PERSPECTIVES OF MIDDLE SCHOOL PRINCIPALS REGARDING FLOOR COVERING AND A COMPARISON OF STUDENT PERFORMANCE WITH SOUND INTENSITY LEVELS

by

CATHY LYNN FOLDEN

(Under the direction of C. Kenneth Tanner)

ABSTRACT

This study explored perspectives of middle school principals on the importance of interior design elements in Georgia middle schools. School principals are the instructional leaders within the school and therefore have a unique viewpoint on the classroom's learning environment. They should also be influential in the design of new schools. Floor covering and its role in absorbing noise, classroom flexibility and safety in respect to student achievement was a focus of this study. Other design elements such as aesthetics, comfort and safety were also investigated.

The following questions guided this research study:

1. What perspectives do Georgia middle school principals have concerning the influence of interior design elements such as floor covering, lighting, flexibility,

acoustics, color texture, patterns, cleanliness and maintenance on student achievement, teacher retention and student attendance?

1. What are the Georgia middle school principals' preferred floor coverings for the middle school classroom environment?
2. How do the acoustics of the environment relate to student achievement?
3. What floor coverings create the best acoustical environments when student achievement is considered?
4. Does the floor covering in the classroom relate to student achievement?

Public middle schools in Georgia for the year of 2002 served as the population for this study. A questionnaire was distributed to a random sample of 100 Georgia middle school principals. A sample of 12 schools having carpeted classrooms and 12 schools having hard surfaces were chosen based on the results of the survey. Site visits were completed to collect data regarding reverberation time and background noise in classrooms. A sound level meter and reverberation time meter were used for these measurements. Official state records provided information regarding student performance, teacher experience, and certification. Ninety-seven percent of principals surveyed agreed that classroom design affected student achievement. Classroom volume, surface area, and background noise were used as covariates to develop adjusted reverberation times. Negative correlations between student achievement and reverberation times were found. Student achievement was adjusted for socioeconomic status, teacher education and experience. This correlation indicated that as reverberation time decreased, student achievement increased.

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

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BS.Ed, Georgia Southern University, 1993

M.Ed., The University of Georgia, 1998

A Dissertation Submitted to the Graduate Faculty of The University of Georgia in Partial Fulfillment of the Requirements for the Degree

DOCTOR OF EDUCATION

ATHENS, GEORGIA

2002

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December 2002

ACKNOWLEDGEMENTS

My deepest appreciation to Dr. Ken Tanner, who provided me with the opportunity to fulfill this dream, he has been my mentor and a sincere pleasure to work with. Although I will never declare myself your equal I will always declare you my friend. Ann Langford, my partner and my friend, has reminded me to truly love myself and live every moment of every day. She is continually a bright light in my heart. For my parents, Al and Jean Folden, the words "Thank You" will never be sufficient. Without their encouragement, support and unconditional love I would not be who I am or where I am. They have always believed in me and my love for them is eternal. My gratitude and my heart belong to Paul Handley who is the most amazing individual I know and without whom I would have been institutionalized years ago. (plus one)

DEDICATION

I dedicate this dissertation to my son, Alec Walker. It is my wish that through my struggle you have learned to finish what you start, in spite of the obstacles in your path. Through adversity, I have gained the courage to try. Through grief, I have gained the strength of independence and the ability to move forward. Through the miracle of being your mother, I have gained the faith and insight to enjoy each new day. My love for you is unconditional and a constant joy.

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CHAPTER 1

OVERVIEW OF THE STUDY

Introduction and Rationale

If schools are to provide students with the latest in technology, scientific breakthroughs and literature, consideration of the physical environment in which these students will absorb these materials should be of prime concern. With the invention of devices such as automobiles and computers, societal needs have changed. Students are required to have more knowledge when they exit the twelfth grade than ever before. Can they learn this new and more advanced material and become prepared for the working world in a classroom that was designed 30-40 years ago in a world that was much different than today? When the audience changes, the program must change with it. Education must keep up with the needs of the workforce just as advertisers must track the desires of consumers. "Education has been obliged to become more inviting, more consumer-oriented; less lecture-oriented and more learner-oriented." (Patterson, 1998, p. 74).

Middle school is a critical time for students. In 1994, only 29 % of eighth graders participating in the National Assessment for Educational progress scored at a proficient reading level and 31 % did not read on grade level (Mizell, 1995). Mizell (1995) reported that 7 % of the eighth grade class of 1988 dropped out of school and by 1992 that number had risen to 12%. Can various components of school design and the learning environment contribute to their students' chances of academic success? Public school

buildings should reflect the needs of the students they serve. The design of the school should balance the social-emotional needs with intellectual development of the students it will house. The learning environment should be safe physically and emotionally. A classroom should be a place where students belong and feel attached (Mizell, 2000).

Never before has more opportunity and knowledge existed about how to build a more learning-conducive school. Fix (2000) stated that schools should be viewed as truly important places where learning occurs, not merely buildings. If the hope for the future of this country does lie in young people who are primarily served through public education, what more important place is there? School planning and design and the influence they have on academic achievement should be considered foremost when new construction or remodeling is needed or when new curriculum programs are being contemplated. Factors that have been researched and determined to be instrumental in the success of designing and planning a school, according to Hawkins (2001), are smaller schools, lower teacher/student ratios, building location, and parental/community involvement. Hawkins (2001) pointed out that, "Bricks and mortar can't eliminate teen incarceration, pregnancy, or substance abuse. But when facilities support a structure that speaks to the latest educational research and the local community's challenges and desires, they can certainly help" (p. 31).

