractive, furniture having minor facial scars but remaining functionally sound and satisfactory in appearance, or furniture being facially scarred or functionally damaged. Approximately half of the respondents reported sound, functional furniture, with an additional 44.50 per cent reporting only minor facial scarring on furniture. Responses are summarized in Table 37.

Table 37

Condition of Classroom Furniture

Description	N	%
Functionally sound/facially attractive	94	49.20
Sound with minor facial scars	85	44.50
Functionally damaged/facially scarred	11	5.80
No response	1	0.50
Total	191	100.00

Structural Characteristics of Classrooms

Question 27 asked principals to select the best description of the majority of their classrooms. Descriptions were classrooms that were self-contained with a door that could be closed, classrooms in modified open spaces with boundaries created by movable partitions or furniture, or classrooms in open space areas shared with other classrooms. Over 90 per cent of the responses indicated traditional self-contained classrooms with a door that could be closed. Table 38 summarizes the responses.

Table 38

Structural Characteristics of Classrooms

Description	N	%
Self-contained with door	174	92.00
Modified open space using partitions or furniture as boundary	13	6.00
Open space classrooms	2	1.00
No response	2	1.00
Total	191	100.00

Overall Cosmetic Conditions in Classrooms

Question 28 asked principals to rate overall classroom cosmetic conditions in their schools as outstanding, very good, satisfactory, needs improvement, or poor. Over 60 per cent rated cosmetic conditions as outstanding or very good. Responses are summarized in Table 39.

Table 39

Overall Cosmetic Conditions in Classrooms

Description	N	%
Outstanding	39	20.40
Very Good	85	44.50
Satisfactory	52	27.30
Needs improvement	13	6.80
Poor	1	0.50
No response	1	0.50
Total	191	100.00

General Questions Relating to the School

Overall Condition

Question 29 asked principals to rate the overall condition of their school after taking into consideration all building, classroom, and technology characteristics. Answer choices were outstanding, very good, satisfactory, needs improvement, or poor. Over 60 per cent of respondents rated their buildings as outstanding or very good. Responses are summarized in Table 40.

Table 40

Overall Condition

Description	N	%
Outstanding	33	17.30
Very good	89	46.60
Satisfactory	45	23.60
Needs improvement	21	11.00
Poor	2	1.00
No response	1	0.50
Total	191	100.00

School Enrollment

Question 30 asked principals to provide their school's enrollment from the March 30, 1998 enrollment report to the Virginia Department of Education.

School enrollments of schools responding to the survey ranged from 65 students to 1147 students, with a mean enrollment of 487.55. Enrollments are summarized in Table 41

Table 41

School Enrollment

Description	N	%	M	SD
Less than 100 students	3	1.50		
101 to 200 students	15	7.90		
201 to 300 students	21	11.00		
301 to 400 students	23	12.00		
401 to 500 students	32	16.75		
501 to 600 students	39	20.70		
601 to 700 students	26	13.40		
701 to 800 students	22	11.50		
Over 800 students	10	5.25		
Total	191	100.00	487.55	206.06

Free and Reduced-price Lunch

Question 31 asked principals to indicate the percentage of the school enrollment that qualified for free or reduced-price lunches on or about March 30, 1998. Responses ranged from 0.50 per cent to 100 per cent qualifying for the program, with a mean of 35.61 per cent. A summary of responses is found in Table 42.

Table 42

Free and Reduced-price Lunch as a Percentage of School Enrollment

Description	N	%	M
10 percent or less	31	16.25	
11 to 20 per cent	30	15.75	
21 to 30 per cent	24	12.50	
31 to 40 per cent	33	17.00	
41 to 50 per cent	18	9.50	
51 to 60 per cent	28	14.75	
61 to 70 per cent	10	5.25	
Over 70 per cent	17	9.00	
Total	191	100.00	35.61

School Site Acreage

The final question asked principals the approximate acreage of the school site. Site sizes ranged from 0.80 acres to 50 acres, with a mean site size of 12.21 acres. A total of 20 principals (10.5 per cent) did not respond to this question. Responses are summarized in Table 43.

Table 43

School Site Acreage

Description	N	%	M	SD
5 acres or less	40	21.00		
6 to 10 acres	43	22.50		
11 to 15 acres	44	23.00		
16 to 20 acres	24	12.50		
Over 20 acres	20	10.50		
No response	20	10.50		
Total	191	100.00	12.21	8.35

Additional Comments Provided by Respondents

At the conclusion of the survey respondents were invited to provide additional information about the condition of their school building or classrooms in narrative form. They were also invited to make comments that might aid in the study of the role school facilities play in student achievement. The text of their actual responses can be found in Appendix B, and the responses are summarized in Table 44. Five distinct thematic clusters emerged from their responses: building condition factors, classroom factors, renovation factors, human factors, and site factors. A number of concerns and themes identified are consistent with the literature on facilities.

