PERCEPTIONS OF ELEMENTARY SCHOOL PRINCIPALS REGARDING FLOOR COVERING AND A COMPARISON OF ELEMENTARY SCHOOL STUDENTS' PERFORMANCE WITH SOUND INTENSITY LEVELS

by

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(Under the direction of C. Kenneth Tanner)

ABSTRACT

Although there is some documented information about perceptions of teachers concerning the physical environment and its influence on student learning, behavior, and achievement, the literature is silent regarding perceptions of elementary school principals on importance of interior design elements, including floor coverings, in schools and the influence of floor covering on student achievement. The issues of the floor covering's role in absorbing noise, its contribution to classroom flexibility, safety, and security were investigated with respect to student achievement. The issues addressed in this study were investigated according to these questions:

1. What are the perceptions that elementary school principals have concerning the influence of the interior design elements such as floor and wall coverings, lighting, flexibility, acoustics, color, texture, patterns, cleanliness, and maintenance on student achievement, teacher retention, and student attendance?

2. Does the acoustics of the environment relate significantly to student achievement?

3. What floor coverings in the classroom relate significantly to the acoustics of classroom?

4. Are there any possible links between floor coverings in the classroom and student achievement?

The population for this study included public elementary schools in Georgia in the year 2002. To collect perceptual data, a questionnaire was distributed to a random sample of 100 public elementary school principals in Georgia. Based on the results of this survey, a sample of schools having carpeted and hard surface flooring in classrooms were selected for site visits to measure reverberation time and background noise. A sound level meter and reverberation meter were used for measuring acoustics. Information regarding student performance, teacher experience, and certification was also gathered from official records. Over 93% of the principals noted that the general classroom design has a somewhat strong impact on student achievement. When student achievement was analyzed, the control variables included socioeconomic status and teacher education and experience, while the volume of the classroom, surface area, and background noise were used in comparing reverberation times. A negative correlation was found when reverberation times and student mathematics achievement were analyzed, indicating that student mathematics achievement scores in classrooms with lower reverberation times were higher. In all subject areas studied, students attending schools having carpeted classrooms had higher achievement scores than those attending schools in hard surfaced classrooms.

INDEX WORDS: School Facility, Design, Floor Covering, Carpet, Student Achievement

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DEDICATION

This dissertation is dedicated to my mother, Reba Patricia Pittman Langford. Thank you for being the most wonderful, kind, loving person in my life. You are my TEACHER OF THE YEAR every year. Without your encouragement, I could not have accomplished my goals. Bell loves you!

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CHAPTER 1

NATURE OF STUDY

Introduction

School construction is becoming a major industry in the United States. Counties, cities, districts, and states are allotting fiscal funds and taxpayer dollars to build the newest, most modern and technologically advanced facilities in which to educate people for the future. As educators embrace how to adequately prepare students for their academic futures, there arises the question of where to educate these individuals, and these concerns are not necessarily limited to a certain state, town, or city. The dilemma focuses on specifically in what type of facility are students given the best advantage in which to most greatly benefit their learning. As this particular issue surfaces, many of the school buildings presently inhabited by students and staff are viewed to be in declining conditions. Local school boards throughout the country continually struggle with the decision to renovate, add to, or construct new facilities to meet the growing population needs (Castaldi, 1994). Such a decision is difficult to make when trying to consider short and long-term expenses and production and correlate this information with demanding requirements and community desires (Tanner, 2000b).

Any commitment made by a local school board requires community support in order to adequately meet the needs of parents, students, and area businesses. The undertaking by a school board to make a decision relating to facility construction is a lengthy and ongoing process which usually begins with a comprehensive school study

involving a community and economic analysis, education program analysis, financial analysis, and building reviews (Castaldi, 1994; NCES, 2000). The school facility is a large infrastructure with many technical specifications that must be examined thoroughly in order to create the most appropriate spaces for student learning and teaching. The perceptions that teachers and principals have about where students learn should now be considered as a guide to conducting research on the physical environment's influence on student achievement and behavior. This particular study focused on perceived variables that may link student achievement and the physical environment, specifically the various floor coverings as they influence the acoustics of the environment.

Statement of the Problem

Although there is some documented information about the perceptions of teachers concerning the physical environment and its influence on student learning, behavior, and achievement (Schapiro, 2000), the literature is silent regarding the perceptions of elementary school principals on the importance of interior design elements, including floor coverings, in schools. For example, there is a lack of information regarding what elementary school principals perceive about the impact of interior design elements such as acoustics, maintenance, cleanliness of the school, color and color patterns, textures of the floors and walls, the floor covering's role in absorbing noise, classroom flexibility, safety, and security relating to student achievement. Beyond perceptions of teachers and principals, there exist only a few scientific studies of the influence of the physical environment on student achievement (Heschong Mahone Group, 1999; Tanner, 2000b; Weinstein, 1979; Yarborough, 2001). While The National Center for Educational Statistics (2000) provided some research in the area of school facilities concerning age

and maintenance of buildings, it failed to include data relating the physical environment to student learning.

In order to address this dearth in the literature, this study addressed principals' perceptions of the physical environment. Using the results of the principals' perceptions, a sample of schools having both a "perceived good and bad acoustical environment" was selected for further study. The latter component of the study dealt with acoustical measures in the "perceived good and bad acoustical environments" and compared the measures of sound levels in these two environments to student achievement. The issues of the floor covering's role in noise absorption, its contribution to classroom flexibility, safety and security were investigated with respect to student achievement.

Purpose

One purpose of this study was to extend the findings of Schapiro's 2000 study to include the perceptions of elementary school principals regarding the interior design of the schools. Schapiro (2000) discovered that 73% of a national sample of teachers perceived the interior design of schools to be very important for creating a good learning environment; 55% perceived that classroom design impacts student achievement; and 69% of the teachers preferred carpet or a combination of carpet and linoleum, tile, or hardwood. Another purpose of this study was to provide an objective measurement of student achievement and determine if it is possibly a function the acoustical environment. The underlying theory relevant to this research was that the space where the children learn makes a significant impact upon academic achievement. More specifically, this study was designed to explore the effects of the type of flooring in the classroom on student outcomes.

Importance of the Study

No studies have yet dealt collectively with the perceptions of the school leader, the principal, regarding the impact of interior design components such as acoustics, comfort and safety, and aesthetic effects of floor coverings upon the student's academic achievement. Why is it important to know the perceptions of the school leader? As Hart and Bredeson (1996) have pointed out, "Principals are central players in bringing about improvement in educational outcomes for all learners in their schools" (p. 33). The principal is the instructional leader of a school and has the immediate responsibility for the school facility. Furthermore, school systems should involve the school principal in the planning and design of the school (McGhee, 2001). From the results of this study, school administrators and architects can use the information provided to create future optimal learning environments or modify existing ones using allotted funds for the most appropriate type of floor covering that will foster student academic growth. In essence, the findings from this study may fill the void that exists in what is now offered as information for the construction of the school facility.

Research Questions

Given the gaps in the research as delineated in the previous sections, the following research questions guided the two parts of this study:

1. What are the perceptions that elementary school principals have concerning the influence of the interior design elements such as floor and wall coverings, lighting, flexibility, acoustics, color, texture, patterns, cleanliness, and maintenance on student achievement, teacher retention, and student attendance?
2. Does the acoustics of the environment relate significantly to student achievement?

3. What floor coverings relate significantly to the acoustics of classroom?

4. Are there any possible links between floor coverings in the classroom and student achievement?

Assumptions

Several assumptions guided this study. First, it was assumed that appropriate methodology and instrumentation could be designed to scientifically answer the research questions. Second, socioeconomic and other variables were controlled in order to create an unbiased sample and make comparisons regarding student achievement among the schools. Third, it was assumed that the existing measures of student achievement were unbiased, valid, and reliable. Finally, it was assumed that the measures of the acoustical environment and the questionnaire were valid and reliable (See Table 3.1).

Summary of Procedures

For the purpose of this study, sets of data were gathered to answer the research questions. One set of data was related to the physical environment; another set dealt with the population of students and teachers. The population included the public elementary schools of Georgia in 2002. The sample (classified as rural, urban, and rural-urban) consisted of 100 randomly selected schools having pk-5 or k-5 organizational structure.

To collect the perceptual data, a questionnaire was created and sent to a random sample of 100 public elementary schools in Georgia. The questionnaire was validated in Spring 2002. This questionnaire, completed by the principals of the schools, was similar to that used in the national survey of school teachers by Schapiro (2000). The survey question regarding the present type of floor covering in classrooms was used to select schools to be visited. Other variables of particular importance to this study addressed by

the questionnaire included acoustics, comfort and safety, and aesthetics. Thirty-one of these schools were selected for site visits. Schools were divided into two categories: those with "perceived good and bad acoustics".

Other instruments were needed to measure acoustics in the sample of schools. A digital sound level meter (Model 407764) was used to measure initial background decibels, and a reverberation time meter (Goldline – GL 60) was used in measuring reverberation time. The researcher, to learn the appropriate use of this instrument and ensure a systematic data set for the 31 schools, attended a special seminar determining the most effective procedures to collect acoustical data in an existing school building. Measures of acoustics in the 31 schools were taken scientifically with the standardized instruments and measurement procedures.

Following the collection of the environmental data, information regarding student performance and teacher experience and certification was gathered for each of the schools. These data were collected from recent standardized testing scores and information indicating student ethnicity and socioeconomic status were also collected. Data regarding teachers that were collected included teacher training, experience, and certification level. These factors relative to the teaching staff and socioeconomic status were used as covariates to ensure valid comparisons on the dependent variable of student achievement. Furthermore, information regarding school characteristics and floor covering was also detailed in the analysis. Following data coding, statistical treatment included frequency counts, percentages, analysis of variance, and multiple regression analysis (alpha $\leq .05$).

Definition of Terms

Acoustics (Acoustical Society of America, 2000) relating to the airborne sounds

Decibels (Acoustical Society of America, 2000) (dB) the measurement of sound intensity levels and sound pressure levels

Noise Reduction Coefficient (Gilliland, 1972) single number rating average of material's sound absorption

Reverberation (Acoustical Society of America, 2000) measurement of how quickly sound decays in a room

Rural (U.S. Census Bureau, 2000) all territory, population and housing units, located outside of urbanized areas and urban clusters

Signal- Noise Ratio (Acoustical Society of America, 2000) comparison for estimating understandable speech in a room

Sound Absorption Coefficient (Gilliland, 1972) percent of reduction of airborne sound

Urban (U.S. Census Bureau, 2000) all areas, population and housing units, located within urbanized areas and urban clusters.

Urban Areas (U.S. Census Bureau, 2000) areas of densely settled territory that contains 50,000 or more people.

Urban Clusters (U.S. Census Bureau, 2000) areas of densely settled territory that has at least 2500 people but fewer than 50,000 people.

Limitations of the Study

Some limitations, constraints, considerations, and gaps that may have hindered accurate findings were inherent in this study. Assessment of acoustics was thorough,

given the instrumentation. The instruments used for sound measure were the Extech Sound Meter and the Goldline reverberation time meter (GL 60). Many other variables possibly caused limitations. For example, the evaluation was dependent on the responses to the mail out survey. Socioeconomic status was represented in all schools studied through percentages of free and reduced lunches serving as indicators. Teacher quality was another concern for the sample studied, given as the education level of the teachers, teachers having the same degree of education from various institutions of higher education may not provide equal services to students through teaching. Even equal levels of certification may be questioned regarding quality of teaching. These gaps in the study were addressed and acknowledged as limitations associated with the conclusions and findings.

Organization of the Remainder of the Study

This study attempted to discover the relationship of floor covering in the elementary school classroom to student performance. Therefore, the history and information of carpet is established, and the research regarding floor selection, maintenance and cost is reported. The research presented in this paper acknowledges the benefits of carpet to the elementary classroom arena, specifically regarding the acoustics of the environment.

Chapter One outlined the need for the study including the statement of the existing problem and the purpose for the study. The research questions were presented and the summary of procedures used for the study. Definitions of terms relative to the study were provided, and limitations and assumptions were identified. In addition, the organization of the remainder of the study was given.

Chapter Two, The Review of Literature, details the literature reviews relative to school design, floor covering information and studies. Chapter Three, The Design of the Study, sets forth the research design used, the methodology, sampling procedures, and instrumentation details. Furthermore, in this chapter, the data collection method and analysis are described.

The Presentation and Analysis of Data are provided in Chapter Four of this study. This chapter analyzes the data collected from the mail out questionnaire, the survey conducted at the on-site elementary school visits, and the student and teacher population data. The results of the ANOVA are discussed. Furthermore, the variables factored into the study are identified.

Chapter Five summarizes the findings of the study. Additionally, suggestions for future studies are described. A list of references and citations are included followed by the appendices.

CHAPTER 2

REVIEW OF THE LITERATURE

Introduction

The purpose of this chapter is to review the related literature regarding the role of the floor covering as it relates to student achievement in elementary education. Involved in the review is a brief history of the elementary school, the design elements of the elementary school, and various studies and agencies which have reported specific findings and information as it relates to floor covering.

History of Elementary School

According to Castaldi (1994), the original school facility which surfaced in the mid 1600's can be described as the one room school housing approximately twenty to thirty students of various ages and grade levels. Though primitive, this basic design met the needs of the students and teacher. Castaldi (1994) suggested that these school buildings were simple and utilitarian. The citizens of this era considered the design of the one room building to be efficient and gave no additional thought to a design or plan. Historians concluded that the establishment used was often one of convenience and if constructed for the use of the school building was done so with whatever available materials could be gathered. These learning environments were not thought to be those of stimulation; adversely, these areas were described as gloomy, poorly ventilated, and overcrowded. Throughout the eighteenth century, there was no significant change in the look of these American schoolhouses. Free public education came to be through the

efforts of such men as Horace Mann and Henry Barnard (Castaldi, 1994). There was great regard given to providing education and what should be taught and to whom; yet, little thought was made to the advancement of the facility. Evan as larger cities began to house students in a more elaborate setting, there was still a lack of concern with regard to the specifics of the establishment. The results of the consolidated school movement included a variety of structures to be erected for educational purposes (Castaldi, 1994). The most common type of facility constructed during the twentieth century included these institutions, and they were seen as drab and uninviting. Following the Civil War, school facility construction exploded to meet the growing demands of the population. Bringing natural components into the environment was the stressed area of architecture (Castaldi, 1994). Natural lighting and window walls led the design for facilities of this era. However, energy problems soon developed and controlling the heat build up within the building became a concern. To compensate for this problem that had existed since the beginning of the century, windowless schools were constructed in the 1970's as school systems came into the possession of funding for buildings. For a period of time, this interior design was acknowledged as a positive facet. However, it was eventually noted that such windowless rooms were deemed less appropriate for the educational setting (Castaldi, 1994).

Prior to World War II, the elementary education classification was loosely defined and most often included grades one through eight, the traditional grammar school; while the high school housed grades nine through twelve. After the World War II, the junior high school came onto the scene and alleviated some of the overcrowding for the elementary schools. In different sections of the country, the regions allotted for the

various groupings and classifications of levels and grades (Castaldi, 1994). Such classifications became important to the designs of the schools as certain needs of the facility were and presently still must be addressed at the different grade level specifications. With the creation of the school lunch program, came the implementation of the cafeteria, gymnasium, media center and other multi-purpose rooms. As the population demanded new facilities, design teams, formerly uninterested in school buildings, began to focus on school facility construction. Often such ideas and innovations as the open classroom and windowless environments proved to be less efficient and were remodeled.

Before the 1950's very little research was conducted that directly related to the school facility. Since the middle of the twenty-first century, research has been completed that demonstrates that there is some scattered, scientific evidence that may specifically impact the school facility (NCES, 2000).