One factor in middle school design that has received minimal exposure is the area of sound or acoustics in classrooms. It is clear that an increase in noise, whether it is internal or external can interfere with a student's ability to listen and comprehend, therefore information retention is diminished. Many researchers have concluded that listening decreases as classroom noise increases (Day, 1999). Therefore, the typically

noisy classroom could potentially put every child at risk of learning difficulties. "Children, especially elementary and middle school students struggle in noisy classrooms" (Anderson, 1997). Considerations are made for students who suffer from hearing impairments through legislation such as the Americans with Disabilities Act (ADA) and through the efforts of The U.S. Architectural and Transportation Barriers Compliance Board, and The Access Board, which provides support for the implementation of the ADA (Anderson, Smaldino & Crandall 2000). What has not been adequately addressed, however, is the effects of noise on normal hearing children and to what extent noise is a barrier to the learning and academic achievement of the regular education student. If good classroom acoustics could be a positive and successful factor in student achievement it should be explored further.

In an effort to create school buildings that adequately reflect the needs of the community including parents, students and area businesses, local school boards must solicit community support. Constructing new school facilities usually begins with a comprehensive community study and economic analysis as wells as an analysis of school curriculum and finances (Castaldi, 1994; National Center for Education Statistics, 2000). The value of teacher and principal perceptions should also be considered and used to guide further research regarding how the school's physical environment affects student achievement. Because teachers and principals have a hands-on perspective of the classroom environment and how students relate to it, their perspectives are unique. This study focused on design elements that may bridge the gap between student achievement and the physical environment. A major component that was targeted was floor covering as it relates to classroom acoustics.

Statement of the Problem

One aspect of the problem addressed in this study was that there is limited knowledge regarding perspectives of school principals concerning the school's physical environment and its relationship to student outcomes. Another component of the problem was that there is limited evidence regarding the effects of classroom acoustics, especially in carpeted and non-carpeted classrooms, and how sound levels in these two environments relate to student outcomes. The overall problem addressed was how does the physical environment possibly influence student outcomes? Two aspects of this problem were addressed: first, perspectives of curriculum leaders regarding the physical environment, the principal, and second, classroom acoustics and student outcomes. Additionally, how do students fare academically in schools with carpeted floor coverings compared to schools without carpeted floor covering? Five research questions were examined:

1. What perspectives do Georgia middle school principals have concerning the influence of interior design elements such as floor covering, lighting, flexibility, acoustics, color texture, patterns, cleanliness and maintenance on student achievement, teacher retention and student attendance?
2. What are the Georgia middle school principals' preferred floor coverings for the middle school classroom environment?
3. How do the acoustics of the environment relate to student achievement?
4. What floor coverings create the best acoustical environments when student achievement is considered?
5. Does the floor covering in the classroom relate to student achievement?

Statement of the Purpose

School Design is not limited to the blueprints and physical layout of the building. The interior of the building is of equal importance. Recognizing the detrimental effects that poor acoustics can have on academic achievement and understanding the need to acknowledge and address options for controlling noise in the classroom combined to formulate one major aspect of this study. By comparing sound absorbing materials in classrooms through the use of sound tests, and comparing those results to students' standardized test scores, it was assumed that a trend in favor of carpeted or non carpeted classrooms would be found.

A recent survey of more than 1,000 teachers, cooperatively sponsored by the International Interior Design Association and The Carpet and Rug Industry, examined what teachers perceive are the most important features in an ideal learning environment. Results included good lighting, adequate temperature control, comfortable and flexible furnishings and carpeting (Sellers, 2001, Schapiro, 2000). The study discussed herein was loosely based on the concept of surveying educators, in this case, principals, about their perspectives of the physical environment of their schools and how it may or may not influence students and teachers. However, this study also was extended into taking field measurements of the acoustics in a random sample of 8^{th} grade classrooms in middle schools across the state of Georgia in an effort to compare noise levels and student achievement.

Significance of the Study

Data concerning facility design is needed now more than ever and the market is ripe for more detailed research in the area of acoustical design. Next to roads and

highways, schools are the largest infrastructure investments in the United States, and statistics reveal school enrollments are expected to increase each year, nationwide (Jones, 1997). If ever there was a time for facility planners to acquire as much information as possible about the relationship between student learning and the physical environment, that time is now. While children who suffer from hearing impairments have certain rights as provided by the Americans with Disabilities Act (1990), very little research has been done concerning the effects of poor classroom design and acoustics on all of the regular education students.

Assumptions of the Study

The first assumptions involved in conducting this study was that appropriate methodology and instrumentation could be designed to answer the specified research questions in a scientific and effective manner. Second, it was assumed that bias could be restricted; hence, socioeconomic status and teacher training and experience were controlled when comparisons of student achievement were made. The third supposition involved the measures of student achievement, assuming that they were valid and reliable. The fourth, assumption was that the measures of the physical environment were also valid and reliable. Finally, it was assumed that the procedure used to collect the principals' perspectives was comprehensive.

Constraints of the Study

Limitations that existed in this study were addressed to provide a perspective for the results to be well founded and useful. These limitations included valid survey responses from the school principals, the socioeconomic status and teacher education and experience at the schools surveyed, and the ability of the researcher to understand the

complex set of acoustical variables being evaluated. To compensate for gaps that occurred, the researcher was trained in the use of sound measuring devices.