The largest number of comments related to the inadequacy of the buildings principals were rating. They cited numerous weaknesses, with poor heating and

Table 44

Building and Classroom Topics Identified in Respondents' Narrative Comments

Concern	N
Building Condition Factors	
HVAC system problems	8
Lack of office/clinic/conference space	5
High quality of building maintenance	5
Facility plays important role	3
Inadequate restroom facilities	2
Inadequate storage	2
Moisture problems in building	2
Roof integrity	2
Poor window condition	2
Crumbling plaster	1
Cosmetic concerns	1
Poor state specifications for buildings	1
Doors need replacement	1
Classroom Factors	
Lack of specialized instructional spaces including art, music, gymnasium	5
Classrooms too small	4
No space for small group instruction	3
No internet access	1
Poor lighting	1
Shortage of classrooms	1
Likes open space design	1
Poor locker condition	1
Needs classroom walls	1
Renovation Factors	
Building undergoing major renovation	5
Need for electrical upgrade	4
Building to be demolished/replaced	4
Human Factors	
Faculty as important as facility	2
Health concerns for building occupants	1
No covered access to trailers	1
Asbestos concerns	1
Site Factors	
Site size	1
Inadequate parking	1

air conditioning systems, a lack of office and teacher work space, inadequate restrooms, inadequate storage, moisture problems, roof integrity, and poor window conditions emerging as consistent concerns The building conditions receiving the most comments were heating and air conditioning systems, meriting eight written comments. Five different comments specifically mentioned the excellent job school maintenance employees did in maintaining aging facilities. They were noted for quick responses to problems and for maintaining school facilities in the face of shrinking budgets. Most comments supported the notion that facilities played an important role in student achievement.

Classroom factors also were frequently mentioned. Lack of specialized instructional spaces was cited as a problem, including lack of appropriate art, music, and gymnasium spaces. Small classroom size and a lack of space for small group instruction were cited.

Building renovation factors were mentioned in narrative comments. Four schools were undergoing major renovations, and three additional schools were slated for closure or demolition at the end of the school year.

Two respondents stated that faculty performance was as important to student success as the facility. Health concerns for occupants and a lack of covered access to trailers were mentioned as negative factors for building occupants.

Finally, inadequate site size and a lack of parking were noted as site concerns.

Achievement Scores

All achievement scores are taken from the spring 1998 administration of the Virginia Standards of Learning Assessments. Scores were provided by the Virginia Department of Education's Division of Assessment and Testing. Scaled scores were provided for the third grade English, third grade mathematics, fifth grade English, and fifth grade mathematics assessments. Scaled scores for the fifth grade technology assessment were not available as they were not included in the state's report card to parents and not produced by the testing company. The percentage of students achieving a passing score of 70 or above was used for the analysis. A summary of the scores for surveyed schools is provided in Table 45.

Table 45

Selected Test Scores, Virginia Standards of Learning Assessments, Spring, 1998

Test results for surveyed schools N=191	M	SD	Min.	Max.
English – grade 3	404.20	26.57	344.50	482.50
English – grade 5	422.56	21.87	365.70	492.00
Mathematics - grade 3	421.35	47.67	326.90	516.50
Mathematics – grade 5	396.63	33.29	311.40	488.40
Technology – grade 5[a]	71.98	17.33	19.67	100.00

[a]Reflects percentage of students passing Technology Assessment – not a scaled score.

Tests of Significance for Partial Returns

Lehman (1963) discussed the problems that arise from the rate of return of mailed questionnaires. He developed a technique that compared results of early and late survey returns in order to ascertain if the surveys not returned would substantially change the results of the data analysis. By analyzing the returns, a number of patterns might emerge. The best case scenario would be for there to be no difference between early and late returns, indicating that it could be safely assumed that nonrespondents did not significantly alter the outcome of the analysis. Other cases might involve results getting stronger or weaker with later returns, allowing the researcher to make assumptions about nonrespondents. In the final case, no pattern would emerge, indicating that no conclusions could be reached concerning the nonrespondents.

Lehman's (1963) methodology was applied to the results of this survey. Responses received as a result of the first mailing were received between December 4, 1998 and January 4, 1999 and were classified as early returns. Surveys received as a result of the second mailing were received between January 7, 1999 and January 29, 1999 and were classified as late returns. These data are shown in Table 11.

Surveys were divided into two groups, early returns (N=150) and late returns (N=41). A t-test was conducted using each variable as the dependent variable and group designation as the independent variable. The research questions was is there a statistically significance difference between the ratings of early respondents and late respondents for each question on the survey? The results of these analyses is shown in Table 46.