Design Elements

Though the research is limited, past researchers have studied individual topics and the elements related to the school facility and the influence on student attitude or student achievement. Some of the noted studies have focused on the lighting, color, age, climate, density of students and space, openness, and size. The findings of the various studies have produced information, though perhaps not deemed scientifically significant, that suggests these factors have impact on student attitude and student achievement. These characteristics, if individually influential to the achievement and attitude of students, when combined may be defined areas of the design of the instructional facility that may not be ignored (Tanner, 1999). Schapiro (2000) indicated that 92 % of the 1,050 public

school educators surveyed noted that classroom design has a strong impact on student learning. Research also indicated that quality-learning environments begin in the early planning stages.

> "The priority for good interior design elements in schools must begin at the pre-design and budgeting phases to evaluate inclusion in the project. Such evaluations should gauge the relative impact good design has on children's health and safety, and the school system's life-cycle cost and operating budgets." (Gavin, 2001, p. 1)

Very few teachers, 18%, who were surveyed (Schapiro, 2000) reported their classrooms to receive an "A" in the area of school design.

Lighting is one element that is observed to impact student achievement (Heschong, 1999). Luckiesh and Moss (1940) compiled data from a study of fifth and sixth students in well-lighted classrooms and those in poorly lighted (regular) classrooms. The study compared scores on the New Stanford Achievement Test of the students in the specifically defined classrooms. Those of the well-lighted classrooms demonstrated significant increases in scores of the achievement instruments. Another study conducted in 1970 by Knirck determined that improper illumination levels were abusive to the eye and created physiological consequences. The follow up study completed by Bowers and Burkett in 1987 demonstrated that improper maintenance of fixtures led to lower than average student performance including misinterpretation of the written word on a handout or at the chalkboard. Tinker (1939) experimented with the color, light, and intensity and light distribution focusing the study on the intensity element. His results suggested that minimum intensity at desktop level be no less than ten-foot candles for

classrooms. Hawkins's and Lilley's (1992) conclusions supported the Illumination Engineering Society suggestion of having 50 foot candles for regular class instruction and one hundred for instruction involving the viewing of the chalkboard. In addition to these requirements suggested by the study, a one window per wall per instructional space minimum was noted to enhance the educational environment.

Color schemes may impact learning and student attitude and achievement as determined by Sinofsky and Knirck (1981). Through the study, the researchers concluded that color schemes affect the student attention span and student's and teacher's sense of time. Rice (1953) indicated that planned color schemes positively impacted student achievement, especially those in kindergarten. In 1973, Papadatos concluded that color created an environment pleasing and stimulating rather than depressing and monotonous. Further indications of the study by Papadatos included such conversion of the atmosphere led to reduced absenteeism and fostered positive school climate.

School building age as studied impacted a variety of learning aspects such as student attitude and student achievement. School building age and its relationship to student achievement was reported by McGuffey and Chan in 1978. This study determined that those fourth grade students attending newer, more modern facilities had higher academic achievement as measured by standardized testing instrument, Iowa Test of Basic Skills. Another study directed by McGuffey and Crammer (1976) found that those attitudes of students who attended newer and renovated facilities were more positive than those students who attended older, dilapidated facilities.

Climate or thermal setting is specific regarding its relationship to learning. Herrington (1952) determined that temperatures above 80° F produced harmful

physiological effects and decreased efficiency and output. Manning and Olsen (1964) concluded that air conditioning was considered to be the most important factor in creating the appropriate thermal environment for learning. McDonald (1960) studied teacher attitudes and the relationship to the thermal environment. Teacher surveys indicated that improved air conditions through air conditioning reduced annoyances and improved flexibility. Teachers viewed their improvements in attitude as a result of less fatigue created by the pleasant atmosphere. McCardle (1966) found those students in environments with ideal thermal conditions tended to make fewer errors and required less time to complete assignments and tasks than those students instructed in these less than optimal conditions. Stuart and Curtis (1964) discovered students of climate-controlled schools had greater academic achievement gains than those in schools with no climate control.

External and background noises influenced student achievement and were viewed to be a major blockade to instruction. Unwanted noise reduced human energy and efficiency as reported by Glass (1985). Dixon (1953) concluded that external noises detrimentally affected verbal interaction between students and teachers. Bronzaft and McCarthy (1975) reported the elevated noise levels of New York City hindered reading skills of students nearer to the subway tracks. In a detailed study conducted by Cohens, Evans, Krantz, and Stokols (1986), findings indicated that some students from noisy schools had elevated feelings of helplessness, higher blood pressure, and less cognitive task success.

Class size and teacher and student ratio were reported to significantly impact student achievement (Tanner, 2000a). Project Star and various other studies suggested

higher student achievement of students in smaller class sizes. Furthermore, increased equity was viewed as a factor of the smaller class size. Through the Project Star, determinations made indicated those students of economic disadvantage greatly benefited from smaller class size and pupil density (Achilles, Finn, & Bain, 1998). As class size relates to density, there have been few studies with regard to student performance conducted in the elementary setting. Krantz and Risely (1972) studied kindergarteners and found that those closely surrounding the teacher reading a story or leading instruction were less attentive than those who were seated in a semicircle setting with more space between and about them. Shapiro (1975) concluded noninvolved behavior of nursery school aged children was most frequent in settings with less than 30 square feet per pupil and least frequent in areas that had between 30 and 50 square feet per student. However, the noninvolved behavior was higher in areas with more than 50 square feet per child. These findings supported the issue of density of the physical education setting and student behaviors.

These suggested factors when combined may have significant influences upon student achievement and attitude (Tanner, 1999). Such elements may also impact teacher attitude. In addition to these suggested design elements, carpet was another recommended factor of creating an ideal learning environment. The American Institute of Architects described carpet as an integral, vital part of school design (Cutler, 1973).

Carpeting and Other Types of Floor Covering

When selecting floor covering, other factors are considered along with cost of floor covering. According to Schapiro (2000), selection is based upon acoustics, safety,

comfort, cleanliness, maintenance, and aesthetics. These suggested parameters guided the remainder of the literature review.

Prior to the 1950's the standard floor covering was a hard surface covering (Castaldi, 1994). The first elementary school reported to have installed carpet was the Peter Pan Elementary School in Andrews, Texas in 1956. This new wool material enabled educators and architects to create a more controlled environment for the learning process. At this introduction, many began to realize the importance of carpeting in creating a stimulating, comfortable learning environment. As the importance of soft flooring began to be acknowledged, other schools installed carpeting as well. In 1958, Shaker High School in Latham, New York installed an acrylic and wool blend of carpet. Andrews High School in Texas opened in 1961 with wool carpet as its choice of floor covering. Gilliland (1972) suggested that the trend of using carpeting for the major portion of the school building created an excellent atmosphere in a good learning environment.

Factors that have been considered important to school administrators and architects regarding the selection of carpet have remained consistent since the introduction of carpet into the school environment. Such qualifications for chosen carpet include compactness, durability, ease of cost and maintenance, and antistatic and flame retardant properties (Frese, 1973). Shaw and Davis noted as early as 1976 that the reasons for choosing carpet for the school setting include "sound absorption, aesthetics that improve student discipline and attention, maintenance savings, thermal economies, and protection against slips and falls" (p. 53). Gilliland (1972) indicated that the different backings of carpets vary greatly and affected to the sound control of the area. Various

backings included rubber backs, jute backs, and polyvinyl chloride backs. Density was another criteria relative to choice carpeting. The number of tufts through the width and length of the carpet specified pile density or pile height. Accordingly, Bayman (1975) noted, " the closer the tufts, the better the carpet. It is advisable to purchase a carpet with a high, dense pile; if the cost is prohibitive, a low dense pile should be the next choice" (p. 5). For the purposes of commercial carpeting, five main fibers are used for manufacturing including wool, nylon, acrylic, polypropylene, and polyester. (Bayman, 1975) A large majority of the carpets in schools are tufted with quality dependent upon yarn quality, yarn pile, and backing material. (Dole, 1973) Additionally, Droper (1974) reported "tight, weave hard fiber carpets, appear better, longer" (p. 49).

There are a variety of flooring options that are available to schools, which include any combinations of tile, carpet, hardwood floor, linoleum or vinyl, and carpet. According to research conducted by Schapiro and Associates (2000), preference of flooring varies by the region of the United States. Carpeting was present in 61% of the Mountainous and Farming regions, 52% in the Southwest, by 46% on the West Coast, 43% in the Midwest, 35% in the South, and 32% in the Northeast. Furthermore, carpeting was most favored by teachers in the areas where its presence was greatest, and it was less popular in areas where least prevalent (Schapiro, 2000). Schapiro also indicated that 79% of the teachers who have carpet favor it as flooring choice. Elementary teachers were more likely than their colleagues teaching middle or high school students to think that carpet was a factor of learning and achievement (Schapiro, 2000). Elementary educators and those who have carpet in the instructional area indicated carpeting as making the classroom quieter (74%), carpeting more comfortable

to stand on while teaching (65%), carpeting providing more classroom flexibility (54%), and carpeting making a classroom more attractive (44%). Thirty-three percent of the elementary teachers and those who had carpeting who were surveyed strongly agreed that carpeting helped to prevent falls and injuries making a classroom safer (Schapiro, 2000).

The Carpet and Rug Institute (CRI) communication specialist, Kathy Sellers, reported in the *Pittsburgh Business Times* (2001) that the installation of carpet in the education setting provided a quieter, safer, more comfortable area. Shapiro (2000) informed that those teachers who teach in settings with carpet were more likely to give those settings higher scores for overall design features.

Hardwood flooring surfaces including vinyl and tile provided good performance, but concern has surfaced that such types of flooring lend to problems ranging from glare, noise, and foot fatigue (Ellis, 1999). Gilliland (1972) maintained that carpet is not to be viewed as a luxury, but a tool that motivates the learner providing benefits of safety and noise control. Bayman (1975) reiterated that carpet is not a frill, but it is a floor covering that endures high traffic and stress creating a long life expectancy. Schools and various other industries reported the life expectancy of carpet from twelve to twenty years maintaining proper care (Bayman, 1975).

Acoustics

Guilan (1974) acknowledged that complex tasks are impacted negatively when studied in conjunction with intense noise of unannounced bursts. However, these same conclusions have not been directed to the educational setting (Slater, 1968). Slater studied seventh graders' performance on standardized reading test varying in the settings of a quiet classroom, average classroom, and noisy classroom. These classroom settings

were defined according to their decibel ratings. Results demonstrated no noise effects. However, Bronzaft and McCarthy (1975) detailed reading scores of students housed in an elementary setting near an elevated train. Scores of the students closest to the noise were lower than those who were on the other side of the school building away from the noise. Another study conducted by Cohen, Krantz, Evans, and Stokols (1986) did not reach the similar conclusions of the Bronzaft and McCarthy study. Cohen, et al. (1986) studied the effects of noise on students who were educated in the air corridor of the Los Angeles International Airport. These students' reading and math performance was indicative of other students outside the corridor. However, the students in the air corridor region performed poorer on puzzle tasks and were more likely to experience learned helplessness and higher blood pressure following prolonged exposure to the noisy area.

"With the increased emphasis on education, we must seize the opportunity to end a long-standing American practice: the building of classrooms with inferior acoustics. This invisible problem has far-reaching implications for learning, but is easily solved" (Acoustical Society of America, 2000, p. 1). Solving the acoustical problems can be accomplished through simple planning measures. The acoustics of an area is measured through the sound absorption coefficient and the noise reduction coefficient. According to the Acoustical Society of America (2000), these measure the sound absorbed by a particular material. Another important measurement of acoustics is reverberation time, which indicates how quickly sound of a room decays. The volume and surface materials of a room determine reverberation time. The ideal reverberation time of a classroom ranges from .4 to .6. To reduce reverberation time, one of two things must be accomplished. Either the sound absorption materials must be used or the volume in the

room must be decreased. The absorption materials that reduce reverberation time include soft materials such as wall panels, carpet, or acoustical ceiling tiles. Signal to Noise Ratio is that which is used to measure understandable speech of a room. Signal to Noise Ratio is reduced further away from the speech or near a maximum noise distraction. Sound measurement in the form of decibels (dB) reports intensity level and pressure levels. Loud sounds have a greater decibel value than that of lower sounds. However, decibels cannot be added in a usual fashion due to their being on a logarithmic rather than linear scale (Acoustical Society of America, 2000).

> "In many classrooms in the United States, the speech intelligibility rating is 75% or less. That means that, in speech intelligibility tests, listeners with normal hearing can understand only 75% of the words read from a list. Imagine reading a textbook with every fourth word missing, and being expected to understand the material and be tested on it" (Acoustical Society of America, 2000, p. 2).

Elementary school classrooms can be very noisy settings in which children and adults may have problems concentrating. Paper shuffling, student talking, and the movement of desks and chairs are deemed to be internal noises by the American Speech, Language, and Hearing Association (1995). These greatly interfered with student learning. Glass (1985) reported these internal noises contributed to aggravated states of individuals. The reason for poor acoustics in the classroom cannot be attributed to lack of funds, but the Acoustical Society of America (2000) noted that it is lack of awareness that serves as the reason for this situation. Such acoustical problems can be avoided with forethought and

arrangement during the designing of the school facility (Acoustical Society of America, 2000). A weak suggestion for improving signal-to-noise ratios in classrooms was the sound reinforcement system. These are usually inexpensive and typically consist of a wireless microphone worn by the teacher with loud speakers located throughout the premises of the classroom. Though not costly, such systems had additional negative facets. For example, the sound from the loud speakers grew creating other sound problems. Often, the teacher's voice was the only voice made more intelligible through the use of this system. Even when the students who may ask questions or make comments used an additional microphone, this was cumbersome and creates extra static noises (Acoustical Society of America, 2000).

The Carpet and Rug Institute (2001) maintained, "Carpet is an investment in schools, our children, and the learning environment" (p.1). CRI (2001) further supported carpeting as a main factor for controlling the acoustics of an area and acknowledges that no other material can perform the dual function of providing a soft floor covering and absorbing airborne noises. CRI (2001) reported the 1995 findings of a survey conducted by the General Accounting office. The results of this survey cited that the number one problem affecting learning environment as reported by school administrators as poor acoustics.

Signal-to-noise ratio and reverberation are the measures representing the acoustical environment (Crandall & Smaldino, 2000). Siebein, Gold, Siebein, and Ermann (2000) cited air conditioning as the noise that overpowers the voice of the teacher in his study of classrooms. Other noises interfering with student learning include external noises such as cars and airplanes. Siebein, et al. (2000) suggested builders use

sound absorption materials to reduce the noise level below 35 decibels in the classroom creating an environment suitable for student learning. Among the materials cited by this professor for creating such environment include carpeting. "Simply including a sound-absorbing lay- in ceiling and thin carpet n the floor will usually result in good classroom acoustics and low reverberation time. This solution is inexpensive for new construction and is also an affordable way to renovate existing classrooms" (Acoustical Society of America, 2000, p. 11). However, the Acoustical Society of America (2000) further indicated, "Renovation of poorly designed classrooms is much more expensive. Even then, the cost of renovation is small compared to the social costs of poor classroom acoustics that impair the learning of millions of children" (p. 2).

A study reiterating the effects of external noises in the classroom relating directly to student comprehension was conducted by Eddy (1999). The researcher provided solutions naming carpet as an element combating these external noises. Teachers who have taught in carpeted and vinyl flooring classrooms noted noises were reduced in those classrooms with carpet (Eddy, 1999). Schmidt (1994) noted carpet as providing acoustical treatment for the classroom more appropriately than any form of hard surface floor covering. Gilliland (1972) documented that carpet produces 12 times the control of sound waves as that of hard floor covering.

Frese (1973) reported a detailed study conducting a series of scientifically controlled field experiments measuring noise levels before and after carpet installation, wall and floor. "As schools become more aware of the psychological effects of noise on the performance of their students and teachers, solutions will be sought. Ranking high among these solutions will most certainly be carpeting, for it has demonstrated

effectiveness as a reducer of impact and airborne noises both in the lab and in the human environment" (p. 52). Shaw and Davis (1976) cited sound absorbent carpeting as an essential element in creating the proper learning environment for students and teachers. "As a floor covering, carpet helps control both impact and airborne noises" (p. 38). Research demonstrated that floor carpeting reduced noise levels by 37% and wall carpeting reduced noise levels by 24% with the combination of flooring and wall carpet creating a 51% noise reduction (Bayman, 1975).