The population of middle schools was represented by a random sample of 100 schools. This sample was selected from all Georgia middle schools containing grades 6-8. From this sample, 30 school sites were selected for further acoustical study based on items 16, 17, 28 and 30 in the principal's questionnaire (see Appendix B).

Definition of Terms

Middle School - a school consisting of only grades 6 to 8

Noise Reduction Coefficient – (Scott, 1999) NRC, measures the ability of a material to absorb sound

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

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

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

Urban Clusters - (U.S. Census Bureau, 2000b) consists of densely settled territory that has at least 2,500 people but fewer than 50,000 people.

Procedures

The procedures for this study were as follows:

1. A questionnaire, for school principals, was developed to complement the national survey of schoolteachers (Shapiro, 2000). The results of this questionnaire were also used to select the sample of schools for site visits and acoustics testing.

2. The questionnaire was sent to a stratified random sample of 100 middle schools in Georgia based on a rural or urban classifications. The researcher used this survey to determine a sample size of 30 schools. In these 30 schools, 15 were well maintained and carpeted and 15 had poorly maintained, non-carpet, floor covering as determined by the survey.
3. An expert in the field of acoustical engineering tutored the researcher in the use of scientific acoustical measuring instruments.
4. Data were collected to measure acoustic levels within the selected schools. These data were collected using standardized instruments and measurement procedures on a site visit by the researcher.
5. The researcher collected information regarding the student achievement of the selected schools from the public information data set on the Internet. The data included information from standardized test scores on the Stanford 9, a test taken by all 8^{th} grade students in the state of Georgia.
6. Also retrieved from the Internet, were data revealing student ethnicity and socioeconomic status as well as information regarding the school faculty. This information included teacher training, years of experience, certification level, and ethnicity. The information received in this category was used as a covariate in order to increase validity and decrease the risk of error and bias.
7. All data collected were coded and submitted to frequency counts, percentages, analysis of covariance and a multiple regression analysis. An alpha of .05 was assumed for this study.

Organization of the Study

Chapter 1 provided the introduction, statement of the problem and the purpose of the study. This chapter also details the research questions concerning this study as well as the limitations, assumptions and definition of terms. A summary of procedures used for this study is also located in Chapter 1. Chapter 2 presents a review of the literature concerning acoustics, carpet and school design. Chapter 3 is a description of the methodology used in this study. The analysis of data is targeted in Chapter 4 and a summary of the study's results is located in Chapter 5.

CHAPTER 2

REVIEW OF THE LITERATURE

Introduction

The theory behind this study was that school design elements, specifically acoustics and carpeting, does have an effect on student achievement. This chapter explored the relationship between classroom acoustics and student achievement. The role of carpet as a floor covering and noise barrier was a focus of this literature review. In addition, how aesthetics, comfort and safety factor into student achievement in the classroom were examined.

School Design

During the post World War II era, education began a change toward providing education for similar grade groups, it was then that the first junior high schools emerged. This was the first time schools provided specifically for middle grades education needs (Castaldi, 1994). Initially, these changes helped with the overcrowding in elementary schools but as programs such as school lunch, physical education, art, music and libraries entered public school design began to evolve further (Castaldi, 1994). For example, carpet was introduced to elementary educational facilities in Andrews, Texas in 1956 (Castaldi, 1994).

Past research on school design has focused on student attitudes and achievement and how the students are influenced by certain individual elements of school design such as lighting, color and class size. Tanner (1999) suggested that it is unwise to ignore the

influence of these elements as a combined group when designing school facilities. Creating school facilities that promote student achievement and positive learning environments must begin in the early stages of development. Gavin (2001) contends that "good interior design elements in schools must begin in the pre-design and budgeting phases" and should include evaluations that "gauge" the effect design elements have on "children's health and safety" (p.1).

In the middle school classroom, how much of a student's academic achievement or underachievement is dependent on his or her ability level and how much of it is affected by other factors such as delivery method, room temperature, natural light, and, more specific to this study, noise level? Palmer (1997) identified six factors concerning the classroom that can have a negative effect on a student's ability to hear: teacher delivery, classroom noise, reverberation, distance from the teacher, hearing impairments of the students, and the linguistic experience of a student. Can a student's level of academic success be increased in an environment that is designed to control distracting factors such as noise and reverberation? The academic standards of a school should be augmented by the school facility but when those facilities are inadequate, the academic program cannot be completely successful (Klauke, 1988). The idea is that a school building should serve as an extension of the educational process. Unfortunately, as Bradley (1998) pointed out, the one part of our educational system that has not been held to a higher standard is the way schools are planned, designed, and built.

Acoustics

Special consideration has already been given to students who have auditory impairments, but research indicates the normal hearing or regular education child, is also

at an increased risk of listening and learning problems in a noisy classroom (Americans with Disabilities Act, 1990). Day (1999) agreed that regular education students without hearing impairments experience difficulty hearing in a modern classroom. A study conducted by Nobler and Nobler (1975) determined that students with and without auditory disabilities had performance and achievement difficulties in noisy classrooms. This inability to hear can diminish learning by interfering with central auditory processing, which simply means, what we do with what we hear (Day, 1999). Nixon (2002) states, "Children are especially vulnerable to interference of the acoustical signal, with reverberation and background noise being the most notable culprits. They lack the knowledge and maturity to fill in missed words that can be rationalized by adults." (p. 23). Dahlquist (1999) agrees that this could be critical when considering that the average student spends 75% of his day engaged in listening activities in schools that were not designed with listening in mind. In this case, for children to recognize speech accurately, the speech must be projected much louder than for an adult. The earliest in which a child's listening skills will begin maturing to that of an adult is age 13 (Crandell, 1995; Elliot, 1982). A noisy classroom may be an issue that negatively affects student achievement.