Table 46

t-Tests for Independent Samples of Group

Variable	Number of cases						t
	Early	M	SD	Late	M	SD	
Site acreage	133	12.72	8.40	38	10.45	8.02	1.52
Building age	150	33.25	19.63	41	39.00	16.23	-1.92
Air conditioning	149	2.34	.68	41	2.05	.77	2.21*
Ceiling material	148	4.17	3.57	41	3.83	.38	1.13
Cosmetic Condition	149	3.81	.82	41	3.68	.93	.76
Room color	149	2.21	.44	41	2.34	.48	-1.60
Electrical service	146	2.22	.77	40	2.08	.76	1.06
Electrical outlets	149	2.43	.52	41	2.37	.49	.73
Enrollment	150	482.73	212.24	41	505.17	183.00	-.67
Exterior painting	125	4.46	4.79	33	4.85	3.03	-.58
Floor type	148	2.41	.53	41	2.41	.59	-.02
Free lunch	150	34.89	23.99	40	38.31	24.88	-.78
Furniture condition	149	2.39	.61	41	2.61	.54	-2.24*
Heating system	148	1.88	.86	41	1.85	.85	.16
Interior painting	142	4.26	4.09	40	4.80	4.20	-.72
Internet access	149	1.71	.46	41	1.71	.46	.05
Local area network	149	1.83	.38	41	1.80	.40	.29
Lighting type	146	1.32	.48	39	1.18	.39	1.84
Mopping frequency	148	2.53	.74	41	2.56	.74	-.26
Number of rooms	149	28.91	10.59	40	30.53	10.44	-.87
Noise in environment	149	2.72	.61	41	2.54	.75	1.49
Rooms w/ no windows	148	2.88	5.50	41	1.59	5.10	1.42
Building condition	149	3.68	.92	41	3.68	.93	.01
Building maintenance	149	3.80	.81	41	4.00	.81	-1.42
Rooms in permanent structure	148	26.80	10.42	40	28.20	10.91	-.73
Original purpose of building	149	3.64	.82	41	4.61	5.71	-1.08
Years since last renovation	142	7.92	12.00	41	9.07	11.62	-.55
Room structure	148	2.90	.35	41	2.95	.22	-1.19
Roof integrity	148	2.40	.73	41	2.32	.72	.64
Structural condition	149	3.85	.86	41	4.37	2.91	-1.12
Sweeping frequency	149	2.98	.14	41	2.98	.16	.16
Rooms in trailers	148	2.34	3.55	40	1.95	2.94	.72
TV connection	149	1.87	.34	41	1.88	.33	-.10
Wide area network	149	1.64	.48	41	1.66	.48	-.25

*p .05 **p .01

Data Analysis

Building Conditions and Third Grade English Assessment Scores

A step-wise multiple regression analysis was conducted using third-grade English Assessment Scores as the criterion variable. Predictor variables used in the analysis were principals' ratings or reporting of site size, air conditioning system condition, ceiling type, wall color, cosmetic condition of classrooms, electrical system adequacy, the number of electrical outlets, total enrollment, years since last exterior painting, floor type, free and reduced-price lunch participants as a percentage of total enrollment, furniture condition, heating system condition, years since last interior painting, internet access, local area network access, lighting type, mopping frequency, the total number of classrooms, classroom noise control, the number of rooms with no windows, overall building condition, overall building maintenance, the number of classrooms in the permanent structure, the school's original purpose when constructed, the years since the last renovation, room structure, roof integrity, overall structural condition, sweeping frequency, the number of classrooms in trailers, access to television, and access to a wide-area network. Results of this analysis are found in Table 47.

Five variables were found to be significant in explaining the differences in English 3 test results among schools. The percentage of students receiving free

See Table47p108.pdf

and reduced-price lunch accounted for the greatest portion on the variance (48.6 per cent). Building and classroom factors contributing to the variance were ceiling type (3.0 per cent), air conditioning (1.6 per cent), site size (1.6 per cent) and frequency of sweeping (1.7 per cent). No other variables entered the equation.

Building Conditions and Fifth Grade English Assessment Scores

A step-wise multiple regression analysis was conducted using fifth grade English Assessment Scores as the criterion variable. Predictor variables used in the analysis were principals' ratings or reporting of site size, air conditioning system condition, ceiling type, wall color, cosmetic condition of classrooms, electrical system adequacy, the number of electrical outlets, total enrollment, years since last exterior painting, floor type, free and reduced-price lunch participants as a percentage of total enrollment, furniture condition, heating system condition, years since last interior painting, Internet access, local area network access, lighting type, mopping frequency, the total number of classrooms, classroom noise control, the number of rooms with no windows, overall building condition, overall building maintenance, the number of classrooms in the permanent structure, the school's original purpose when constructed, the years since the last renovation, room structure, roof integrity, overall structural condition, sweeping frequency, the number of classrooms in

trailers, access to television, and access to a wide-area network. Results of this analysis are found in Table 48. Two variables were found to be significant in explaining the differences in English 5 test results among schools. The percentage of students receiving free and reduced-price lunch accounted for the greatest portion on the variance (52.2 per cent). Classroom connection to a wide-area network was the only other variable identified as having significance, accounting for an additional 2.1 per cent of the variance in test scores. No other variables entered the equation.

Building Conditions and Third Grade Math Assessment Scores

A step-wise multiple regression analysis was conducted using third grade Math Assessment Scores as the criterion variable. Predictor variables used in the analysis were principals' ratings or reporting of site size, air conditioning system condition, ceiling type, wall color, cosmetic condition of classrooms, electrical system adequacy, the number of electrical outlets, total enrollment, years since last exterior painting, floor type, free and reduced-price lunch participants as a percentage of total enrollment, furniture condition, heating system condition, years since last interior painting, internet access, local area network access, lighting type, mopping frequency, the total number of classrooms, classroom noise control, the number of rooms with no windows, overall building condition, overall building maintenance, the number of classrooms in the permanent

See Table48p111.pdf

structure, the school's original purpose when constructed, the years since the last renovation, room structure, roof integrity, overall structural condition, sweeping frequency, the number of classrooms in trailers, access to television, and access to a wide-area network. Results of this analysis are found in Table 49.

Three variables were found to be significant in explaining the differences in math 3 test results among schools. The percentage of students receiving free and reduced-price lunch accounted for the greatest portion on the variance (25.9 per cent), although this was much smaller result than in the analyses of English and technology scores. Room structure, which included whether or not rooms were open or closed spaces, accounted for an additional 3.8 per cent of the variance in test scores, while the frequency of floor mopping accounted for an addition 2.5 per cent of the variance. No other variables entered the equation.