Frese (1973) reported the residual effects of the noise reduction included evidence of student behavior and improved teacher attitude. Elliot (2001) summarized well when reporting to the *Pittsburgh Business Times*, " 'Good design will enhance a student's learning potential. For instance, if you have flooring that is acoustically sensitive, there will be less noise and students will be better able to focus on what the teacher is discussing' " (p. 20). Additionally, in conjunction with other absorptive materials, the Acoustical Society of America (2000) claimed "add thin carpeting to the floors, and the result can be an acoustically wonderful classroom, with a low reverberation time, no echoes, proper distribution of reflections, and low self-noise, all achieved with common building materials" (p. 12).

Safety

The issue of safety may be two fold with regard to carpet. Various research cited carpet as creating safe measures in the classroom through preventing falls and slips and reducing glare encouraged by hard surface flooring. In addition, the indoor air quality of carpet has been studied and reported. Carpet and Rug Institute (2001) suggested that with the installation of carpet there are fewer slips and falls and reduced severity of

injuries due to cushioning of carpet when the falls and slips occur. Schmidt (1994) sounded these same findings acknowledging that carpet was slip resistant and the carpet created a cushioned barrier.

Schmidt (1994) conducted a study analyzing the health effects of carpet and hard surface flooring. His study followed the research conducted by Shaffer in the 1960's and Anderson in the 1980's. Schaffer and Anderson's studies specifically investigated the health effects of flooring in hospitals. Schmidt echoed this study in the classroom setting noting that much of the concern regarding indoor air quality of carpet was related to in adequate ventilation and moisture control. Poor maintenance and inadequate carpet installation may have caused some of these indoor air quality concerns. However, such concerns were not directly related to the inherent characteristics of the carpet. Schmidt's research (1994) found the airborne counts and bacterial counts to be significantly lower in the carpeted area than in the hard floor surfaced area. "The carpet and hard surface comparison conducted by the author indicated that there is no valid reason why carpet is not appropriate for schools, as well as for the hospital environments that have been studied" (Schmidt, 1994, p. 21).

> "Carpet use in schools provides a decrease in noise, falls, and injuries. Indoor air quality problems can be encountered with carpet and many other materials used if the school has any type of water problem, such as a leaky roof. If carpet remains damp, it can become a primary source for microbial growth which frequently results in adverse health effects on people" (The Environmental Protection Agency, 2001, p.1).

> Ellis (1999) cited moisture as the cause for less than adequate indoor air quality and emphasizes, "The biggest concern about carpet in this regard is its installation process, which traditionally used volatile, wet adhesives and required a lengthy 'off-gassing' period in unoccupied buildings. However, a non-wet installation adhesive eliminates harmful VOC's and permits installation during the school day. For example, 'peel and stick' non-toxic installation systems exceed the Carpet and Rug Institute's Indoor Air Quality by 20 times. While carpet is often blamed for problems ranging from allergies to air quality, tests show that poor indoor air quality in schools is caused most often by HVAC systems" (p. 2).

As a final summation, Schmidt (1994) cited, "Properly maintained carpet provides for better indoor air quality, primarily as a result of the sink effect and is appropriate for use in schools" (p. 22).

Comfort and Safety

The Carpet and Rug Institute outlined carpet to create a more flexible, comfortable learning environment. Carpet creates comfort for sitting and walking and provides insulation establishing a feeling of warmth. This warmth is measured according to actual thermal resistance or R-value (Carpet and Rug Institute, 2001).

> "Carpet provides a soft spot for young students to expand their learning space onto the floor. It seems impossible to think of a primary school class without carpet for play, music, games, learning, and rest time. It is also good for older students who want to sit around on the

> floor in brainstorming sessions or just 'hanging out'" (Carpet and Rug Institute, 2001).

Ellis (1999) reported that carpet established ergonomic comfort, which creates less stress on the young students' bones and muscles. This researcher also noted that carpet creates thermal comfort by reducing the hardness, coldness, and exceptional warmth of floors.

> Day (1999) noted, "Temperature control is easier and less costly to maintain when carpet covers the floor. Recent studies have shown that carpet can reduce fuel consumption from 5, 13% when compared to hard floors. The kinds of areas that are now carpeted in middle and high schools are expanding to include locker rooms and cafeterias" (p. 1).

Schmidt (1994) indicated that carpet was more comfortable to walk on especially when doing so for extended periods of time.

Cleanliness and Maintenance

The success and desirability of carpet relied greatly on the cleanliness and maintenance of the floor covering. Of those teachers surveyed (Schapiro, 2000), 26% rated their classroom floor coverings as "very well" cleaned and maintained, 53% responded that their floor coverings were "adequately cleaned and maintained, while 21% indicated their floor coverings were "poorly" cleaned and maintained. The Carpet and Rug Institute reported the importance of not only choosing appropriate carpeting, but also implementing and maintaining a specific maintenance program. Kennedy (1993) described effective elements in properly caring for carpeting revolving around the

establishment of a program outlining preventive maintenance, daily maintenance, and periodic cleaning.

Gilliland (1972) noted that carpet problems result from maintenance errors which surface from using inappropriate cleaning materials and inappropriate cleaning methods. As already noted, the Environmental Protection Agency described improper maintenance and cleaning can lead to poor indoor air quality. Excessive moisture has been identified as a major component in creating this "unclean" and poor air quality related to carpet (Environmental Protection Agency, 2001).

Cost

The Carpet and Rug Institute has established a formula for evaluating the cost associated with floor covering. The following formula describes the method of calculation:

$$\frac{\textit{Initial cost + Removal cost in renovation + cost of maintenance}}{\textit{Years of use}} = \textit{Life cycle cost}$$

The Carpet and Rug Institute assigned values to each of the parts of the formula noting that the price of carpet includes the initial carpet cost and installation. While renovating, the labor cost of removing existing carpet must be factored into the equation. The maintenance costs were estimates for the time and the labor of the daily regimen for cleaning the flooring (Carpet and Rug Institute, 2001). Gilliland (1972) reported that the cost of maintaining carpet are half the cost of maintaining tile though the initial cost of the carpet may be greater than that of the tile. The life of the carpet related directly to the

cost. A proper maintenance and cleaning program utilized the life of the carpet or diminished it (Gilliland, 1972). Bayman (1975) suggested,

> "When comparing the 'life' cost of carpet to most other material, research shows carpet to be far less expensive. Research has shown the man-hours of maintenance to be much less for carpet than tile, vinyl, or hardwood floors. Not only is there less labor costs in maintaining carpet, but there are far less costs in materials to do the job" (p. 3).

Furthermore, the initial cost of carpet must be added to the cost of supplying an adequate acoustical system in order to gain a true perspective of the relative costs relating to carpet and other floor covering types. In addition to these noted costs, long-range factors concerning the thermal value of carpet and reduced energy expenses must be calculated (Allen, 1972; Bayman, 1975).

Color, Texture, and Patterns

Color, texture, and pattern create carpet design (Niemeyer, 2001). The Carpet Information Centre (2001) advised,

> "Modern contract carpets offer virtually unlimited options in this respect from plain, discrete finishes to exciting, vibrant ones which enhance their surroundings. Even extreme design effects can be achieved without any loss of wear performance and long-term appearance retention" (2).

Color has been reported to have impacts upon student achievement (Sinofsky and Knirk, 1981 and Rice, 1953). Gilliland (1972) described color as being vital in selection of carpet. The quality of lighting and reflection of light in the classroom was directly related to color. Soothing effects were reported as a result of cool colors, blues and greens. Excitement and active behaviors were produced by the brighter colors, reds (Gilliland, 1972). Color also contributed to the ease of cleaning and maintenance of the carpet. Dark colors of carpet that absorbed light also highlighted soiled areas. With these thoughts in mind, great consideration must be given when selecting the color of carpet. "Use a color similar to the earth soils most prevalent in the area where the school building is located. It should be noted, however, that the color selected must be light enough to provide reflectance, which is necessary for a good visual environment" (Gilliland, 1972, p. 22-23).

The size and twist of yarns and the structure of the surface of the carpet establishes the texture of a carpet. The textures of carpet include a wide range of choices, such as velvet plush, bulky Berbers, and sheared shags (Niemeyer, 2001). The majority of carpet construction is created by loop pile surface. Loop pile surface can be arranged in a variety of ways including level loop pile, multi-level loop pile, and cut pile. Frieze, tip-sheared, random sheared, shag, and carved sculptured are other surface designs are also loop pile textured used for carpet surface construction. The loops in the level loop pile surface texture have the same height, and the tighter these are woven, the more durable the construction of the carpet. Multi-level loop texture arranges the loops by varying heights. Though this carpet construction is not as durable, soils and other wearing are hidden more easily than other textures of carpet. Cut pile textured carpet is

level loop pile texture; however, the ends have been cut so no loop is present. Velvet, plush, and Saxony are forms of cut pile carpet. Velvet or plush carpeting yarn has no twist; Saxony texture is created through twists. Velvet or plush carpeting looks as if the carpet has shading and shows foot and vacuum prints. Frieze texture is also created through tight twisting of the yarn and shows little soiling. Tip-sheared texture is a level height and created through a combination of cut and uncut loops. Shading is not evident with tip-sheared texture; however, footprints are easily shown. Random sheared textures have multi-level loop pile of cut and uncut loops. Shag textures also have long cut and uncut piles hiding soils well but less durable than multi-level loop pile textures. Carved sculptured texture is produced by removing sections of the surface of yarn in distinct patterns. (Niemeyer, 2001). Bayman (1975) further suggested that the representation of patterns in the fabric of carpet was equally important in carpet selection. The best selections included those with tweeds or patterns. Bayman (1975) also noted that the various extremes of the spectrum regarding color and patterns should be avoided. Dole (1973) indicated with regard to carpet choice, "When in doubt, select a muted tweed" (p. 46).

Summary

Documented research has provided the history of the elementary school and the relevance of proper school design as it relates to the elementary school setting. The focus of this study was to discover the relationship of carpet in the elementary school classroom to student performance. Therefore, the history and information of carpet have been established, and the research regarding floor covering selection, maintenance and cost reported. The research presented in this paper acknowledged the benefits of carpet to the

elementary classroom arena. Each research question has been addressed through the review of literature (See Table 2.1).

Table 2.1 provides an overview of the literature review and research questions.

Research Questions	References
What are the perceptions that elementary school principals have concerning the influence of the interior design elements such as floor and wall coverings, lighting, flexibility, acoustics, color, texture, patterns, cleanliness, and maintenance on student achievement, teacher retention, and student attendance?	Achilles, Finn, & Bain (1998), Bowers & Burkett (1987), Bronzcraft & McCarthy (1975), Castaldi (1994), Cohens, Evans, Krantz, & Stokols (1986), Dixon (1953), Gavin (2001), Hawkins & Lilley (1992), Herrington (1952), Krantz & Risley (1972), Knirck (1970), Luckiesh & Moss (1940), Manning & Olsen (1964), McCraddle (1966), McDonald (1960), McGuffey & Chan (1978), McGuffey & Crammer (1976), NCES (2000), Papadatos (1973), Rice (1953), Schapiro (2000), Shapiro (1975), Sinofsky & Knirck (1978), Stuart & Curtis (1964), Tanner (1999), Tanner (2000a), Tanner (2000b), Tinker (1939)
Does the acoustics of the environment relate significantly to student achievement?	Acoustical Society of America (2000), American Speech, Language, and

	Hearing Association (1995), Bronzaft & McCarthy (1975), Cohen, Krantz, Evans, & Stokols (1986), Crandall & Smaldino (2000), CRI (2001), Eddy (1999), Glass (1985), Guilan (1974), Siebein, Gold, Siebein, & Ermann (2000), Slater (1968)
What floor coverings in the classroom relate significantly to the acoustics of classroom?	Allen (1972), Bayman (1975), Carpet Information Centre (2001), CRI (2001), Day (1999), Dole (1973), Elliot (2001), Ellis (1999), EPA (2001), Frese (1973), Gilleland (1972), Kennedy (1993), Niemeyer (2001), Shaw & Davis (1976), Schapiro (2000), Schmidt (1994)
Are there any possible links between floor coverings in the classroom and student achievement?	Allen (1972), Bayman (1975), Carpet Information Centre (2001), CRI (2001), Day (1999), Dole (1973), Elliot (2001), Ellis (1999), EPA (2001), Frese (1973), Gilleland (1972), Kennedy (1993), Niemeyer (2001), Shaw & Davis (1976), Schapiro (2000), Schmidt (1994)

CHAPTER 3

DESIGN OF THE STUDY

Introduction

This chapter reports the design of the study noting method, sample selection, instrumentation, procedure for data collection, and analysis of data. Following the review of the research questions, collection of data and statistical treatment are explained.

Research Questions

Given the gaps in the research as delineated in the previous sections, the following research questions guided the two parts of this study:

1. What are the perceptions that elementary school principals have concerning the influence of the interior design elements such as floor and wall coverings, lighting, flexibility, acoustics, color, texture, patterns, cleanliness, and maintenance on student achievement, teacher retention, and student attendance?
2. Does the acoustics of the environment relate significantly to student achievement?
3. What floor coverings in the classroom relate significantly to the acoustics of classroom?
4. Does the floor covering of the classroom relate significantly to student achievement?

Participants

The population for this study included all of the public elementary schools in the state of Georgia for the 2001-2002 school term having the grade structure of pre-kindergarten through five or kindergarten through five. School districts were categorized as suburban, urban, or rural according demographic characteristics and the definition of each of these as outlined by the United States Census Bureau (2000). From the population, a stratified random sample of 100 schools was drawn according to the percentages of urban suburban, and rural schools. All city and county school districts in the state of Georgia were identified by the researcher. Using the Georgia state map provided by the 2000 Census, each district was placed into one of three categories: rural, rural-urban or urban. This map is available to the public, on the Internet (See Appendix C). After each school district was identified and categorized, individual elementary schools, grades Pk-5 or k-5, were documented in each district. Using the total number of elementary schools and the total in each category, the sample size for each category was determined. With a total sample size equaling 100, the researcher selected 73 rural schools, 11 rural-urban schools and 16 urban schools using a systematic random sampling method. Schools were randomly chosen to represent the population of 180 school districts in the state of Georgia. The sample size was divided by total school districts. This provided the researcher with a randomized number with which to choose the school districts that were included in the sample (See Table 3.1). For rural districts the systematic number used to select from the population of was 3, the number for rural-urban was 1 and the number for urban school districts was also 1. An alphabetized listing of Georgia schools and districts was used to randomly select the sample population. A

coin toss determined that the first eligible school in each rural district would be chosen until a total of 73 schools were achieved. Another coin toss determined the second eligible school in each urban-rural district would be chosen until the goal of 11schools had been attained. A third coin toss determined the second eligible school in each of the urban districts would be chosen until 16 schools had been identified. To be eligible for the study, the elementary school had to serve grades PK-5 or k-5. If the randomly assigned school did not meet the criteria the researcher advanced to the next eligible school in that district and rolled forward from this point using the same systematic process. If the end of the district list was reached before the predetermined number of schools was attained the researcher looped back to the beginning of the alphabetized list until the correct number of schools had been identified. The table below provides the sampling information for the school selection.

Table 3.1 Sampling Information for Selecting Elementary Schools

Classification	Rural	Rural-Urban	Urban	Total
# City School Districts	12	20	9	41
# County School Districts	119	0	20	139
Total # Districts	131	20	29	180
# of Schools in Each Classification	262 (73%)	40 (11%)	58 (16%)	360

A survey and cover letter (see Appendix A and B) explaining the purpose of the study was sent to each school principal. The survey requested subjective information regarding acoustics, comfort and safety, and aesthetics of the principal's school. The responses were then used to create a listing of 31 schools that the researcher visited to complete a test of acoustics with the real time data logging sound level meter and the reverberation time meter. Information regarding the classroom was recorded noting size,

volume, surface area, furniture arrangement, absorbing materials, floor covering, windows, and colors of walls.