Research establishing the level of noise that interferes with performance is somewhat contradictory. However, it is abundantly clear that noise, whether intermittent, constant, or in sudden unpredictable burst, does interfere with concentration, reading ability, mathematics ability, and auditory processing (Bronzaft & McCarthy, 1975; Dahlquist, 1999; Frese, 1973; Woodhead, 1964, Viteles & Smith, 1946). Additionally, a student's lack of listening may be a result of the student's inability to know how to filter

out unwanted noises that prevent them from listening (Day, 1999). Anderson (1997) has reported that developmental stages concerning the hearing of children have been established: adults need 11 decibels of sound pressure level, SPL, to understand spoken words, whereas three-year-olds need 38 decibels SPL, 5 year-olds need 25 decibels SPL, and 10-year-olds require 18 decibels SPL (Anderson, 1997). Therefore, controlling noise levels in a classroom may be an important part of the learning environment.

Poor classroom acoustics can compromise individual student success and teacher health (Anderson, 2001). In relation to teachers, two separate studies by Allen (1995) and Grotass and Starr (1993) showed 80% of teachers reported vocal fatigue from straining over the noise in their classrooms and 20% missed between one day to one week of work annually due to voice problems. This study was important when considering speaking is a teacher's job and the average teacher talks for 6.3 hours each day (Siebert, 1999). The American Speech-Language-Hearing Association (1995) reported that teachers must speak 15 decibels louder than the background noise in order for students to comprehend the teacher's speech. Research indicated the teacher's job of teaching and the student's job of listening become increasingly difficult in a noisy classroom.

Student behavior becomes an issue, in addition to the vocal health of teachers and student achievement, in a noisy classroom. Concerns in education such as student attention span and the student's ability to focus their listening skills can be affected by noise in the classroom, and Anderson (2001) recognized that appropriate classroom behavior is also "compromised by excessive noise in the classroom" (p. 78). When classroom noise increases, children become restless and self-generated noises increase

because students cannot hear or distinguish the teacher's voice due to competing noises (Anderson, 2001; Reichman & Healy, 1993). Research by Evans and Maxwell (1997), Evans and Lepore (1993) and Maxwell and Evans (1993) identifies three other categories of non-auditory effects of noise on children in school classrooms. These categories are physiological effects, motivational effects, and cognitive effects.

The physiological effects include the increase in a student's blood pressure. This is an unhealthy pattern that when transferred into adulthood increases the risk of cardiovascular disease. A study by Cohen, Evans, Krantz and Stokes (1980) measured student's blood pressure in a school that was exposed to aircraft noise. Blood pressure measurements, for students exposed to chronic noise, were higher and continued to be higher into adulthood, than were measurements of students in quiet schools. Motivational effects related to classroom noise include learned helplessness. In this case, a student is more likely to abdicate choices to their teacher and exhibit less mastery-oriented behaviors than do children in quieter learning environments (Evans & Maxwell, 1997; Maxwell & Evans, 1993; Evans and Lepore, 1993).

The cognitive effects of noise are closely related to specific types of noise such as chronic noise or continuous exposure. This is relevant when considering the location of a school or the location of a classroom within the school. Research by Evans and Maxwell (1997) indicate that memory is not affected by noise if the task is simple, but as the difficulty of the task increases, the ability of the student to retain and recall details decreases. Chronic noise also interferes with a student's ability to focus their attention on a task or speech. Children are more distracted in noisy environments and this distraction can interfere with student achievement (Evans & Maxwell, 1997). Evans and Maxwell

(1997) identified a link between chronic noise exposure and reading ability. Children in noisy classroom environments exhibited lower reading skills and were less able to distinguish the spoken word in their environment than were students in environments where noise was minimal and controlled. This study helped to solidify the argument that school boards, administrators, teachers, and parents should be concerned with the levels of noise and controlling noise in the school environment.

What is noise and where does it come from? Background noise is noise that is created and unrelated to the educational activities in the classroom. Background noise can be divided into two categories: external, originating outside of the building and internal, originating from the inside of the building. External noise consists of items such as car traffic, airplanes, railroads, construction, playgrounds and mechanical equipment. Consider a classroom located at the end of an airport runway, in the midst of new school construction or next to a major highway intersection. Unfortunately a school very similar to this operates in Dade County, Florida (Jones, 1997). Conventional wisdom would suggest that this location was not conducive to the ideal learning environment, but the taxpayer's dollars have not always been flexible when purchasing land and locations for school buildings. Many school buildings have been built near major noise generating sources such as airports, railroads, interstates or highways. Classrooms are often located near other sources of noise and disruption that are physically connected to the building itself, such as unloading zones for trucks and busses, mechanical equipment, dumpsters and playgrounds (Seep, Glosemyer, Hulce, Linn, & Aytar, 2000). Schools are often built on the most economical property available. This land may be located in areas of loud external noise that may interfere with the learning process of children. Glass (1985) and

Dixon (1953) agreed that unwanted classroom noise reduces human energy and efficiency and had a detrimental affect on the verbal interaction of students and teachers. In two previous studies, children who are exposed to excessive noise such as airports, highways and train tracks score significantly lower on standardized tests (Bronzaft & McCarthy, 1975; Cohen et. al., 1980). If the school cannot physically be relocated to a quieter external environment, increasing the efficiency of noise control mechanisms in the internal environment is a prudent investment.