Building Conditions and Fifth Grade Math Assessment Scores

A step-wise multiple regression analysis was conducted using fifth grade Math Assessment Scores as the criterion variable. Predictor variables used in the analysis were principals' ratings or reporting of site size, air conditioning system condition, ceiling type, wall color, cosmetic condition of classrooms, electrical system adequacy, the number of electrical outlets, total enrollment, years since last exterior painting, floor type, free and reduced-price lunch participants as a percentage of total enrollment, furniture condition, heating system condition,

See Table49p113.pdf

years since last interior painting, internet access, local area network access, lighting type, mopping frequency, the total number of classrooms, classroom noise control, the number of rooms with no windows, overall building condition, overall building maintenance, the number of classrooms in the permanent structure, the school's original purpose when constructed, the years since the last renovation, room structure, roof integrity, overall structural condition, sweeping frequency, the number of classrooms in trailers, access to television, and access to a wide-area network. Results of this analysis are found in Table 50.

Two variables were found to be significant in explaining the differences in Math 5 test results among schools. The percentage of students receiving free and reduced-price lunch accounted for the greatest portion on the variance (15.8 per cent), although this factor had its lowest significance in this particular regression when compared to the others in this study. Air conditioning accounted for an additional 2.8 per cent of the variance in fifth grade math scores. No other variables entered the equation.

Building Conditions and Fifth Grade Technology Assessment Scores

A step-wise multiple regression analysis was conducted using fifth grade Technology Assessment Scores as the criterion variable. Predictor variables used in the analysis were principals' ratings or reporting of site size, air conditioning system condition, ceiling type, wall color, cosmetic condition of classrooms,

See Table50p115.pdf

electrical system adequacy, the number of electrical outlets, total enrollment, years since last exterior painting, floor type, free and reduced-price lunch participants as a percentage of total enrollment, furniture condition, heating system condition, years since last interior painting, internet access, local area network access, lighting type, mopping frequency, the total number of classrooms, classroom noise control, the number of rooms with no windows, overall building condition, overall building maintenance, the number of classrooms in the permanent structure, the school's original purpose when constructed, the years since the last renovation, room structure, roof integrity, overall structural condition, sweeping frequency, the number of classrooms in trailers, access to television, and access to a wide-area network. Results of this analysis are found in Table 51.

Five variables were found to be significant in explaining the differences in technology 5 test results among schools. The percentage of students receiving free and reduced-price lunch accounted for the greatest portion on the variance (41.9 per cent). Building and classroom factors contributing to the variance were air conditioning (4.8 per cent), ceiling type (3.6 per cent), overall building maintenance (2.9 per cent) and floor type (1.5 per cent). No other variables entered the equation.

See Table51p117.pdf

CHAPTER 5 DISCUSSION, CONCLUSIONS, IMPLICATIONS FOR PRACTICE, AND RECOMMENDATIONS FOR FUTURE RESEARCH

In Chapter 5, the results reported in Chapter 4 will be analyzed and discussed, and appropriate conclusions provided. Implications that these results have for educational practice will be provided. Recommendations for future research to clarify and extend this study will also be made.

Discussion of Survey Responses

A careful analysis of the survey responses provides a profile Virginia's elementary schools. On the surface, the profile is overwhelmingly positive. Over 70 per cent of respondents found that their schools were maintained in an outstanding or very good fashion, and a similar percentage found their schools overall structural condition to be outstanding or very good. Across the majority of survey questions, principals gave their school facilities very high ratings. However, on closer analysis several areas of concern and potential problems surface that are not in line with the overall favorable ratings.

One such area concerns the age of elementary school buildings. Only 13 per cent of the schools surveyed were less than 10 years old. More than half of the elementary schools in use today (58 per cent) are more than 30 years old, and almost 35 per cent are over 40 years old. Aging structures present challenges to school divisions as they often are more costly to operate and maintain, lack

flexibility for instructional programming, and often having aging infrastructure including heating, cooling, and electrical systems. School divisions across Virginia will continue to be confronted with considerable costs to maintain and renovate these structures or will face the high costs of new construction. Respondents indicated that 20 per cent of the schools in the sample had undergone significant renovation within the last five years. The general satisfaction with existing facilities should not be seen as a license to ignore the considerable liability that an aging infrastructure might produce in future budget years. Nor can the general satisfaction with existing facilities mask specific defects that are identified in the results.

School roof integrity stood out as a significant structural defect. More than 47 per cent of all schools reported some sort of roof leak, with 14 per cent reporting that roofs were deteriorating. Left unrepaired, roof leaks can lead to significant structural damage and can also cause significant cosmetic damage through stained ceilings, peeling paint, and damaged floors. Assuring roof integrity must be given a high priority to protect the significant investment localities have in school structures and prevent further cosmetic deterioration. Roof repair is clearly a capital investment that divisions can not ignore.

An additional infrastructure challenge facing older schools involves electrical system adequacy. Over 57 per cent of respondents reported they lacked capacity for electrical expansion. Over 57 per cent of the respondents did not meet the generally accepted standard of at least one electrical outlet per wall.