Instrumentation

The questionnaire was tested in a pilot study to determine its reliability. The test-retest method was completed in the Spring of 2002. This statistic was interpreted as a reliability coefficient or index of stability. The reliability of the questionnaire was determined in the spring of 2002 using a test-retest method in a pilot study. In order to determine the reliability of the instrument, a two - week interval lapsed between the first and second administrations (n = 17). Seventeen professional educators including teachers and administrators responded to the questionnaire to determine reliability. Table 3.2 reveals correlation that range of from .6971 to .9990. There are various acceptable levels of reliability according to Garrett and Woodworth (1958). At this point in the study, it became important to know if the reliability coefficient for each sub-scale was satisfactory. According to these authors, the size of the reliability coefficient that is needed depends upon the nature of the instrument and the purpose for which it was designed. Garrett and Woodsworth (1958) stated that a reliability coefficient need be no higher than 0.50 or 0.60 if the instrument is designed to make a diagnosis (separating or classifying people or objects, for example). This study focused on the identification and classification of perceptions about reliability was set at 0.50 for each sub-scale. Table 3.2 reveals the reliability coefficients for each of the five sub-scales. All sub-scales were included in this study.

Table 3.2 Test- Retest Reliability Anaysis of the Questionnaire

Category	Questions	Correlations	Coefficients
Importance of interior design for learning, student retention, and attendance	1-3	.6971	p=.002
Impact on student achievement	4-15	.5689	p=.017
Maintenance and cleanliness of floor covering	16-17	.9990	p=.001
Agreement on acoustics, safety, flexibility, maintainability, and comfort	18-22	.5952	p=.012
Condition of schools and classrooms	23-24	.8734	p=.001

A standardized sound level meter and reverberation time meter were used to test acoustics. These readings were correlated to standardized test scores for each school. A checklist (See Appendix C) was used to make notations about classrooms of the schools visited.

Stanford 9 scores (from the 2000 tests) per school are available too the public through the Internet. The fifth grade average composite or reading and mathematics

scores were used to correlate with the scores on the acoustical measures and the specific floor covering of the classroom.

Method

As previously noted, the public elementary schools of Georgia served as the population for this research study. A variety of instrumentation was used to collect the data necessary for evaluating the research questions posed for this study. Principals responded to a mail out questionnaire. Student information obtained included the standardized test score as well as ethnicity and socioeconomic status. Teacher information included teacher training, experience, and certification level.

The student achievement scores represented the dependent variable. In addition to this variable, other teacher and student data served as covariates to establish valid comparisons of the dependent variable and student achievement. The covariates included student socioeconomic status, teacher certification and experience. The measures of acoustics served as the independent variable. Also, the floor covering material was an independent variable. Again, the study and statistical treatment controlled for student socioeconomic status, teacher experience, and teacher certification. From the identified schools visits were made in to 3 which fifth grade classroom were acoustically tested using a sound level meter manufactured by Extech and reverberation time meter manufactured by Gold. During the visits, the dimensions of the classrooms were measured and information about the room was recorded on the checklist. The sound level meter was placed in the center of the room, and the background noise was recorded. Following this observation, the observer stood near the center of the largest chalkboard in the classroom and fired a .22 caliber starter pistol manufactured by Jex (202) to record

the noise used to calculate the reverberation time. This procedure was also repeated by popping a paper bag (a alternate noise making device employed in case some schools would not allow the starter pistol). The acoustical measures were then correlated with student outcomes that were identified via school report card published on the Internet.

Of the 100 surveys mailed, 48 were returned. One of these was unusable because it was not completed on both sides. Two of the schools whose principals returned the survey were not pk-5 or k- 5 and thus did not meet the qualifications of the schools to be studied. These rejections narrowed the usable number of schools in the pool for site visitation to a total of 45.

Statistical Treatment

After the collection of the data, the researcher coded data by school (the unit of analysis) using a spreadsheet format. This statistical information generated from the sample data set included frequency counts, percentages, analysis of variance (ANOVA) and multiple regression analysis (alpha = .05). The student performance represented the main dependent variable, while other variables as noted above were covariates and independent variables.

Summary and Conclusions

In summation, the mail out questionnaire similar to that developed by Schapiro and Associate's (2000) established the baseline sample of schools to be visited by the researcher. Acoustics and classroom size were measured in each of the 31 schools as well as other specifics as indicated by a checklist. A comparison of achievement test scores and measure of acoustics was completed. The acoustics were compared in relation to the floor covering. Additionally, a comparison of achievement test scores and type of

floor covering was completed. It was hypothesized that those students attending schools with carpet, meeting the criteria established through the review of literature, would demonstrate higher achievement levels.

CHAPTER 4

PRESENTATION AND ANALYSIS OF DATA

Data Collection

A mail out questionnaire was sent to 100 randomly selected elementary principals in Georgia. In order to qualify for the study, the elementary school was required to include kindergarten through the fifth grade or pre-kindergarten through the fifth grade. Of the surveys mailed, 48 were returned, and 45 were usable as some were not adequately completed. Using the responses from the survey, specifically the question regarding floor covering and acoustical environment, there were 31 schools selected for site visits. However, some principals responded to the question with the whole school in mind, rather than the classrooms. This was discovered during site visits and justified the data reduction as noted later in this chapter. Additionally, the condition of the floor covering and the acoustical rating of the classroom were factors determining whether or not a school would be included for a site visit. This variable also figured into the necessary data reductions.

Supplemental data noting fifth grade test scores were collected for those schools identified for school visits. Specifically, test score information from the 2001 Stanford-9 was obtained via the School Report Card posted on the Internet by the Georgia Department of Education. Along with the test scores, other information including school size, student ethnicity, the reduced and free lunch ratio, teacher certification, and teacher experience were also reported. The reduced and free lunch information was used to

approximate socioeconomic status (SES). The variables used as covariates in the analysis of the student data were SES of the students, teacher certification, amount of teacher training, and teacher experience. These were included to minimize bias in the findings.

During the site visits, an individual fifth grade classroom was examined noting the dimensions specific to surface area and volume. Other notations on a checklist (Appendix C) were made specifying HVAC operation status, ceiling material, wall material, absorbing materials, furniture arrangement, floor covering type, color, and quality. These variables were included to assist in decisions about data reduction, if that became necessary. They were also needed to clarify any unusual variability in background noise and reverberation times.

In order to determine initial background noise, the decibel reading meter was placed in the center of the room, and the settings were placed on slow and 30 rather than fast or any other logging level. These speeds were the recommended settings by the manufacturer. This omni-directional recording instrument measured the background noise of the classroom. The reverberation time of the classroom was identified through the use of the reverberation time meter. This instrument was placed in the same position as the decibel reading meter. The researcher stood at the center of the largest white board area to produce the sounds to be measured for reverberation time. This was always in the front of the classroom and was assumed to be the place where the teacher did the majority of instruction. The reverberation time meter was set on the standard settings recommended by the individual manufacturers for the instrument. A paper bag was blown to capacity and popped to create the first noise to be recorded. Bags of equal sizes

were used through the testing. The reverberation time meter was reset to original settings, and the starter pistol was fired and the reverberation time was recorded. All of the information and data collected were documented in a database relative to each school code. These procedures and methods of data collection were used to provide information for assessing the following research questions:

Research Questions

1. What are the perceptions that elementary school principals have concerning the influence of the interior design elements such as floor and wall coverings, lighting, flexibility, acoustics, color, texture, patterns, cleanliness, and maintenance on student achievement, teacher retention, and student attendance?
2. Does the acoustics of the environment relate significantly to student achievement?
3. What floor coverings in the classroom relate significantly to the acoustics of classroom?
4. Are there any possible links between floor coverings in the classroom to student achievement?

Perceptions of Elementary School Principals - Question 1

Because of identified gaps in the literature, this study focused on this question: What are the perceptions that elementary school principals have concerning the influence of the interior design elements such as floor and wall coverings, lighting, flexibility, acoustics, color, texture, patterns, cleanliness, and maintenance on student achievement, teacher retention, and student attendance? Using the survey results, frequency counts were completed. Table 4.1 and Figure 4.1 identify the principals' perceptions of

questions #1 –3 of the survey. Approximately 98% of the responders noted that the school's interior design is important for creating a good learning environment.

Table 4.1 Responses to Questions # 1 - 3

Question	**2- Not very important**	**3- Somewhat important**	**4- Very important**
1-Importance of school's interior design for creating a good learning environment	2.1%	2.1%	95.8%
2-Importance of school's interior design for teacher retention	8.3%	54.2%	37.5%
3-Importance of school's interior design for student attendance	12.5%	60.4%	25%

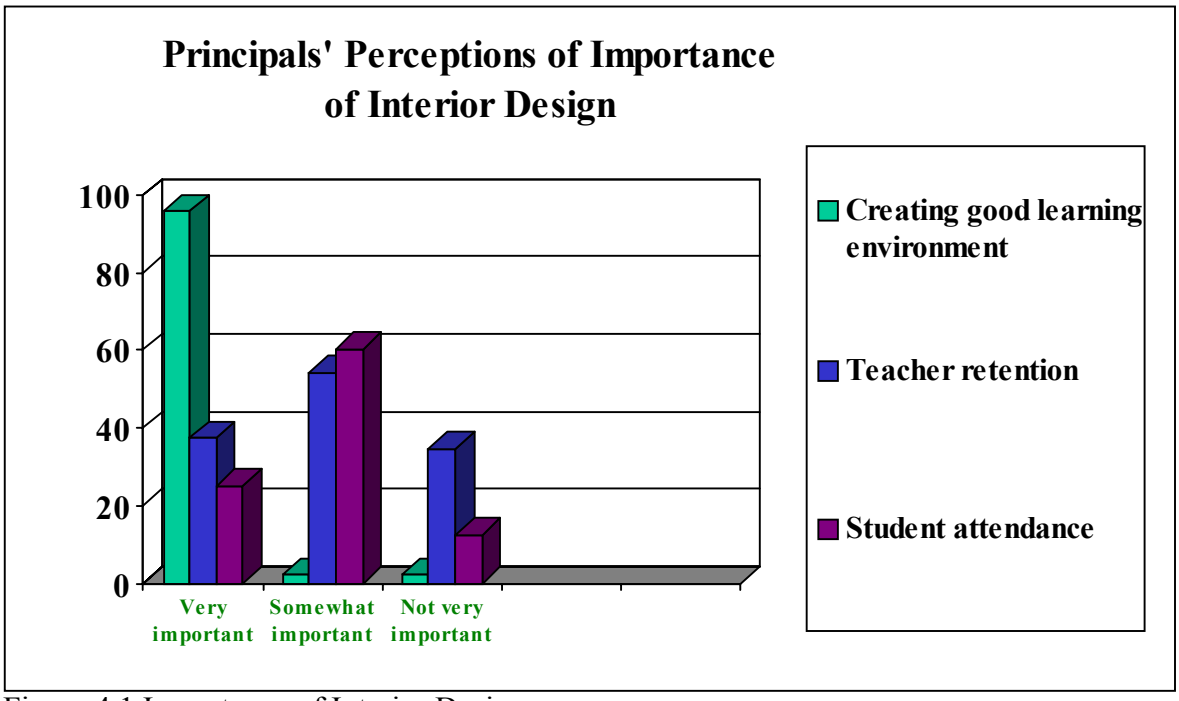

Figure 4.1 Importance of Interior Design

Questions #4- 17 asked principals to indicate the impact particular design aspects of the classroom have upon student achievement. Of those responses, 93.7% of the principals suggested that the general classroom design had a somewhat to strong impact on student achievement. More specifically, 4% indicated the classroom design has very little impact; while, 59% noted the classroom design has a somewhat strong impact, and 35% agreed that the classroom design has a very strong impact on student achievement.

Figure 4.2 outlines the principals' perceptions of the overall impact of the classroom design upon student achievement (question 4). Student achievement is impacted strongly by the classroom's physical environment, according to 94% of the principals surveyed.

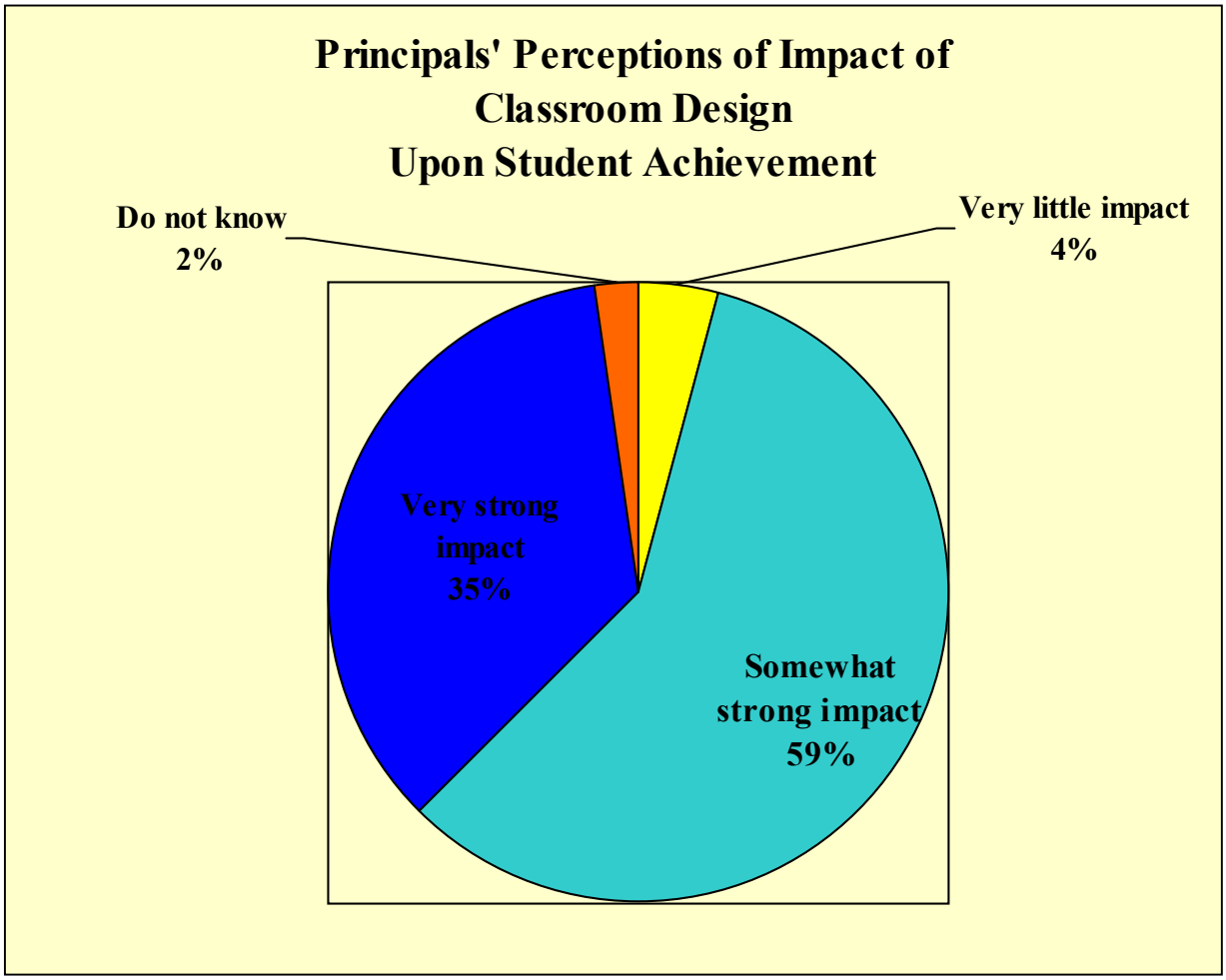

Figure 4.2 Impact of Classroom Design

Questions #5-7 of the survey dealt with the perceptions of elementary school principals regarding the lighting of classroom and the flexibility to arrange the classroom and the impact these factors have upon student achievement. For example, Table 4.2 identifies that natural lighting is perceived to have a strong or very strong impact on student achievement by 85.4 % of the principals.