Internal noise, on the other hand, is generated from inside the building itself and could consist of factors such as the cafeteria, gymnasiums, corridor noise and classroom noise such as, chairs scraping, talking, or the heating and cooling systems. "High ambient noise form mechanical equipment such as noisy ventilation and air conditioning systems is all too common in existing schools" (Seep, et. al., 2000). Scott (1999) notes that noise tends to generate more noise and in classrooms with poor acoustics, that noise may be overwhelming. Excessive noise levels, in the classroom, interfere with speech intelligibility, which results in reduced understanding, reduced learning and reduced retention (Seep et. al., 2000)

Another concern is reverberation time, which is the time needed for sound to dissipate (Day, 1999). If a child needs to hear speech sounds at a higher level and they are in an environment where sound echoes and reverberates excessively, the level of understanding of the spoken word could be diminished. When considering a child's developmental level of hearing in relation to a classroom learning environment, research indicates that the classroom should be a quiet haven where listening is of paramount concern.

Much of the noise discussed in this review refers to the reverberation and distortion of sound as it bounces from hard surfaces and around a classroom. School classrooms have a variety of hard surfaces such as walls, floors, chalkboards and ceilings that cause excessive reverberation and distortion. Reverberation, the reflection of sound off of those surfaces, can be controlled with sound absorbing materials (Herbert, 1999). Excessive reverberation interferes with understanding and learning (Seep, et. al., 2000).

Scott (1999) determined that when a teacher's voice is inaudible or indistinguishable a student's mind may wander and students find themselves struggling to hear rather than striving to understand. In some instances, sound-absorbing material may aid in achieving the desired reverberation time of 0.4 - 0.6 seconds (Acoustical Society of America (ASA), 1997). Anderson (1997) explained that, poor acoustical conditions in the classroom contribute to academic underachievement, and listening is often synonymous with academic achievement and behavior. By using sound absorbing materials to reduce excess noise and reverberation, schools may increase the chance of student success.

The American Speech-Language-Hearing Association Guidelines for Acoustics in Educational Settings (1995) also recommended that sound should dissipate in 0.4 seconds or less. A research study conducted in Edinburg, Scotland by scientists at Heriot-Watt University emphasized a connection between reverberation time and background noise levels in classrooms (Scott, 1999). By adding soft, sound absorbing materials to the floors, walls and ceiling, reverberations can be reduced. Carpet especially helps reduce reverberation time at high frequency of sound (Herbert, 1999).

Adding carpet as an absorbing material can control disturbing echoes. Scott (1999) determined that the percentage of voice consonants lost in the echoes was between 15 percent and 50 percent in classrooms with hard surfaces. This is of serious concern in school classrooms which are essentially auditory-verbal environments where listening is a predominant skill (Dahlquist, 1999). The Acoustical Society of America (ASA) has determined, poor classroom acoustics is not only a barrier to learning it could "stunt intellectual growth, lower self-esteem, and [serve] to diminish the potential for the child to grow into a productive citizen" (1997, p. 1). Noise affects listening, which in turn affects learning. Research has suggested reducing the noise level through the use of carpet can increase a student's ability to listen and consequently increase their ability to comprehend, retain and learn information that will be valuable in their efforts to be positive productive citizens. By adding absorption materials such as carpet to a classroom, facility planners are able to decrease and have more control over reverberation and echoes, which can interfere with a student's ability to discern the spoken word. However, carpeting can do more than muffle sound.

Scott (1999) reported that The American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE) has established some guidelines and procedures concerning carpet. They suggested, carpet, rather than tile improves acoustics, absorbs airborne sounds, reduces surface noise, and helps block sound transmission to other rooms. In an environment where participants are expected to listen and retain and reuse information, carpet is the suggested solution.

With so many choices of carpet to choose from what type is deemed best by carpet experts? Carpet is rated by the Noise Reduction Coefficient (NRC), which

measures the ability of a material to absorb sound. The higher the coefficient, the more sound absorption is enhanced. For example, the NRC of a concrete floor is 0.015, the NRC of conventional carpet is 0.20 but the NRC of carpet with a polyurethane cushion is an impressive, 0.25. Choosing a good padding and using a carpet with an integrated polyurethane cushion is important (Scott, 1999). It has also been suggested that carpeting more than just the floor, and including the walls, is beneficial. A study by Frese (1973) reported that carpet reduced noise by 37%, wall carpet by 24%, and the combination of wall carpet and floor carpet by 51% when compared to the bare walls and floors.

The benefits of carpet seem to outweigh the cost and relatively speaking, in terms of school construction or renovation, carpet is inexpensive and oftentimes easier and less costly to maintain than hard surfaces (The Carpet and Rug Industry, 2000a). Carpet is a cost-effective way to improve learning in schools by improving the acoustical environment and should be evaluated (Day, 1999). "School planners and architects must begin the design process with acoustics in mind" (Seep, et al., 2000, p. 2). With a bit of forethought acoustical problems can be minimized or avoided in the learning environment.