Adequate electrical service will continue to be needed as more and more technology is developed and purchased for classroom use. While state and federal programs have provided significant funding for technology purchases, these funds can not be used for building infrastructure improvements. Providing technology to classrooms where there is inadequate electricity for its use is impractical, and means of providing funds for electrical renovations and upgrades should be found.

Another major area of infrastruture concern involved school's heating, ventilation, and air conditioning (HVAC) systems. Over 68 per cent of the schools responding reported that heat was difficult to control in individual classrooms. Almost 15 per cent of schools reported no air conditioning in classroom spaces, with an additional 42 per cent stating the air conditioning that was available was difficult to regulate. In the narrative comments, poor HVAC systems garnered the most written comments. As the Commonwealth continues to struggle with proposals to lengthen the school year, this lack of air conditioning appears to be a significant barrier for some schools. Likewise, it is difficult to imagine students being able to focus their complete attention on learning in classrooms that are too hot or too cold at any time during the school year. These distractions need to be removed to help provide a more optimal learning environment.

While more than half of respondents reported access to local-area networks, wide-area networks, the Internet, and cable television, those who do

not have this access remain a concern. Lack of classroom access to the Internet was reported by 29 per cent of the respondents. The Internet provides a wealth of instructional resources for classrooms in many divisions, and both students and teachers lacking this resource may find themselves at a growing disadvantage. Students without this access will have a difficult time mastering the Technology Standards of Learning. This situation is all the more troubling considering the significant level of both state and federal funding that has been made available to provide Internet access to individual classrooms.

Although respondents reported high levels of satisfaction with their schools, their dissatisfaction with specific infrastructure factors like roof integrity, air conditioning, electrical service, and Internet access seem to be at odds with this reported high level of satisfaction, particularly when combined with the fact that so many buildings are 30 years old or older. This dichotomy may have emerged because of a reluctance on the part of building principals to criticize their building in an abstract sense. However, when asked to provide an appraisal of specific factors, their responses might be a more accurate representation of their building's structural and cosmetic characteristics.

Discussion of Analysis of Partial Returns

In the analysis of partial returns, two variables were found to have significance (p .05). Air conditioning quality was significantly different between

early and late returns. In the later returns, respondents reported significant concerns with air conditioning system quality. According to Lehman (1963), one conclusion that could be reasonably drawn from these results would be that those not responding to the survey would have similar concerns with air conditioning. This is notable as air conditioning quality emerges as a significant factor in several of the regression analyses conducted. Similarly, furniture condition was more of a concern in later returns than in early returns. A reasonable conclusion based on this information would be that non-respondents would rate at least two predictor variables, air conditioning quality and furniture condition, as areas of concern.

Discussion of Factor Analysis Results

Principal components factor analysis was conducted to determine interrelationships among the independent variables. Thirteen underlying factors were identified through this analysis as discussed in Chapter 3.

In several cases, a number of variables loaded on a particular factor. For example, roof integrity, electrical system adequacy, overall building maintenance, heating system quality, air conditioning quality, overall cosmetic condition, and overall combined condition all loaded on factor 2, the overall condition factor. The strong interrelationship among these variables may mask the role that any one of them plays in influencing student achievement.

A similar situation exists with factor 3, the technology factor. Access to a local area network, access to a wide area network, access to the Internet, furniture condition, and overall combined condition all loaded on this factor. This strong relationship between three of the technology variables and furniture condition may again mask the individual role any play in student achievement.

The results of this factor analysis, combined with other data, should be used to make modifications to the survey instrument. When the reluctance principals showed to give low summary rankings to their buildings is considered along with the fact that many of these summary ratings have strong relationships to individual variables as identified in the factor analysis, removal of these summary questions might be warranted. Individual variables such as heating quality and air conditioning quality might be combined into a variable that measured overall environmental comfort.

Discussion of Regression Analyses

An analysis of the five step-wise multiple regression analyses conducted as part of this study reveal that free and reduced-price lunch participation entered as the first significant variable in each equation. Air conditioning entered as a factor in three of the five analyses. Other variables found to be significant were ceiling type, site size, connection to a wide-area network, room structure, overall maintenance, floor type, and sweeping and mopping frequency.

Free and Reduced-Price Lunch Participation

In all five multiple regression analyses conducted, the percentage of students participating in the free and reduced-price lunch program accounted for the greatest percentage of variance in test scores and in all five cases was the first variable entering the equation. In reviewing the English assessment scores, free and reduced-price lunch percentages accounted for 48 per cent of the variance at grade 3 and 52 per cent of the variance at grade 5. For each additional percentage of participation in the lunch program, the English assessment score declined by .82 points. A similar finding occurs in the technology assessment analysis, with free and reduced-price lunch percentages accounting for 41 per cent of the variance in technology test scores. For each additional percentage of lunch participation, the percentage passing the technology assessment declined by .47 points.

However, there is a very different finding when reviewing the Math assessment scores. While the free and reduced-price lunch percentage still enters the equation first at both grade 3 and grade 5, the percentage of variance accounted for is quite different from the findings in the English assessments. The free and reduced-price lunch percentage accounts for only 26 per cent of the variance in third grade math scores, and only 16 per cent of the variance in fifth grade math scores. An additional increment of participation in the free and reduced-price lunch program would decrease third grade math scores by 1.17

points and fifth grade math scores by .63 points. As measured by these tests, student achievement in math appears to be less effected by socio-economic factors than student achievement in English or technology.