Table 4.2 Responses to Questions #5 - 7

Question	1-No impact at all	2- Very little impact	3- Somewhat strong impact	4- Very strong impact	5- Do not know
5-Impact natural lighting in classroom has on student achievement	0%	6.3%	20.8%	64.6%	8.3%
6-Impact the ability to control lighting in classroom has on student achievement	2.1%	4.2%	43.8%	50.0%	0%
7-Impact flexibility to arrange classroom has on student achievement	0%	10.4	31.3%	58.3%	0%

Question #8 of the survey introduced the floor covering topics specifically regarding the impact a carpeted classroom has on student achievement. Fifty percent of the principals suggested that carpet has somewhat strong impact to very strong impact on student achievement. Of this 50%, 12.5% viewed the impact to be a very strong one upon student achievement. Only 4.2% noted that carpet has no impact at all on the student achievement, and 37.5% reported the carpet has very little impact on student achievement.

Table 4.3 notes the assessment of questions #9 – 12 which focused on the impact of quiet environment in the classroom, minimizing accidents in the classroom, ease of cleaning the classroom, and comfortable seating on student achievement. These questions focused on the impact that safety, security, and comfort might have on student

achievement. For example, 97.9% indicated that acoustics had a somewhat to very strong impact on student achievement.

Table 4.3 Responses to Questions #9 – 12

Question	**2- Very little impact**	**3- Somewhat strong impact**	**4- Very strong impact**
9-Impact a quiet environment with good acoustics has on student achievement	2.1%	27.1%	70.8%
10-Impact classroom that minimizes risk of accidents on student achievement	4.2%	29.2%	66.7%
11-Impact a classroom that has comfortable seating for students has on student achievement	18.8%	43.8%	37.5%
12-Impact of comfortable seating for students has on student achievement	0%	31.3%	68.8%

The next three questions of the survey centered on the aesthetics of the floor covering. Approximately 63% reported that attractive floor colors have a somewhat strong to very strong impact upon student achievement. Over half of those surveyed, 56.3%, indicated the texture of the floor had little to no impact on student achievement, and 16.5% were unsure of the impact of the floor texture. Fifty percent noted the patterns of the floor covering had little to no impact upon student achievement.

Questions #16 and #17 examined principals' perceptions and the maintenance of and ease of cleaning the floor covering in their schools. Eighty-three percent responded that the floor covering of their school was well to very well maintained. Eighty-five percent of the responses indicated their floor coverings were well to very well cleaned.

Table 4.4 provides information regarding principal perceptions with specific focus on carpet. Issues of safety, acoustics, maintenance, and comfort are addressed. For example, 66.7% of the responders agreed that carpet helps prevent injuries in the classroom. Chart 4.3 outlines principals' perceptions concerning carpet maintenance noting that 42.6% agreed that carpet is somewhat easy to maintain, while 21.3% strongly disagreed.

Table 4.4 Responses to Questions #18 – 22

Question	**Strong Disagree**	**Somewhat Disagree**	**Somewhat Strongly Agree**	**Very Strongly Agree**	**Do Not Know**
18-Carpet absorbs noise helping to make a classroom quieter	0%	4.2%	33.3%%	60.4%	0%
19-Carpet helps to prevent falls and injuries making a classroom safer	4.2%	18.8%	39.6%	27.1%	8.3%
20-Carpet gives a teacher more flexibility, such as allowing children to sit comfortably on the floor	2.1%	6.3%	39.6%	47.9%	2.1%
21-Carpet is easy to maintain	20.8%	31.3%	35.4%	6.3%	4.2%
22-Comfortable to stand teaching	0%	6.3 %	27.1%	62.5%	2.1%

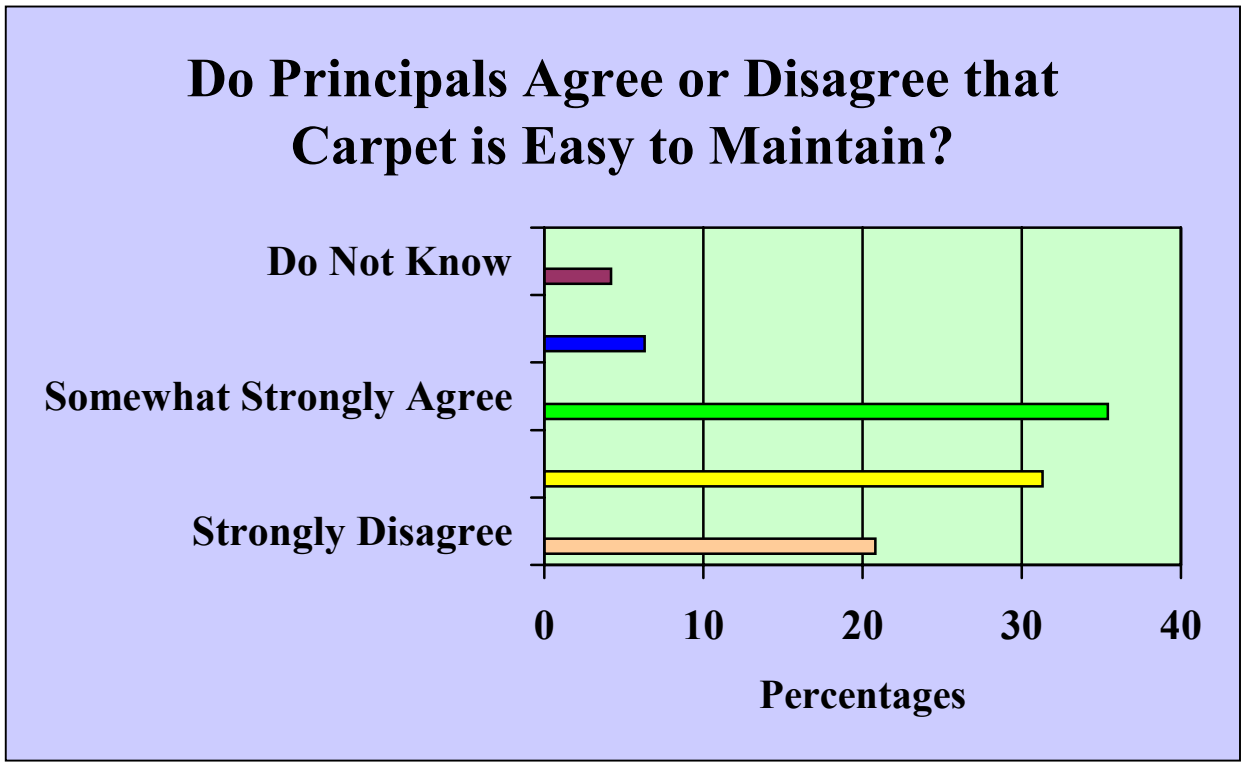

Figure 4.3 Ease of Carpet Maintenance (Question 21)

Questions #23-24 focused on the condition of the principals' schools and classrooms. Figure 4.4 outlines principals' perceptions concerning overall conditions of schools. Nineteen percent reported their schools to be in poor to fair condition, and 81% indicated the condition of their schools as good, very good, or superior.

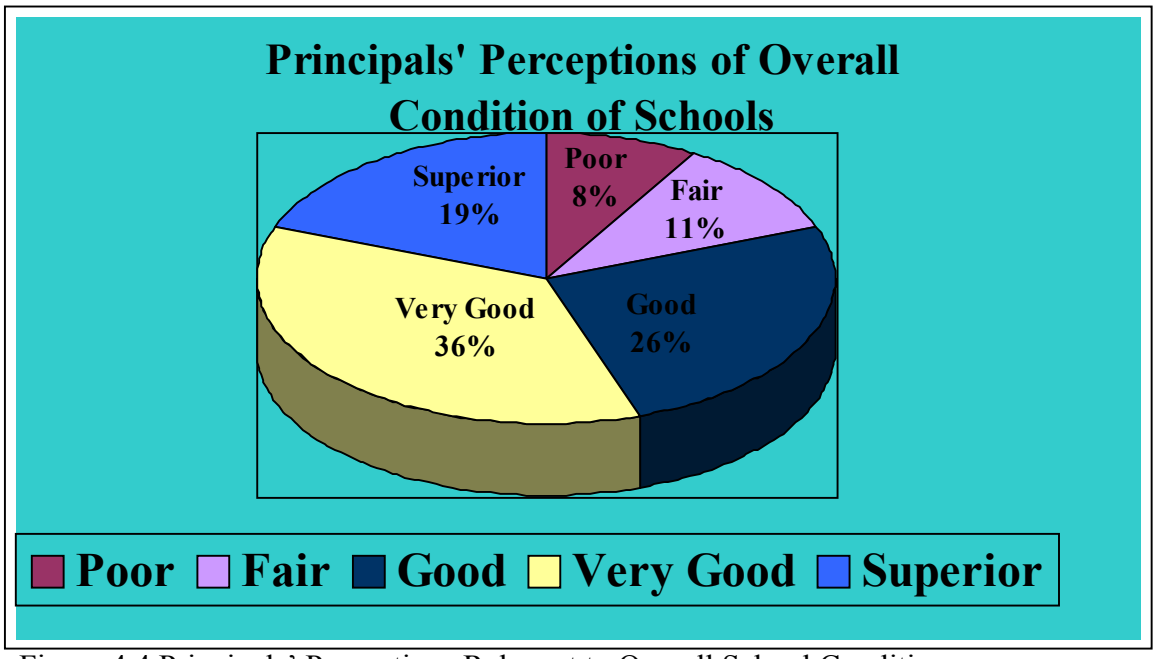

Figure 4.4 Principals' Perceptions Relevant to Overall School Conditions

The classrooms received a similar percentage rating. Nineteen percent of the principals noted that the classrooms were in poor to fair condition. Eighty-one percent indicated that the classrooms were in good to superior condition. Only 26% rated the classrooms to be in good condition.

Fifty-one percent of those responding indicated the classrooms in the school were covered with carpet and 10.6% of the principals noted that their classrooms had tile floor covering. Another 8.5% identified hard surface coverings other than tile and 29.8% were classified as "combination". The floor covering colors of either light or neutral were reported by 75.6 % of the principals, while 20% and 4.4% were dark and very dark, respectively. The mean age range of the school was 21 to 30 years old; while the average number of years in education of the principal ranged from 16 to 20 years.

The responders noted that 51.1% of their schools' classrooms were carpeted, while 29.8 percent had a combination of hard surfaces and carpet. The other classrooms were covered with hard surfaces such as hardwood, vinyl, or tile (19.1 %). Almost 16% preferred hard floor surfaces, while over 84% preferred carpet and a combination of other surfaces (See Figure 4.5).

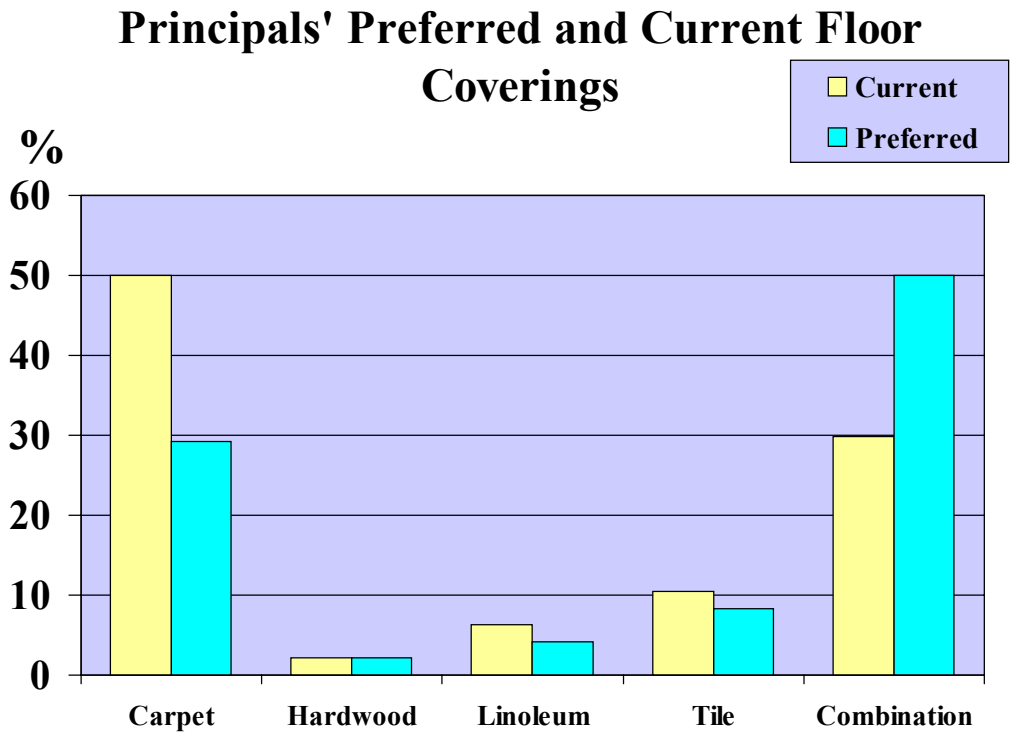

Figure 4.5 Principals' Preferred and Current Floor Coverings

Table 4.5 and Figure 4.6 report the grades principals gave to the overall design of the classroom and acoustics of the classroom environment in their schools. Over 57% of the principals noted that there schools grade on Acoustics was below a "B", and 34.8% perceived the overall design of the classroom to be below the grade of "B".

Table 4.5 Acoustic and Design Grades

Area	A	B	C	D	F
Acoustics of Classroom	10.6%	31.9%	46.8%	6.4%	4.3%
Overall Design of Classroom	17.4%	47.8%	26.1%	8.7%	0%

Figure 4.6 further details principals' perceptions regarding acoustics' grades. Over 57% of the principals indicated that their schools' classrooms were below a "B". In fact, 10.7% of the schools received a grade below "C".

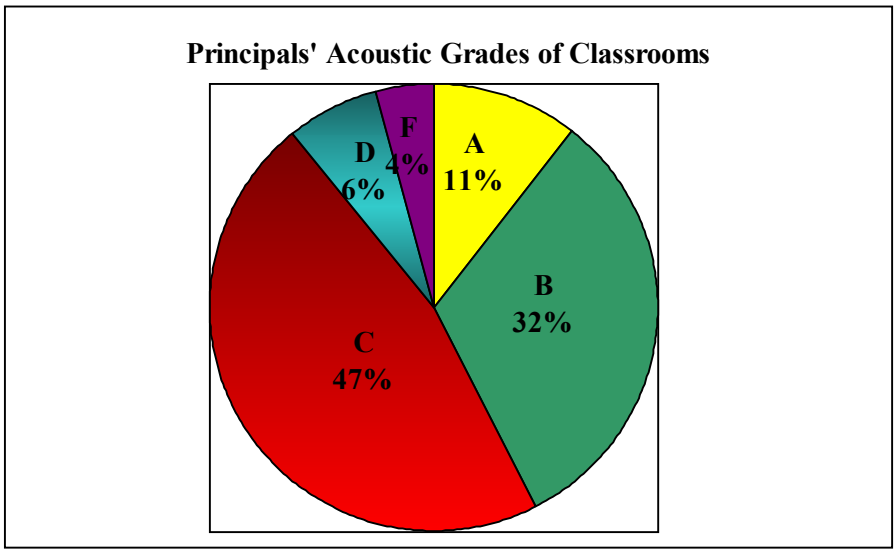

Figure 4.6 Acoustics' Grades

Figure 4.7 demonstrates the perceptions of principals regarding overall design. Forty-eight percent gave the overall design a "B". Only 17% gave the overall design an "A", and 9% gave the design an "F". Twenty- six percent reported the grade of "C".