Aesthetics

Brebner (1982) suggested "an understanding of aesthetic judgment is essential for designing pleasing environments" (p. 158). Aesthetics can be defined, according to Brebner (1982) as "an interaction of cognitive and emotional processes" (p. 159). The aesthetics of an environment can affect a student in many ways. Acknowledging this, makes it necessary to revisit some worthy ideas from Gardner (1983, 1993) who coined the phrase "Multiple Intelligences" in an effort to bring notice to the multiple strengths or

intelligences people have that are perhaps not tested on an IQ test but are nonetheless fundamental. The seven intelligences Gardner (1993) identified are linguistic, logical-mathematical, spatial, bodily-kinesthetic, musical, interpersonal, and intrapersonal. Armstrong (1994) applied Gardner's seven intelligences to the classroom environment asserting that the classroom is more than just an environment it is an "ecology that may need to be fundamentally restructured to accommodate the needs of different learners" (p. 86). According to Armstrong (1994), the spoken word is essential for the linguistically and musically gifted student and noise interferes with their success. For the spatially intelligent student, the arrangement as well as the aesthetics of the room can be beneficial or detrimental, specifically, lighting, color and texture of the walls and floors. Armstrong (1994) stated the bodily-kinesthetic learner needs to move and should be allowed comfortable floor space as an option. Finally, for the intra- and interpersonal gifts of students to be addressed, attention should be given to the comfort, warmth, cooperative learning spaces and individual/private learning spaces (Armstrong, 1994).

In short, brain research lends itself to understanding the importance of the aesthetic component in the student's learning environment. Floor covering is a component of the aesthetics in the classroom. Whether it is the color, texture or patterns found in a classroom, it is recognized that students learn better when all of their senses are being stimulated (Kovalic & Olsen, 1994). Brain research has identified 19 separate senses of the human brain and body and Kovalic and Olsen (1994) state that the physical environment can impair or stimulate these senses. The 19 senses are listed in Table 2.1.

Table 2.1 The 19 Senses of the Human Brain

Senses	**Kind of Input**
Sight	Visible light
Hearing	Vibrations in the air
Touch	Tactile contact
Taste	Chemical molecular
Smell	Olfactory molecular
Balance	Kinesthetic geotropic
Vestibular	Repetitious movement
Temperature	Molecular motion
Pain	Nociception
Eidetic Imagery	Nueroelectrical image retention
Magnetic	Ferromagnetic orientation
Infrared	Long electromagnetic waves
Ultraviolet	Short electromagnetic waves
Ionic	Airborne ionic charge
Vomeronasal	Pheromonic sensing
Proximal	Physical closeness
Electrical	Surface charge
Barometric	Atmospheric pressure
Geogravimetric	Sensing mass differences

Floor covering, should be considered as a part of the physical environment of a classroom, in relation to senses such as, sight, hearing, touch, smell and temperature (Carpet and Rug Industry, 2000b). When taking into account the color, texture, patterns, the benefits of noise reduction, diminishing glare, and safety issues such as, reducing slips and falls carpet begins to emerge as a critical design element for the indoor environment (Carpet and Rug Industry, 2000b; Frese, 1973). Patients, in a mental hospital, responded positively when carpeting was introduced over the bare floors. The patients perceived this as an act of kindness that indicated society cared for their well being (Brebner, 1982).

Color, as it relates to floor covering, is an aesthetic factor in the classroom as well. The psychology of aesthetics is "part of the psychology of human information processing" (Brebner, 1982, 156-157). Color has a tendency to make items more appealing or more desirable. Food is an example. The U.S. Food and Drug Administration (1993) advocates the dying of certain foods to encourage the consumer to buy those products. Guilford (1934) suggested there might be a "fundamental relationship between affective value and the three variables of color, namely hue, tint, and chroma" (p. 342). Color, especially attractive color combinations, can affect a person's mood ("Don't be so Casual about Color", 1970; Papadatos, 1973; Rice, 1953). Nonetheless, color does exhibit certain emotional representations to humans (Don't be so casual about color, 1970; Papadatos, 1973). Sinofsky and Knirck (1981) determined that color schemes affect a student's attitude and achievement in the areas of attention span and sense of time. Rice (1953) concurred that color schemes positively impact student achievement and more so in the younger grades. When choosing colors for schools, colors children will be exposed to regularly, color research is important. Rice (1953) linked color and light to a child's level of aggression and blood pressure determining they can have a positive or negative effect depending on the student's perception of the color. Papadatos (1973) indicated in his research that color created a pleasing and stimulating atmosphere that fostered a positive school environment and contributed to a reduced rate of student absenteeism.

Student behavior may also be controlled through the aesthetic properties of an environment. The presence of "music, the use of angular shapes, or intense primary colors" can be incorporated into the classroom to increase the intellectual level of arousal

in students (Brebner, 1982, p. 169). These colors, shapes and textures can be integrated into a soft floor covering such as carpet. Color can be a stimulant or a depressant and a statement of mood ("Don't be so Causal about Color", 1970).

"When children experience a school obviously designed with their needs in mind, they notice it and demonstrate a more natural disposition toward respectful behavior and a willingness to contribute to the classroom community" (Herbert, 1998, p. 70). A school should not be designed as merely a container for people; a school should be an enriched learning environment, developed to enhance the intellectual growth of the people inside.

Interior design elements, according to research, are relevant to student achievement. "The look and feel of a school matter to children and are deeply connected to their attitudes and behavior. Children's self-esteem, sense of belonging and ambivalent needs both for control over their world and for boundaries to guide that control can be shaped through the thoughtful design of the school and classroom environments" (Herbert, 1998, p. 69)

Which colors are recommended for stimulating the environment of a classroom? Warm illumination has proven to stimulate and cool illumination tends to retard the environment, therefore medium to medium light colors such as gray, beige, green, gold, turquoise, or burnt orange are excellent choices (Don't be so casual about color, 1970). Color should complement the sun's rays without causing glare and visibility issues according to Papadatos (1973). Gulliland (1972) suggested, "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" (pp. 22-23). Selecting a muted tweed is best according to Dole (1973).