Air Conditioning

In three of the five regression analyses conducted, the air conditioning system enters the equations as a variable having significant impact on achievement scores. In third grade English, air conditioning accounts for 1.6 per cent of the variance in scores. Improving by one rating in air conditioning quality would increase third grade English assessment scores by 4.6 points. In fifth grade math, air conditioning accounts for 2.8 per cent of the variance. Improving by one rating in air conditioning quality would increase fifth grade math assessment scores by 8.6 points. In fifth grade technology, air conditioning accounts for 4.8 per cent of the variance. Improving by one rating in air conditioning quality would increase fifth grade technology scores by 3.1 points. Clearly, the physical climate of classrooms as reflected in the low ratings given air conditioning systems is a significant factor in student achievement. These results parallel the results found by Cash (1993), Hines (1996), and Earthman, Cash, and Van Berkum (1996) in their studies of secondary schools. Similar results were also found in the GAO study of Virginia schools (United States General Accounting Office, 1995a.) and the meta-analysis conducted by McGuffey (1982).

Other Predictor Variables

Third Grade English Assessment

In addition to free and reduced-price lunch percentage and air conditioning, three additional variables were significant in explaining student achievement on the third grade English assessment. Ceiling type accounted for 3 per cent of the variance in these scores. An improvement of one rating point in ceiling rating would increase the third grade English assessment score by 1.1 point. Site size accounted for an additional 1.6 per cent of the variance, and an while floor sweeping frequency accounted for 1.7 per cent of the variance. In the case of sweeping, an improvement of one rating point in sweeping frequency would increase third grade English assessment scores by 26.4 points. At first glance, the role that these variables might play in student achievement is not as clear as the role that free and reduced-price lunch percentage or the air conditioning system in a school might play in student learning. The vast majority of ceilings in participating schools (87.5 per cent) were acoustical tile. Since these tiles are often installed during renovation and do have certain noise control properties, ceiling type may be a proxy variable for renovation or noise control. The frequency of floor sweeping may represent overall cleanliness of the learning environment. The relationship of site size to student learning is unclear.

While ceiling type, site size, and frequency of floor sweeping were all variables used in the Cash (1993) and Hines (1996) studies of Virginia secondary schools, they were not found to be significant in either analysis.

Fifth Grade English Assessment

Only one additional variable was significant in explaining fifth grade English assessment scores. Connection to a wide-area network (WAN) accounted for an additional 2.1 per cent of the variance in these scores. An improvement of one rating level in this category would increase the assessment score by 7.0 points.

Third Grade Math Assessment

Two additional variables were significant in explaining third grade math assessment scores. Room structure, which referenced whether or not the room was self-contained or of an open-space design, accounted for 3.8 per cent of the variance in this analysis. Improving by one rating point in this category would increase the third grade math assessment score by 28.5 points. Frequency of floor mopping accounted for an additional 2.5 per cent of the variance. Improving by one rating point in this category would increase the third grade

math assessment score by an addition 10.6 points. These results indicate students learned math better in self-contained classrooms that were cleaned frequently.

Fifth Grade Math Assessment

The only two variables entering the equation for fifth grade math assessment were free and reduced-price lunch participation and the air conditioning system.

Fifth Grade Technology Assessment

In addition to free and reduced-price lunch percentage and air conditioning, three other variables were significant in explaining the variance in fifth grade technology assessment scores. Ceiling type accounted for 3.6 per cent of the variance. Improving by one rating in this category would increase the assessment score by 0.95 points. Overall building maintenance accounted for 2.9 per cent of the variance, while flooring type accounted for an additional 1.5 per cent. Improving one rating in these categories would increase the overall assessment score by 3.4 points and 4.1 points respectively. As in the analysis of third grade English scores, acoustical ceiling tiles are often installed during renovation and may have certain noise control properties. In this case, ceiling type may again be a proxy variable for renovation or noise control. Overall building maintenance, particularly of electrical and cabling systems, could have

an impact on technology availability and functionality and thus impact student achievement in this area. The relationship of floor type is unclear, as responding schools were almost equally divided between carpeting and tile/terrazzo flooring.

Conclusions

Clearly, certain school building and cosmetic characteristics, when combined with socio-economic information, can provide partial explanations for the variance in student achievement on Standards of Learning Assessments in English, mathematics, and technology. Improving certain building conditions, particularly air conditioning systems, can improve student achievement. Air-conditioning was identified as a significant factor in 3 of the 5 regression analyses in this study as well as in the studies conducted by Cash (1993), Hines (1996) and Earthman, Cash, and Berkum (1995). Building cleanliness, while measured by different variables, also was a factor identified by 3 of the 5 regression analyses in this study as well as Hines (1996) study. Elementary schools in Virginia do seem to be in better overall condition than their counterparts nationwide. However, this factor should not mask the fact that considerable expenditures on building infrastructure are needed now to address specific structural weaknesses and will be needed in the future as these schools continue to age.