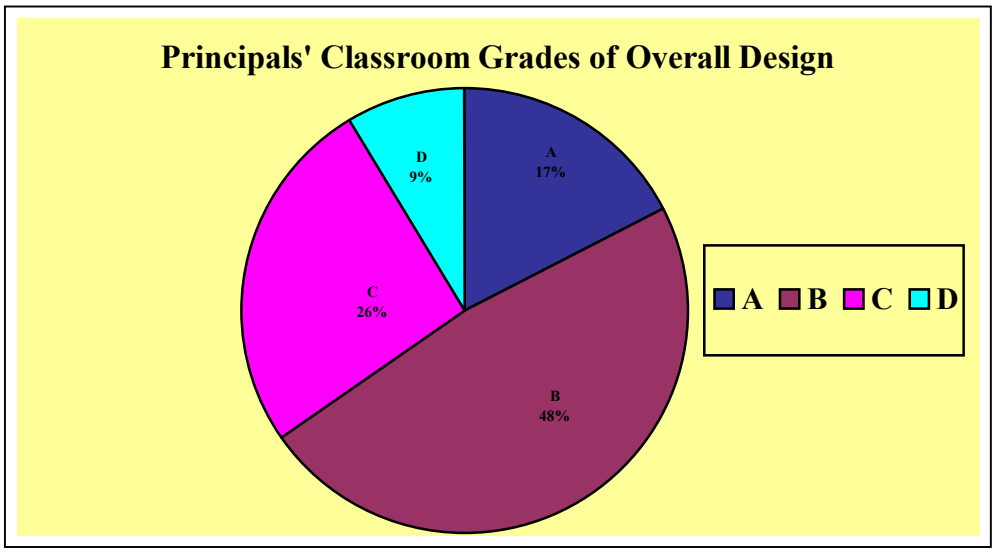

Figure 4.7 Classroom Grades

Acoustics and Student Achievement - Question 2

In order to answer the second research question, a total of 31 schools were visited during the summer of 2002 to check classroom acoustics and assess the physical condition of classroom floor coverings. Since only 11 schools in the sample had no carpet (a fact not discovered in the returned questionnaires), the sample was first reduced to 11 schools having carpet and 11 schools without carpet. This reduction was accomplished by randomly eliminating 9 schools having carpet. This data set was further reduced to 10 schools in each category because of differences in wall coverings and ceiling materials and number of windows. It was hypothesized that equal numbers of carpeted and non-carpeted schools would minimize biased data.

The research question addressed in this section is: Does the acoustics of the environment relate significantly to student achievement? Working with a sample of 20 classrooms (10 carpeted and 10 hard surfaced – hardwood, linoleum/vinyl, or tiled) located in 20 school districts in Georgia, a selected fifth grade classroom was tested for

background noise and reverberation time. First, background noise was tested with the decibel meter. Next a paper bag was "popped" to measure reverberation time with the reverberation time meter. Finally, the starter pistol (recommended by the Rensselaer Polytechnic Institute) was fired and the reverberation time was measured and recorded.

Given the assumption that background noise and reverberation time influenced what student hear in classrooms, these data were correlated to determine the relationships between reverberation times in the two classroom classifications. Before correlations were determined, the reverberation times were adjusted for classroom volume, surface area, and background noise through multivariate analysis for each floor type classification (carpet and hard surfaces, respectively) as noted in Table 4.6. No statistically significant difference was found between the reverberation times $F = 2.389$, $p = .092$ and $F = .90$, $p = .488$ for the starter pistol and paper bag, respectively (Table 4.6). This may be attributed to the R Squared values, however mean reverberation times were always longer in non-carpeted classrooms, regardless of the noise level source (starter pistol vs. "popped" paper bag).

Table 4.6 Adjusted Reverberation Times by Floor Covering and Source of Noise Level (Homogeneous Variances)

A. Between-Subjects Factors

		N
Actual Floor Covering	Carpet	10
	Hard Surfaces	10

B. Descriptive Statistics – Reverberation Times

	Actual floor covering	Mean	Std. Deviation
Starter pistol reverb	Carpet	1.0900	.1312
	Hard Surfaces	1.1740	.1440
	Total	1.1320	.1408
Bag reverb time	Carpet	1.0090	.1429
	Hard Surfaces	1.1120	.1966
	Total	1.0605	.1754

C. Tests of Between-Subjects Effects

Source	Dependent Variable	Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	Starter pistol reverb	.147	4	3.66E-02	2.389	.097
	Bag reverb time	.113	4	2.83E-02	.900	.488
Intercept	Starter pistol reverb	6.971E-02	1	6.971E-02	4.542	.050
	Bag reverb time	4.419E-02	1	4.419E-02	1.406	.254
Volume of Room	Starter pistol reverb	4.649E-02	1	4.649E-02	3.029	.102
	Bag reverb time	2.095E-02	1	2.095E-02	.666	.427
						.7
Surface Area	Starter pistol reverb	3.420E-02	1	3.420E-02	2.228	.156
	Bag reverb time	8.567E-03	1	8.56E-03	.273	.609
Initial Background Noise	Starter pistol reverb	2.920E-02	1	2.920E-02	1.902	.188
	Bag reverb time	3.218E-02	1	3.218E-02	1.024	.328
Floor Covering	Starter pistol reverb	3.032E-02	1	3.032E-02	1.976	.180
	Bag reverb time	7.461E-02	1	7.461E-02	2.374	.144
Error	Starter pistol reverb	.230	15	1.53E-02		
	Bag reverb time	.472	15	3.143E-02		
Total	Starter pistol reverb	26.005	20			
	Bag reverb time	23.078	20			
Corrected Total	Starter pistol reverb	.377	19			
	Bag reverb time	.585	19			

R Squared = .389 (Starter Pistol)
R Squared = .194 (Paper Bag)

The achievement test scores were adjusted for socioeconomic status of the student, level of education of the teachers, and average number of years of experience of the teachers. Table 4.7 reveals the descriptive statistics and effects relative to the adjusted scores.

Table 4.7 Mean Adjusted Scores for Student Achievement

A. Descriptive Statistics (N = 20)

	Mean	Std Deviation
Total Reading	53.6500	9.4327
Total Math	50.5500	9.0698
Complete Battery	51.7000	7.5957

B. Tests of Between-Subjects Effects

Source	Dependent Variable	Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	Total Reading	972.798	3	324.266	7.228	.003
	Total Math	912.973	3	304.324	7.491	.002
	Complete Battery	638.754	3	212.918	7.447	.002
Intercept	Total Reading	3087.071	1	3087.071	68.816	.000
	Total Math	3704.918	1	3704.918	91.201	.000
	Complete Battery	2958.926	1	2958.926	103.494	.000
Surface area	Total Reading	873.334	1	873.334	19.468	.000
	Total Math	772.133	1	772.133	19.007	.000
	Complete Battery	555.929	1	555.929	19.445	.000
Initial Background Noise	Total Reading	1.569	1	1.569	.035	.854
	Total Math	67.023	1	67.023	1.650	.217
	Complete Battery	6.039	1	6.039	.211	.652
Floor Covering	Total Reading	37.328	1	37.328	.832	.375
	Total Math	56.792	1	56.792	1.398	.254
	Complete Battery	48.565	1	48.565	1.699	.211

Error	Total Reading	717.752	16	44.859		
	Total Math	649.977	16	40.624		
	Complete Battery	457.446	16	28.590		
Total	Total Reading	59257.000	20			
	Total Math	52669.000	20			
	Complete Battery	54554.000	20			
Corrected Total	Total Reading	1690.550	19			
	Total Math	1562.950	19			
	Complete Battery	1096.200	19			

R Squared = .584 (Total Mathematics)
R-Squared = .575 (Total Reading)
R-Squared = .583 (Complete Battery)

Regarding the research question (Does the acoustics of the environment relate significantly to student achievement?), a Pearson correlation was completed by using the adjusted scores and reverberation times (Table 4.8). Variables included total reading score (39), total mathematics score (40), complete test battery (41), the starter pistol reverberation time (49), and the bag reverberation time (50). Negative correlations were found for all reverberation times and student achievement scores (Table 4.8.B). A statistically significant correlation (-.446) was found between the "popped" paper bags' reverberation times and mean adjusted mathematics scores (p = .049). The statistical relationships between the reverberation times of the "popped" paper bag and reading and the complete test battery were -.33 (p = .151) and -.359 (p = .120), respectively.

Table 4.8 Correlations Between Reverberation Times and Student Achievement Scores

A. Descriptive Statistics – Reverberation Times and Test Scores (N=20)

	Mean	Std. Deviation
Predicted Value Starter Pistol	1.1320	8.787E-02
Predicted Value Bag Time	1.0605	7.718E-02
Predicted Value Reading	53.6500	7.1554
Predicted Value Math	50.5500	6.9319
Predicted Value Total Battery	51.7000	5.7982

B. Correlations Between Adjusted (Predicted) Variables

	Predicted Value Starter Pistol	Predicted Value Bag Pop	Predicted Value Reading	Predicted Value Math	Predicted Value Total Battery
Predicted Value Starter Pistol	1.000	.349	-.069	-.043	-.060
p	.	.132	.772	.856	.802
Predicted Value Bag Pop	.349	1.000	-.333	**-.446**	-.359
p	.132	.	.151	**.049**	.120
N	20	20	20	20	20

Floor Covering and Acoustics - Question 3

Does the floor covering in the classroom relate significantly to the acoustics of classroom? To answer this question, carpeted and hard surfaced classrooms are compared in Table 4.9 with respect to reverberation times and types of floor coverings. Control variables included background noise, volume, and surface area of the classrooms. \ There was a statistically significant difference in mean reverberation times between the two classroom types with respect to floor covering. For example, considering the reverberation times of the starter pistol, F = 5.700 (p = .028)), the mean reverberation time in carpeted classrooms (1.0900) was significantly lower than reverberation times in the hard surfaced classrooms (1.1740). A similar finding was noted for the reverberation times of the "popped" paper bag, F = 15.875, (p = .001), revealing that the reverberation

times in the carpeted classrooms were significantly lower than those in hard surfaced classrooms.

Table 4.9 Comparison Between Reverberation Times in Carpeted and Hard Surfaced Classrooms

A. Descriptives – Reverberation Times

		Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Min	Max
					Lower Bound	Upper Bound		
Predicted Value Starter Pistol	Carpet	1.0900	7.986E-02	2.525E-02	1.0329	1.1471	.93	1.19
	Hard Floor	1.1740	7.747E-02	2.450E-02	1.1186	1.2294	1.05	1.33
	Total	1.1320	8.787E-02	1.965E-02	1.0909	1.1731	.93	1.33
Predicted Value Bag Pop	Carpet	1.0090	5.404E-02	1.709E-02	.9703	1.0477	.95	1.12
	Hard Floor	1.1120	6.133E-02	1.940E-02	1.0681	1.1559	1.02	1.19
	Total	1.0605	7.718E-02	1.726E-02	1.0244	1.0966	.95	1.19

B. Test of Homogeneity of Variances

	Levene Statistic	df1	df2	Sig.
Predicted Starter Pistol	.111	1	18	.743
Predicted Bag Pop	.318	1	18	.580

C. ANOVA

Mean Square	F	Sum of Squares	df		F	Sig.
Predicted Value Starter Pistol	Between Groups	3.528E-02	1	3.528E-02	5.700	.028
	Within Groups	.111	18	6.190E-03		

	Total	.147	19			
Predicted Value Bag Pop	Between Groups	5.304E-02	1	5.304E-02	15.875	.001
	Within Groups	6.014E-02	18	3.341E-03		
	Total	.113	19			

Links Between Floor Coverings and Student Achievement - Question 4

In order to assess the final research question, a comparison of student achievement according to floor type was made for reading, mathematics, and the complete test battery. Table 4.10 reveals that in all cases, students in classroom s having carpet scored higher in reading, mathematics, and on the total test battery than students in rooms having hard surfaces as a floor covering. While there were no statistically significant differences (alpha = .05), a trend was found in favor of carpeted classrooms.

Table 4.10 Student Achievement and Floor Covering

A. Descriptives

	Floor Covering	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Min	Max
					Lower Bound	Upper Bound		
Predicted Value Reading	Carpet	54.8428	7.9622	2.5179	49.1470	60.5387	40.31	65.29
	Hard Surface	52.4572	6.4444	2.0379	47.8471	57.0672	41.77	60.70
	Total	53.6500	7.1554	1.6000	50.3012	56.9988	40.31	65.29
Predicted Value Math	Carpet	51.6590	7.8618	2.4861	46.0350	57.2830	38.35	63.59
	Hard	49.44	6.0746	1.9210	45.0955	53.7865	39.11	55.76

	Surface	10						
	Total	50.5500	6.9319	1.5500	47.3058	53.7942	38.35	63.59
Predicted Value Total Battery	Carpet	52.6036	6.6829	2.1133	47.8229	57.3842	40.34	61.99
	Hard Surface	50.7964	4.9495	1.5652	47.2558	54.3370	42.29	56.75
	Total	51.7000	5.7982	1.2965	48.9864	54.4136	40.34	61.99

B. Test of Homogeneity of Variances

	Levene Statistic	df1	df2	Sig.
Predicted Value for Reading	.491	1	18	.492
Predicted Value for Math	.518	1	18	.481
Predicted Value for Total Battery	.846	1	18	.370

C. ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Predicted Value Reading	Between Groups	28.458	1	28.458	.542	.471
	Within Groups	944.340	18	52.463		
	Total	972.798	19			
Predicted Value Math	Between Groups	24.597	1	24.597	.498	.489
	Within Groups	888.376	18	49.354		
	Total	912.973	19			
Predicted Value Total Battery	Between Groups	16.330	1	16.330	.472	.501
	Within Groups	622.425	18	34.579		
	Total	638.754	19			

The plots of the student achievement scores are shown in Figures 4.8 through 4.10. Figure 4.8 reveals that the mean adjusted reading score (54.8428) in carpeted classrooms and hard surfaced classrooms (52.4572). While this is not a statistically

significant difference (p = .471), it reveals that the average score in this study was 2.3856 points higher in the carpeted classrooms. Figure 4.9 demonstrates the adjusted math score (variable 40) in carpeted classrooms (51.6590) and hard floor surfaces (49.4410). Again, though not statistically significant, the average score is 2.2180 points higher in the carpeted classroom. Additionally, a difference, not statistically significant, of 1.8072 points is emphasized in Figure 4.10 with regard to the complete total battery (variable 41). The carpeted classroom adjusted score was 52.6036, while the hard floor surface adjusted score was 50.7964.