In situations where carpet is being used, marbleized or stippling textures and tight tweedy textures are good ideas, in addition to color choice ("Don't be so Casual about Color", 1970). Bayman (1975) agreed that the best selections included carpets with tweeds or patterns. Carpeting can add to the aesthetics of a classroom by providing color, texture and patterns to the floor (Papadatos, 1973).

Comfort and Safety

Kovalic and Olsen (1994) helped pioneer the ideas of creating an enriched learning environment and using brain research to improve student learning. Kovalic and Olsen (1994) suggested students need to move about the room and engage in various types of learning activities stating specifically, "seat work" is boring and does not build intelligence (p. 85). Students need to get down and dirty, they need to get in the floor, create projects and presentations, work in groups and have some individual/personal space; all of these ideas, based on brain research, clearly point toward comfortable floor space (Kovalic & Olsen, 1994). "Carpet is especially appropriate for young students who may sit on the floor in groups" (ASA, 1997, p. 3). Frese (1973) reported that after carpeting was introduced students were able to use this space more efficiently for group work, and tutoring, therefore carpet adds to the comfort and utility of a classroom.

Ergonomics, comfort for sitting and standing, is a plus when considering carpet for classrooms (Sellers, 1999). According to Sellers (1999), carpet with attached padding will enhance the standing and walking comfort of students and teachers. Ellis (1999) reported that carpet does create ergonomic comfort, which in turn alleviates stress on the

bones and muscles of students. This is pertinent on many levels such as the safety and comfort of a classroom. When carpeting is introduced slips, falls and injuries are reduced (Carpet and Rug Industry, 2000a; Frese, 1973)

Carpet can feel warmer than bare floor coverings such as tile, because it provides thermal resistance commonly referred to in the carpet industry as R-value (Carpet and Rug Industry, 2001). The padding underneath the carpeting also aids in thermal insulation as well as sound absorption (Sellers, 1999). Sellers (1999) pointed out that the warmth of a room is not limited to the temperature but that carpet can provide a homier atmosphere and contributes to an environment that is more learning conducive. Carpet creates a more comfortable environment by reducing the hardness and coldness of the flooring (Ellis, 1999). Recent studies have actually shown that carpet can "reduce fuel consumption from 5-13% when compared to hard floors" making temperature control easier and less costly to maintain (Day 1999).

Cleanliness and Maintenance

In addition to acoustics, aesthetics, comfort, and safety, carpet may add other features to a room, specifically cleanliness and air quality. It has been debated whether carpet can harbor harmful contaminates that interfere with air quality, this is not true (Carpet and Rug Industry, 2000b). Carpet is not a source for mold or mildew, for example, unless exposed to both dirt and moisture according to information released by the Carpet and Rug Industry (2000b). Other contaminates, called volatile organic compounds (VOCs), are found in the adhesives used to install carpet (Hedge, 2000). However, the amount of VOCs emitted by carpet, including the padding, is lower than vinyl floor coverings (Hedge, 2000, Yeadon, 1999). Hedge (2000) supplemented this

claim by identifying the level of VOCs released when cleaning vinyl as much higher than when cleaning carpet with hot water extraction (Hedge, 2000). In fact, the VOCs emitted from carpet at any point of its life are only trace and deemed inconsequential by the Environmental Protection Agency (Hedge, 2000).

Maintaining carpet cost much less than hard surfaces and by cleaning and maintaining carpet the risk of allergen build up is reduced (Carpet and Rug Industry, 2001). Consider hard floor surfaces in schools that may be swept regularly but are only stripped and cleaned on a scheduled basis, when the students and teachers are out of the building for holidays compared to carpet, which is vacuumed each day. Regular maintenance and vacuuming adds to the life of carpet, as well as the aesthetic value and promotes a clean environment (Carpet and Rug Industry, 2001). Kennedy (1993) recognized the need for establishing a carpet care program that consists of preventative maintenance, daily maintenance and periodic cleaning. It can also exist as an air filter system. When properly cleaned, carpet can improve air quality.

> Carpet can actually help improve the indoor environment. We know the carpet is a reservoir for whatever falls to the floor-dust, pollens, and allergens, anything that we bring in our shoes or on our clothing. What has not been considered is that carpet acts like a filter that can be cleaned over and over, taking the pollutants out of the air space with a good vacuum cleaner and a high filtration vacuum cleaner bag. This process of filtering and then cleaning… is truly a benefit. (Sellers, 2001, p. 57).

It has become prudent in such a litigious climate that school designers be responsible in creating the most beneficial environment possible.

In terms of maintenance, nylon carpeting is the most resilient and has the ease of cleaning (Yeadon, 1999). Other maintenance tips provided by Yeadon (1999) include the

use of walk off mats, which will collect 80 percent of tracked-in soil; regular vacuuming, and the use of high efficiency vacuum bags to increase air quality. The Carpet and Rug Industry (2001) concurs with these suggestions. Maintaining the school's indoor environment is important because it affects human health, image, self-esteem, and attitude as well as sending a message that students and educators care about and take care of their school (Berry, 2001).