Implications for Practice

This study has implications for public educators across Virginia as they continue to confront demands for higher levels of accountability for student achievement in a challenging budget environment. One of the first issues that must be confronted concerns the role that socio-economic factors play in student achievement as measured by the Standards of Learning Achievement tests. Over 40 per cent of the variance on both levels of the English assessment as well as the technology assessment can be explained by the percentage of students participating in the federal free and reduced-price lunch program. A smaller percentage of the variance in math scores at both levels can be explained by free and reduced-price lunch participation. Clearly, schools are not on a level playing field as they move into a period where school accreditation will be tied to SOL assessment scores. The expectation that all schools, regardless of socio-economic profile, should achieve the same level of achievement on the same time schedule is not supported by this research. Policy makers should take this information into account as the expectations for accreditation are reviewed and revised.

The fact that schools are not on a level playing field from a socio-economic perspective magnifies the importance of the other factors identified in the study that can be improved or controlled. The most prevalent factor that emerges is air conditioning. Adding air conditioning to schools that don't have it, or improving efficiency in schools where air conditioning is already in place are logical steps

that can be taken by school administrators and facility planners. Keeping buildings clean and well-maintained also emerged as factors that can be controlled at the school level and have a positive influence on student achievement. Controlling noise as much as possible would also have a positive impact on achievement in some cases. Each of these factors does have budgetary implications at both the school and division level.

Despite significant efforts on the part of both state and federal authorities, there are still elementary schools in Virginia with little or no Internet access. Universal access to the plethora of teaching and learning materials available through the Internet must remain a priority for financial planners and technology officials.

School planners and finance officers should also take the age of school buildings across the state into account when making long-range plans for overall expenditures and facility improvements. Old buildings are not going to improve without significant capital outlay, and the high number of older schools still in use represent an unknown liability for future budget years. Older schools often lack the flexibility needed for innovative programming, and their physical structure often limits their adaptability for instructional technology. Continued use of aging, outdated facilities may send the wrong message to parents, students, teachers and the community about the local commitment to education.

Recommendations for Future Research

Several topics for future research emerge from this study. They include:

1. This study could be replicated at the elementary level in several years after the Standards of Learning Assessments are more established and schools have more experience in preparing students for these tests. As school divisions move closer to the date that these tests will be used to determine their accreditation, they will have had more time to monitor and adjust their instructional program to align with this assessment program. Some consideration might also be given to having someone other than the building principal complete the survey instrument. Site visits to spot-check results or interviews with a principals of schools with very high or very low SOL scores might enhance the research.

2. This study could be repeated on a national level. The survey instrument, though revised, is still very close in content to the instruments used in past Virginia studies. It should now be administered on a national level to determine if similar relationships between these variables and student achievement exist on a national level. This type of study would also be pertinent due to the continued national debate on the role the federal government should play in replacing the aging school infrastructure found across the country. However, certain problems are inherent in a national study. There is no uniform national measure of student achievement that could be used for analysis. While Stanford 9 or similar test scores might be used, they do not have a direct correlation to what is taught in

specific classrooms on a specific grade level in a given school year. In addition, the degree of knowledge building administrators have regarding their school building may not be uniform and may influence results.

3. This study, with minor modifications in the survey instrument, could be administered to a representative sample of middle schools across Virginia. Middle schools are the only level in Virginia that have not been studied using this type of survey instrument. Middle schools are also participating in the same state assessment program used in this study, so a uniform measure of student achievement is available state-wide. Middle school students and their problems continue to be topics of intense study, and the role facilities may play in these students' academic lives is also a worthy topic for review.

4. Finally, a more detailed study of technology infrastructure, equipment, and utilization of technology could be conducted to gain more insight into the factors influencing the technology assessment score as well as the role technology use plays in achievement in other subject areas. With the massive investment of state and federal dollars already made in technology as well as the increased pressure on schools and school divisions to utilize technology in daily instruction, technology is emerging as an important research topic. The high cost of technology and its strong reliance on building infrastructure improvements for implementation also mark technology as a potential source of difficulty for divisions already plagued by aging buildings and tight budgets.

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APPENDIX A

Survey No. _____

AN ASSESSMENT OF

BUILDING AND CLASSROOM CONDITIONS IN

ELEMENTARY SCHOOLS IN VIRGINIA

.

NOVEMBER, 1998

SURVEY CONDUCTED BY
JAMES W. LANHAM, III
VIRGINIA TECH

INSTRUCTIONS: You are asked to rate specific features of your school building and classrooms as well as provide certain demographic information regarding your school. Please use your best judgment and experience as a building administrator to answer these questions. Circle the best response for each question or fill in the appropriate blank.

Part 1 - Questions relating to the school building in general:

1. What is the age of the school building in years? (Please base your answer on your best estimate of the time period during which most of the space used by students was built.)

   _____ years old.

2. What description best fits the school building?

   A. The building was originally designed and built as an elementary school.
   B. The building was originally designed and built as a secondary school, but underwent major renovations before conversion to an elementary school.
   C. The building was originally designed and built as a secondary school, but underwent some renovations before conversion to an elementary school.
   D. The building was originally designed and built as a secondary school and was not renovated before conversion to an elementary school.

3. What year was the last major renovation to the school building completed? _____ (if no renovations have ever been done, write none).

4. Are there visible indications of roof leaks in the building?

   A. No visible signs, or only a few old water spots in ceiling.
   B. Ceiling is currently developing a few new stains due to minor leaks.
   C. Ceiling is deteriorating due to water damage, or water falls in some area of facility requiring buckets for water collection.