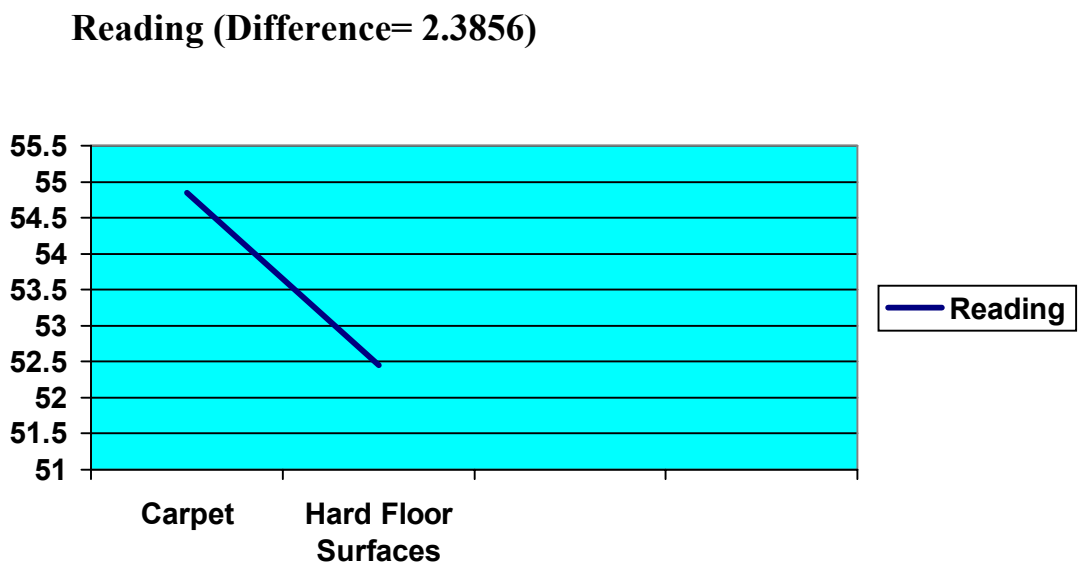

Figure 4.8 Adjusted Reading Test Scores

Math (Difference = 2.2180)

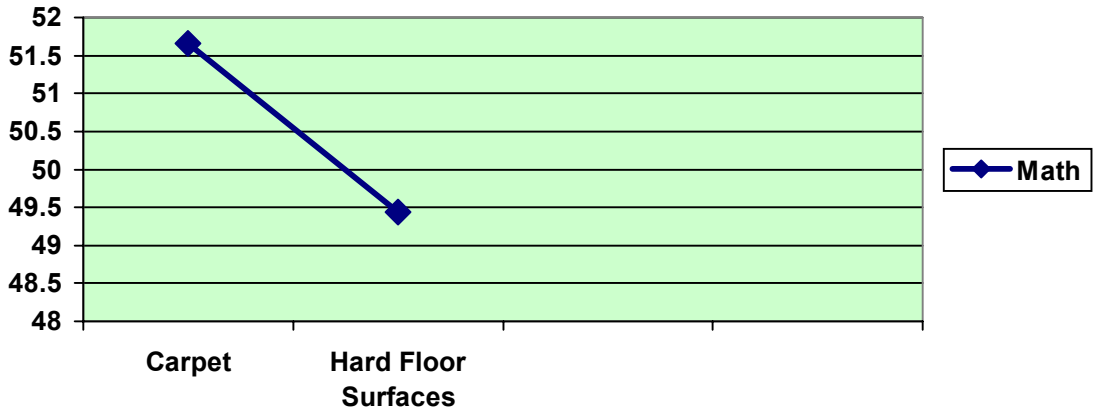

Figure 4.9 Adjusted Mathematics Test Scores

Complete Battery (Difference = 1.8072)

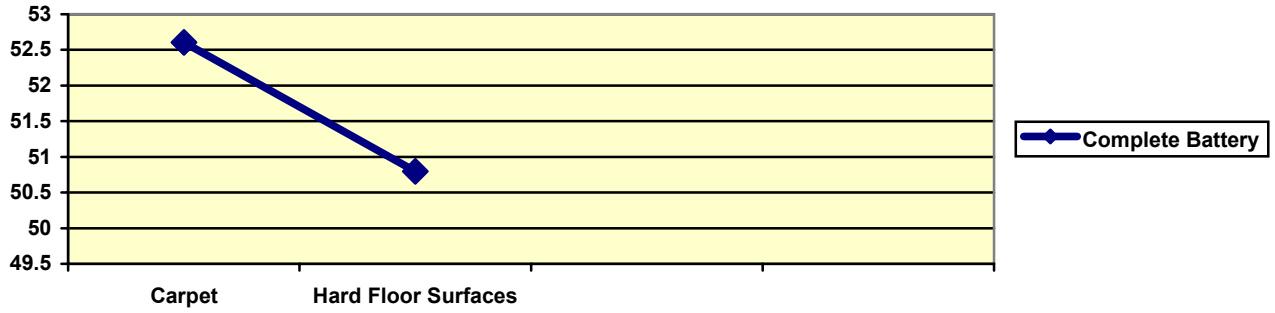

Figure 4.10 Test Scores on the Complete Battery

CHAPTER 5

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

This study examined the perceptions of elementary school principals regarding school design and the relationship between specific elements of design as a function of student performance. Additionally, the study focused on acoustics and the relationship between acoustics and floor coverings and student achievement. For the purposes of this study, following specific research questions were posed:

1. What are the perceptions that elementary school principals have concerning the influence of the interior design elements such as floor and wall coverings, lighting, flexibility, acoustics, color, texture, patterns, cleanliness, and maintenance on student achievement, teacher retention, and student attendance?
2. Does the acoustics of the environment relate significantly to student achievement?
3. What floor coverings in the classroom relate significantly to the acoustics of classroom?
4. Are there any possible links between floor coverings in the classroom and student achievement?

Summary and Conclusions

Elementary school principals were surveyed in order to identify their perspectives regarding design elements and student performance. Over 95% indicated that school interior design is important for creating a good learning environment. Over 90%

suggested that the schools' interior design strongly impacts teacher retention. Approximately 85% agreed that interior design is somewhat to very important in influencing student attendance. In comparison, Schapiro (2000) determined that approximately 99% of the national teachers surveyed found interior design very important to somewhat important for creating a good learning environment. Nearly 90% of the teachers perceived that interior design is at least somewhat important for teacher retention. The interior design is somewhat to very important to almost 70% of the teachers (Schapiro, 2000) (See Figure 5.1, 5.2, 5.3). From this comparison, it was concluded that the importance of the interior design of a school is a slightly higher priority for school principals than teachers.

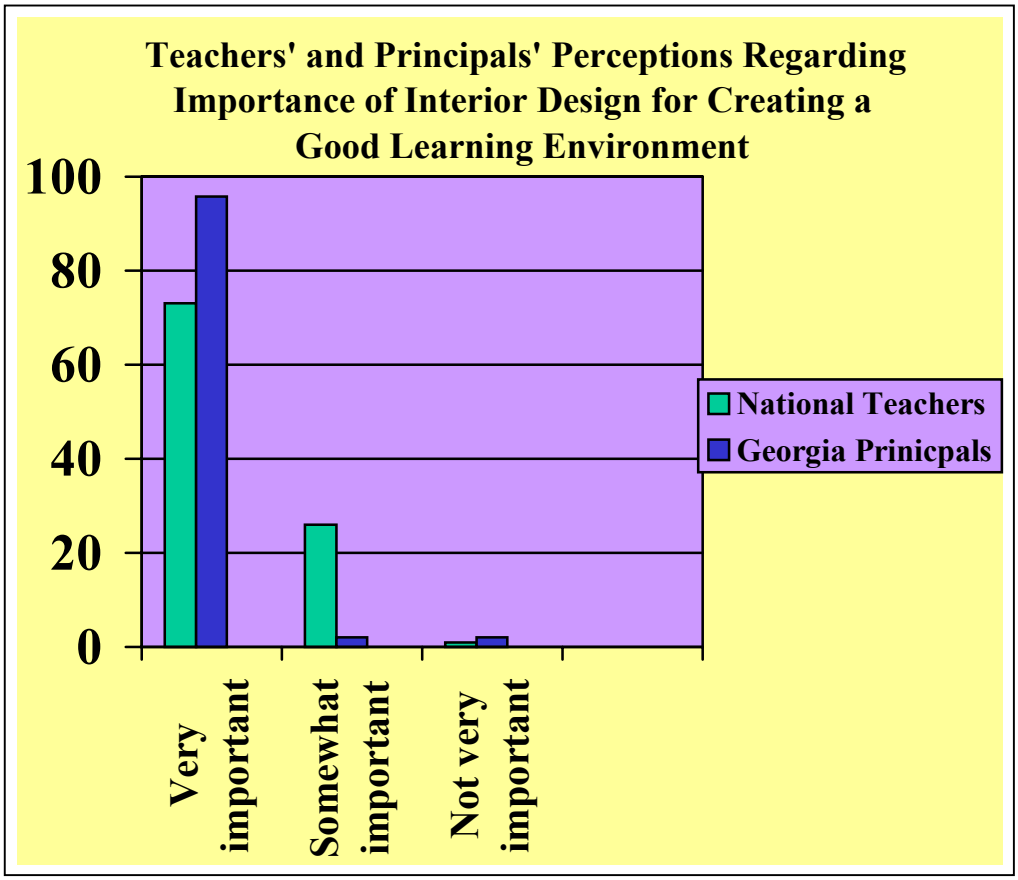

Figure 5.1 Teacher and Principal Perceptions of Interior Design for Creating Good Learning Environment

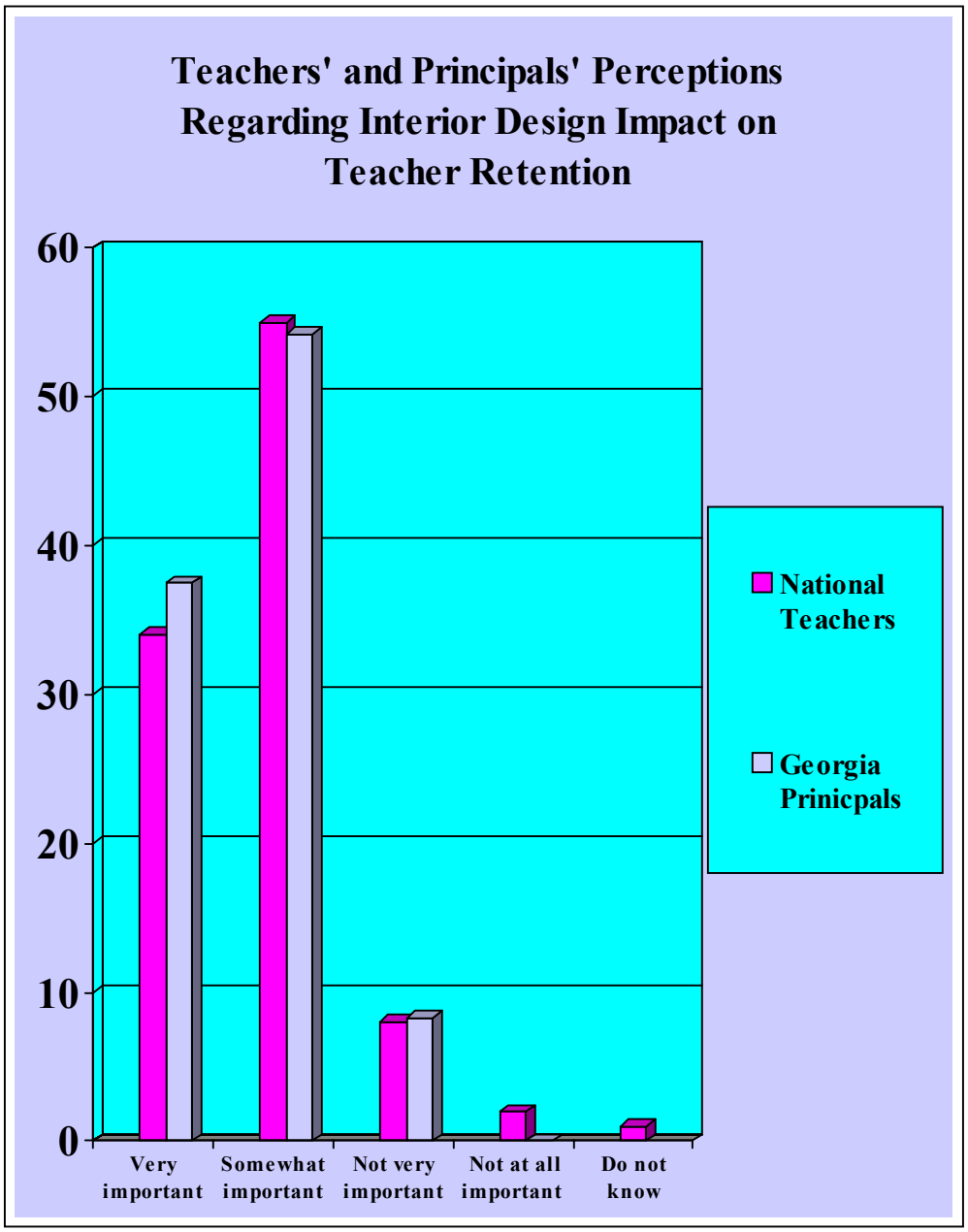

Figure 5.2 Teacher and Principal Perceptions of Interior Design on Teacher Retention

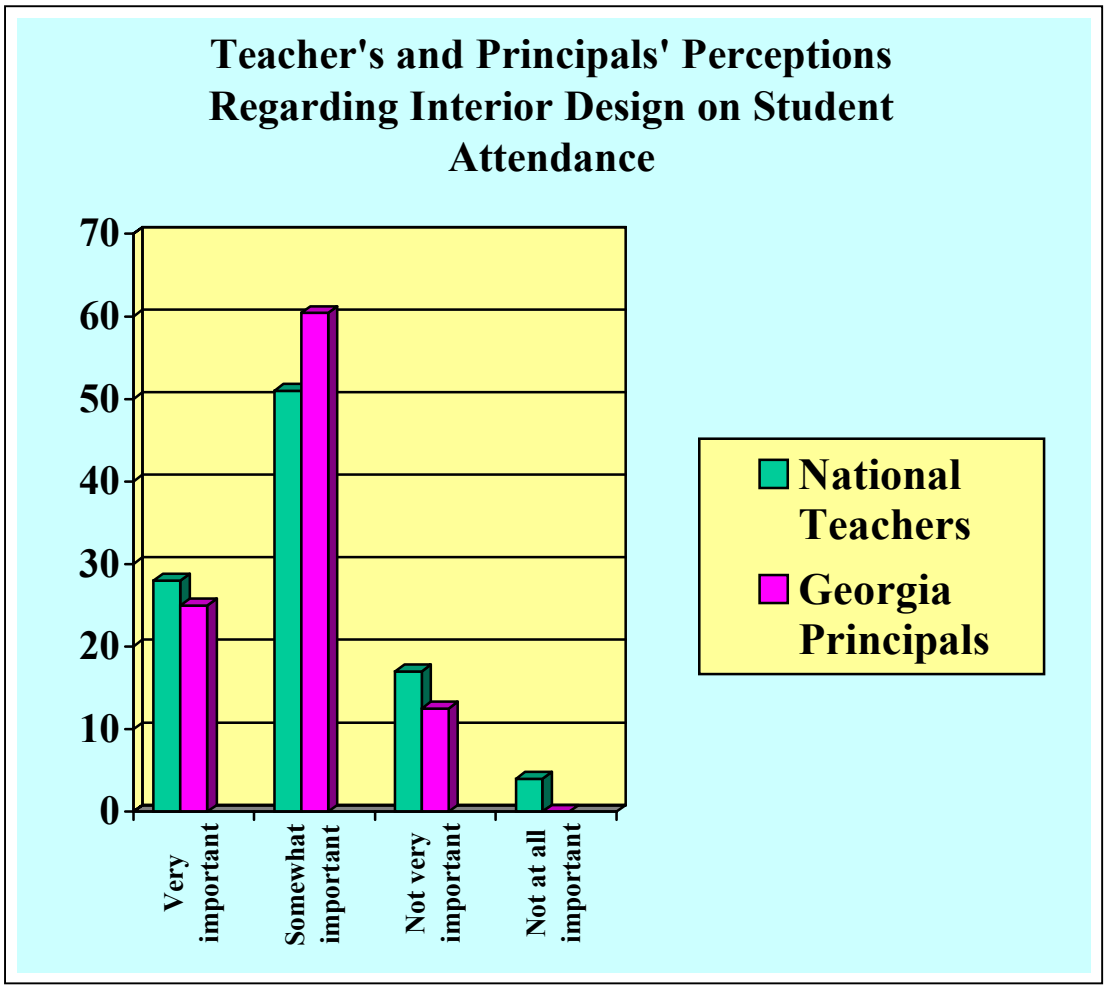

Chart 5.3 Teacher and Principal Perceptions of Interior Design on Student Attendance

Ninety-four percent of principals indicated the classroom design has a somewhat strong to very strong impact upon student achievement. According to Schapiro (2000), 92% of teachers surveyed viewed classroom design as an influence on student achievement. Over 85% of principals regarded natural lighting as having a somewhat strong to very strong impact upon student achievement. Ninety-four percent of principals suggested that the ability to control the lighting has at least somewhat of an impact on student achievement. The flexibility of room arrangement is viewed to have somewhat of an impact to a strong impact on student achievement by approximately 90% of principals. Fifty percent of principals perceived that a carpeted classroom impacts student achievement. An overwhelming 98% of principals indicated the impact of a quiet environment to have at least somewhat strong impact on student achievement. In addition, 96% noted minimizing accidents has somewhat of an impact to strong impact on the student achievement. Over 80% indicated that a classroom that is easy to clean impacts student achievement. Furthermore, 100% of those surveyed suggested that comfortable seating impacts student achievement.

Only 63% surveyed noted that attractive floor colors impacts student achievement. However, at least 45% felt texture of the floor has an impact on student achievement. Floor patterns are thought to impact student achievement, according to 40% of the responders.

Eighty to ninety percent of those surveyed considered their floor coverings to be well to very well cleaned and maintained. Ninety-four percent agreed carpet absorbs noise. Over 66% of principals surveyed suggested carpet helps to prevent falls, and approximately 88% agreed carpet gives flexibility (See Figure 5.4). However, 52%

disagree that carpet is easy to maintain. Almost 90% agreed carpet is more comfortable to stand on while teaching.

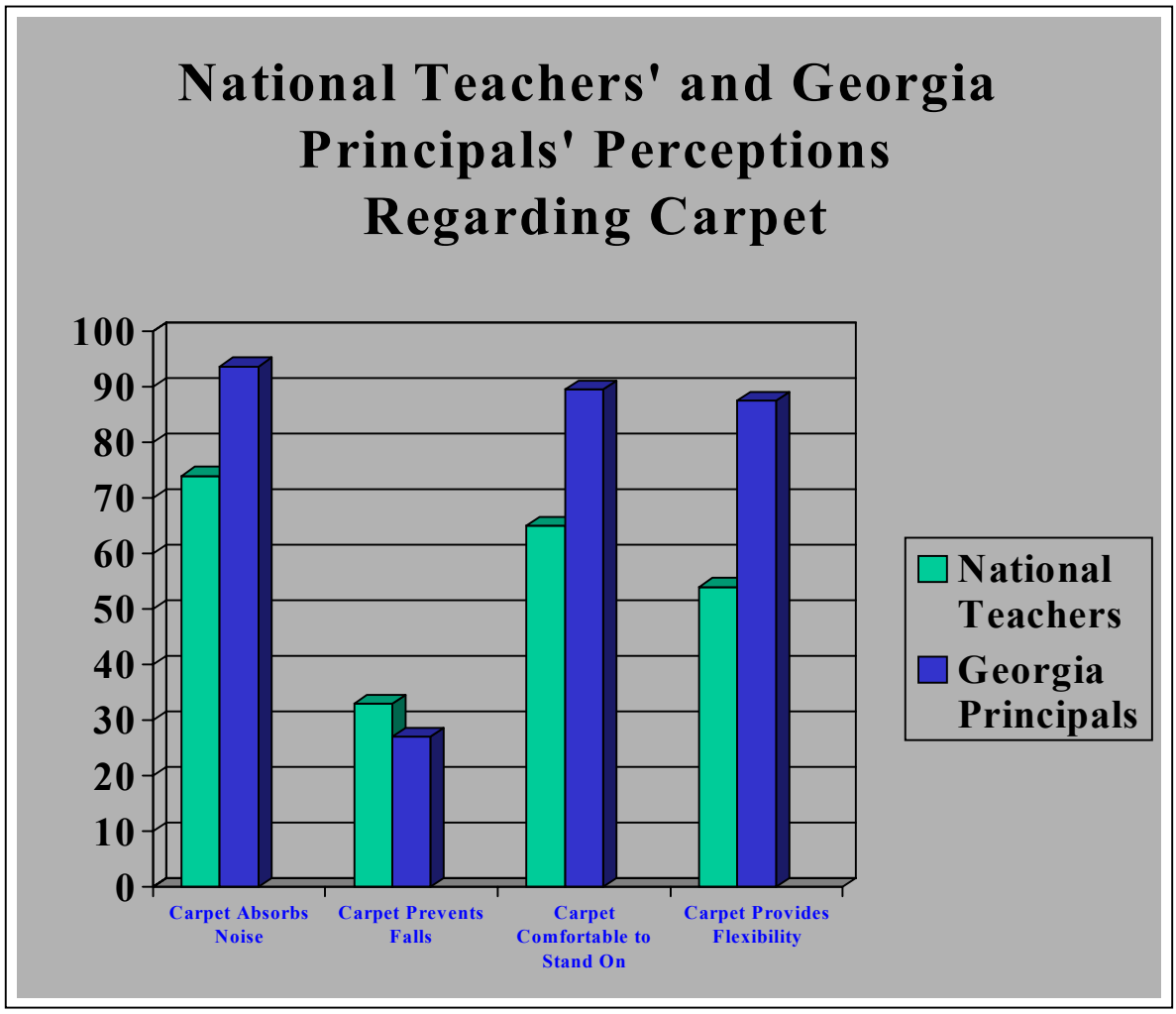

Figure 5.4 Teacher and Principal Perceptions of Carpet

Seventy-nine percent of principals reported the overall condition of their school to be at least in good status. Additionally, 81% indicated the overall condition of the classroom to be in good or better condition. The majority of principals noted their classroom designs to be less than adequate as 62% of the principals surveyed rated the overall design of the classrooms as poor or fair. Only 33.3% gave the design a rating of

good or very good. Light or neutral carpet is the most prevalent floor covering, approximately 50% of the responders. Thirty percent preferred carpet; nearly 10% prefer tile, less than 10% preferred vinyl or hardwood, and 50% preferred a combination of carpet and other surfaces. More than half, 56%, rated the acoustics as good to superior. The remaining 41.7% give poor to fair grades to the acoustics.

Principals and teachers recognize the importance of design elements upon student outcomes. Throughout the study, principals and teachers are cited to have some similar perspectives relative to the aspects of facility design, but there were some discrepancies regarding the importance of acoustics and learning. Principals placed more emphasis on the interior design than teachers, although they did not attach as much importance to the physical environment's ability to influence student attendance as teachers. Additionally, teachers and principals prefer carpet or some combination of carpet and hard surface flooring in elementary classrooms. The correlations between reverberation time and student achievement were negative for reading, mathematics, and the complete test battery. The conclusion from this set of statistics is that in classrooms with lower reverberation times, overall student achievement is higher. This supports the finding of Glass (1985) that unwanted noise reduces human energy and efficiency.

Research question 3 dealt with floor covering and its relationship to the acoustics of the classroom. This study found a significant difference in reverberation times between carpeted classrooms and hard floor surfaced classrooms. Noise levels (reverberation times) in carpeted classrooms were significantly lower than in non-carpeted classrooms. These findings are supported by the Acoustical Society of America (2000), since carpet is cited as an absorption material to reduce reverberation time in

classrooms. The conclusion from this finding is that classrooms with hard surfaces and no acoustical treatment (no carpet) are less desirable because of noise problems.

The dimensions of the classrooms appeared not to be factors, since most classrooms were square in shape. There was some variance in height as some ceilings were as low as 7 feet and others as high as 14 feet. The width in the portable units was differed from the regular classroom setting within the school building. These usually measure between 12 and 14 feet wide. Classrooms within the building measured between 23 feet and 30 feet wide. The length variance was only slight with regard to any of those classrooms measured for the purposes of this study.

To complete the analysis of data regarding the fourth research question, a comparison of student achievement according to floor type (carpet or hard floor surfaces) was made for reading, mathematics, and the complete test battery. Across all academic areas researched, students in classrooms having carpet scored higher than students in rooms having hard surfaced floor coverings. Although there was no statistically significant difference between the two surface classifications regarding student achievement (alpha = .05), the practical significance is highly important for student learning. For example, students in carpeted classrooms scored an average of 2.3856 achievement points higher in the area of reading as compared to students in non-carpeted classrooms. Students in carpeted classrooms scored an average of 2.2180 points higher on standardized mathematics tests and an average of 1.9072 points higher on the complete battery area as compared to students in classrooms with hard surfaces. Practical significance may be considered in cases where consistent findings having social and academic importance are discovered. The findings noted above led to the conclusion that

on the average students in carpeted classrooms score higher on standardized tests, hence the notion of "good acoustics" has merit when student outcomes are considered.

Although there was no causal relationship established in this study, a trend in favor of carpeted classrooms and "good acoustics" emerged. Such data acknowledge the importance of the advice of the Acoustical Society of America (2000) that acoustical problems in the classroom setting can be avoided with forethought and planning in the design phase of the facility. Furthermore, the best remedy for such acoustical problems is soft, sound absorbing surfaces. These findings support the Carpet and Rug Institute's (2001) contentions suggesting that "Carpet is an investment in our schools, our children, and the learning environment" (p. 2).

Recommendations

In conducting a follow-up study the survey instrument should be more specific to help clarify the "best places" for site visits. The idea of *combination* should be more clearly defined to note whether the combination is within the classroom and with what specific floor covering materials. It would be advantageous to have principals identify classrooms of like dimensions and shape, same grade level, and different floor coverings. Only 48 of the 100 surveys were returned, therefore shortening the questionnaire might increase returns. However, some non-responders may not have given much thought to the influence of the physical environment on student learning.

Collecting the data during the school year rather than in the summer would ensure that the classrooms visited would be in their natural state with regard to furniture arrangements. Addressing and more specifically quantifying absorbent materials is necessary in follow-up studies. Determining a scientific measure of the quality of floor

covering would create a more thorough study. Focusing the research to include the students' perspective could also produce a more valuable study, since the client's perspective would be compared to perspectives of principals and teachers.

Another recommendation is to measure different octaves and frequency ranges. This could be accomplished by using a white noise generator with omni directional speakers or a speech intelligibility meter rather than using a starter pistol or popping a paper bag. Such measuring devices would help to reduce variations in reverberation times, a problem that was discovered in this study.

This study was focused in Georgia and was well represented with random site visits throughout the state. However, as Schapiro's (2000) study was a national one citing differences of floor covering and presence of varying attitudes regarding floor covering, it is recommended the study be expanded outside the state of Georgia. This expansion should be approached with caution, since data reporting among several states may become an unwieldy problem.

Given the results of this study, including the response rate of less than 50%, it is recommended that more training be given to teachers and principals regarding the importance of the physical environment to student outcomes. Finally, this study sets the stage for implementing educational policy that includes strict acoustical regulations within learning environments. Because the average of 35 decibels for background noise and between .4 and .6 seconds of reverberation time are the standards for hearing, and the majority of schools' classrooms in this study did not meet these standards, it is important that state and local policy be implemented to ensure "good acoustics" in schools of Georgia.

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APPENDIX A

LETTER TO PRINCIPALS

February 6, 2002

Mr. Principal
Elementary School
Town, GA 30602

Hello (Name of. Principal):

According to a recent national survey, many of our schools' physical environments are substandard. We are attempting to assess Georgia's schools on this important issue. You and your school have been randomly selected as one of 100 elementary schools to participate in the study of principals' opinions of the interior design of their schools. Please respond to the enclosed questionnaire and return it in the self-addressed and stamped envelope within fifteen days of the date of this letter. The results of your responses will remain anonymous. Neither you nor your school will be identified through the course of this study or through any published research findings. Part of the data for this sponsored research will be used as a dissertation project.

From the random sample of 100 schools, a pool of thirty schools will be selected for a site visit by the research team to gather further information about the physical environment of the school. Each one of these thirty schools will receive a $100.00 check for providing a one-hour guided tour of the school. Upon the completion and return of the enclosed questionnaire, if chosen as one of the thirty sites to be visited, you will be contacted and a convenient date and time arranged for the tour.

All participating schools and those not selected for the tour will have the opportunity to view the summary of the findings at the SDPL web site {http://www.coe.uga.edu/sdpl/sdpl.html} under the title "Principals' Opinions of the Interior Design of their Schools."

Thank you for participating in this important study.

Sincerely,

C. Kenneth Tanner, Professor
School Design and Planning Laboratory

Ann Langford
Research Assistant

APPENDIX B

PRINCIPAL SURVEY

Please respond to the following questions and return them in the self-addressed envelope accompanying this questionnaire. Thank you!

Please place your response to the left of each question.

1	2	3	4	5
Not at all important	/ Not very important	/Somewhat important	/ Very important	/ Do not know

___1. Thinking about interior design elements such as furnishings, floor and wall coverings, and lighting, how important do you think a school's interior design is for creating a good learning environment?

___2. How important do you think a school's interior design is for teacher retention?

___3. How important do you think a school's interior design is for students' attendance?

1	2	3	4	5
No impact at all	/Very little impact	/Somewhat strong impact	/Very strong impact	/Do not know

___4. Thinking specifically about the interior design of the classrooms, how much impact do you think the general classroom design has on students' achievement?

___5. How much impact do you feel natural lighting in the classroom has on students' achievement?

___6. How much impact do you feel the ability to control lighting in the room has on students' achievement?

___7. How much impact do you feel the flexibility to rearrange the room has on students' achievement?

___8. How much impact do you feel a carpeted classroom has on students' achievement?

___9. How much impact do you feel a quiet environment with good acoustics has students' achievement?

___10. How much impact do you feel a classroom that minimizes the risk of accidents has on students' achievement?

___11. How much impact do you feel a classroom that is easy to clean has on students' achievement?

___12. How much impact do you feel a classroom that has comfortable seating for students has on students' achievement?

___13. How much impact do you feel a classroom that has attractive colors of floors has on students' achievement?

___14. How much impact do you feel a classroom that has textures of floors has on students' achievement?

___15. How much impact do you feel a classroom that has patterns of floors has on students' achievement?

1	2	3	4	5
Very poorly maintained	/Poorly maintained	/Well maintained	/Very well maintained	/Do not know

___16. How well would you say the floor covering in your school is maintained?

___17. How well would you say the floor covering in your school is cleaned?

1	2	3	4	5
Strongly disagree	/Somewhat disagree	/Somewhat strongly agree	/Very strongly agree	/Do not know

___18. How strongly do you agree or disagree that carpet absorbs noise helping to make a classroom quieter?

___19. How strongly do you agree or disagree that carpet helps prevent falls and injuries making a classroom safer?

___20. How strongly do you agree or disagree that carpet gives a teacher more classroom flexibility, such as allowing children to sit comfortably on the floor?

___21. How strongly do you agree or disagree that carpet is easy to maintain?

___22. How strongly do you agree or disagree that a carpeted floor is more comfortable to stand on while teaching?

1	2	3	4	5
Poor	Fair	Good	Very Good	Superior

___23. What is the overall physical condition of your school?

___24. What is the overall physical condition of your classrooms?

___25. How many years have you been in education?

___26. Approximately how old is your school?

Please circle your answer.

27. What grade would you give to the overall design of the classrooms in your school?

A B C D F

28. What type of floor covering do you currently have in your classrooms?

Carpet Hardwood floor Linoleum/ Vinyl Tile Combination

29. What type of floor covering would you most prefer to have in your classrooms?

Carpet Hardwood floor Linoleum/ Vinyl Tile Combination

30. What grade would you give the acoustical environment of your school?

A B C D F

31. Classify the shade of color of the floor covering in your classrooms?

Light Neutral Dark Very Dark

APPENDIX C

SCHOOL INFORMATION CHART

School Information Chart

School Number Address: Phone Number:	Notes and Other Important Information	Recent Changes or Replacements	Agree/ Disagree with Survey Information
Recorder: Contact Person at School:			
Height			
Length			
Width			
Ceiling Material			
Wall Material			
Floor Covering			
Furniture Arrangement			
Other Absorbing Materials (additional bookcases, etc.)			
General Room Description/ Grade Level			
Windows / Wall Color			