5. When was the last time interior walls, including classrooms, were painted?

   _____ years ago.

6. When was the last time the exterior painting was completed?

   _____ years ago.

7. How would you rate the electrical service in the school building?

   A. There is sufficient electrical service to meet all current building needs with room for expansion.
   B. There is sufficient electrical service to meet all current building needs with little room for expansion.
   C. Electrical service is not sufficient to meet current building needs.

8. What kind of flooring is found in the majority of the instructional spaces?

   A. Carpet
   B. Tile or Terrazzo
   C. Wood Floor

9. Is the facility located near a busy, major highway, a frequently used rail line, an area where aircraft frequently pass overhead, or any other loud noise producing environment?

   A. No
   B. Yes, but measures have been taken to reduce the level of noise within the facility.
   C. Yes, and no measures have been taken to reduce the level of noise within the facility.

10. How would you rate the overall maintenance of the school building? When answering this question, consider such maintenance items as general repairs, light bulb replacement, the maintenance of plumbing, electrical and similar systems, etc.

    A. Outstanding
    B. Very good
    C. Satisfactory
    D. Needs improvement
    E. Poor

11. How would you rate the structural condition of the school building?

    A. Outstanding
    B. Very good
    C. Satisfactory
    D. Needs improvement
    E. Poor

Part 2 - Questions relating to the school's classrooms:

12. Please provide the following information regarding your classrooms:

    Total number of classrooms in your school: _____

    Total number of classrooms located in permanent structures: _____

    Total number of mobile classrooms or trailers: _____

Questions 13-28 apply only to the classrooms in your permanent structure. Do not consider trailers when answering these questions.

13. How many classrooms do not have windows? _____

14. Which of the following best describes the heating system in the school?

    A. Even heat/able to control in each room.
    B. Even heat/unable to control in each room.
    C. Uneven heat/unable to control in each room.

15. Which of the following best describes the air conditioning system in the school's instructional areas?

    A. Air conditioning in all instructional spaces which can be well-regulated
    B. Air conditioning in some instructional spaces, or air conditioning in all instructional spaces, but not well regulated.
    C. No air conditioning in instructional spaces.

16. What is the type of lighting in the majority of classrooms?

    A. Incandescent Lighting
    B. Flourescent Lighting

17. What color are the walls in the majority of classrooms?

    A. Pastel colors
    B. White or off-white
    C. Dark colors

18. What type of material is used for the majority of interior classroom ceilings?

    A. Acoustical tiles
    B. Plaster
    C. Wood
    D. Metal

19. How often are classroom floors swept (if wood, tile or terrazzo) or vacuumed (if carpeted)?

    A. Daily or more frequently
    B. Weekly
    C. Monthly

20. How often are classroom floors mopped (if wood, tile or terrazzo) or cleaned (if carpeted)?

    A. Daily or weekly
    B. Monthly
    C. Annually

21. Which of the following best describes electrical service in classrooms?

    A. There is at least one outlet per wall in each classroom, or four or more outlets.
    B. There are two or three outlets in each classroom.
    C. There is one outlet in each classroom.

22. Do classrooms have connections to a school-wide local area computer network?

    A. Yes
    B. No

23. Do classrooms have connections to a district-wide or other wide area computer network?

    A. Yes
    B. No

24. Do classrooms have Internet access?

    A. Yes
    B. No

25. Do classrooms have cable connections to a central television antenna or other cable television system?

    A. Yes
    B. No

26. Which of the following best describes classroom furniture?

    A. All classrooms have furniture that is functionally sound and facially attractive.
    B. Though at least half the rooms may have some minor facial scars on student desks, all of the furniture is functionally sound and looks satisfactory.
    C. Most classrooms have furniture that is either facially scarred or functionally damaged.

27. Which of the following best describes the structural characteristics of the school's classrooms?

    A. Classrooms are self-contained spaces with a door that can be closed.
    B. Classrooms are in modified open spaces using movable partitions or furniture to identify classroom boundaries.
    C. Classes are held in open space areas shared with other classes.

28. How would you rate the overall cosmetic conditions in the classrooms?

    A. Outstanding
    B. Very good
    C. Satisfactory
    D. Needs improvement
    E. Poor

Part 3 - General Questions relating to the school:

29. How would you rate the overall condition of the school, taking into consideration all building, classroom, and technology characteristics?

    A. Outstanding
    B. Very good
    C. Satisfactory
    D. Needs improvement
    E. Poor

30. What was the school's enrollment on March 30, 1998? _____

31. What percentage of the school enrollment qualified for free or reduced-price lunches on or about March 30, 1998? _____

32. What is the approximate acreage of the school site? _____ acres

Please go to the next page

Is there any additional information you would like to provide about the condition of the school building or classrooms? If so, please use this space for that purpose.

Also, any comments you wish to make that you think might aid in the study of the role school facilities play in student achievement would be appreciated.

Your contribution to this effort is greatly appreciated. If you would like to receive a summary of the results, please print your name and address on the back of the return envelope (**Not** on this questionnaire) and one will be mailed to you.

This survey is derived from the Commonwealth Assessment of Physical Environment developed by Dr. Carol Cash (1993) and from the State Assessment of Facilities in Education © by Dr. Carol Cash and Dr. Glen Earthman (1995). Their assistance and support in this endeavor is acknowledged and greatly appreciated.

See AppendixBp148.pdf