Summary

In a time where new construction and renovation of school buildings are a supreme concern, it is imperative that money be spent wisely. In conjunction with wise financial decisions, when designing student classrooms, there should be concern for the student's well being and a sincere desire to create the best learning environment possible. "We know, or are capable of knowing, how to create schools that have a positive and attractive climate. The challenge is to continually and consciously labor to achieve the goal- to make schools places where people like to be" (Hansen, 1998, p.17). The literature reviewed in this chapter indicates that acoustics are key components of that learning environment and carpeting the classroom can provide much needed support for this key component. Aesthetics have been identified in the field of brain research as useful component in the physical environment and a positive enforcer for engaging students in the classroom. Comfort and safety have also been established in the research as a positive element in the classroom. In establishing good acoustics, aesthetic appeal, comfort and safety in the classroom, floor covering, carpet in particular could be considered a significant asset. When looking to reduce slips and falls on school property

as well as increasing the level of comfort in the learning environment carpet is a possible solution (Carpet and Rug Industry, 2000a).

Ellis (1999) noted that hard surfaced floors provided good performance but fell short in comparison to soft surfaces in terms of glare, noise and leg fatigue. Gilliland (1972) and Bayman (1975) agreed that carpet should not be identified as a luxury or a frill but a tool that motivates students, endures high traffic, provided benefits of comfort, safety and noise control while having a considerably long life expectancy of 12-20 years. Of course, proper maintenance is necessary as with any flooring choice but the benefits are immediate and long lasting Bayman 1975). Carpet brings noticeable value to the learning environment such as,

> diminished noise for a more productive learning environment, fewer slips, falls and injuries (an important element for active children), [and] the creation of more learning space on the floor, walking comfort and lack of leg fatigue, [and] reduced glare for the visually impaired in a home-like visual appeal that creates a positive productive place to learn. (Sellers, 2001, p 58).

This chapter proposed to bring the documented research of acoustics, comfort and safety, and aesthetics and the research on student learning environments together to strengthen the argument that interior school design does have an effect on student achievement.

In an effort to distinguish the lines between the related research and the research questions, a reference table was created (see Table 1.0). This information is intended to aid the reader in relating the literature to the research questions.

Table 2.2 Literary Review Reference Table

1. What are the perceptions of Georgia middle school principals concerning the influence of 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.	Acoustical Society of America (1997) Allen (1995) American Speech-Language-Hearing Association (1995) Anderson, (2001) Anderson, Smaldino & Crandall (2000) Anderson (1997) Armstrong (1994) Bayman (1975) Berry (2001) Brebner (1982) Bronzaft & McCarthy (1975) The Carpet and Rug Industry (2001, 2000a, 2000b) Crandell (1995) Dahlquist (1999) Dole (1973) "Don't be so Casual about Color in your Classrooms" (1970) Day (1999) Elliot (1982) Ellis (1999) Frese (1973) Gardner (1993, 1983) Grotass and Starr (1993) Gulliland (1972) Hawkins (2001) Hedge (2000) Herbert (1999, 1998) Hopkins (1997) Klauke (1988) Kovalic with Olsen (1994) Mizzell (2000) Papadatos (1973) Rice (1953) Reichman and Healy (1993) Seibert (1999) Sellers, 2001) Sellers (2000) Schapiro (2000) U.S. Food and Drug Administration (1993) Yeadon (1999)

2. What are the Georgia middle school principals' preferred floor coverings for the middle school classroom environment?	Castaldi (1994) Gavin (2001) Tanner (1999)
3. How do the acoustics of the environment relate to student achievement?	Acoustical Society of America (1997) Allen (1995) American Speech-Language-Hearing Association (1995) Americans With Disabilities Act (1990) Anderson (1997) Anderson (2001) Bayman (1975) Bradley (1998) Bronzaft & McCarthy (1975) The Carpet and Rug Industry (2001, 2000a, 2000b) Cohen, Evans, Krantz & Stokes (1980) Crandell (1995) Day (1999) Dahlquist (1999) Dole (1973) Elliot (1982) Ellis (1999) Evans & Lepore (1993) Evans & Maxwell (1997) Maxwell & Evans (1993) Frese (1973) Grotass and Starr (1993) Nixon (2002) Nobler & Nobler (1975) Palmer (1997) Reichman and Healy (1993) Seep, Glosemyer, Hulce, Linn, & Aytar (2000) Scott (1999) Woodhead (1964) Viteles and Smith (1946)
4. What floor coverings create the best acoustical environments when student achievement is considered?	American Speech-Language-Hearing Association (1995) Bayman (1975) Carpet and Rug Industry (2001, 2000a, 2000b) Dole (1973) Ellis (1999) Frese (1973) Gulliland (1972)

	Herbert (1999) Schapiro (2000) Seep, Glosemyer, Hulce, Linn, and Aytar (2000) Seibert (1999) Scott (1999)
5. Does the floor covering in the classroom relate to student achievement?	American Speech-Language-Hearing Association (1995) Bayman (1975) Carpet and Rug Industry (2001, 2000a, 2000b) Dole (1973) Ellis (1999) Frese (1973) Herbert (1999) Schapiro (2000) Seep, Glosemyer, Hulce, Linn, and Aytar (2000) Seibert (1999) Scott (1999)

CHAPTER 3

DESIGN OF THE STUDY

The study design included method, sample selection, instrumentation, and data collecting procedures and data analysis.

Method

Population and Sample

The population used for this study was public middle schools, grades 6-8, in the state of Georgia, for the school year 2001-2002. Each Georgia school district was categorized as rural, urban-rural or urban as defined by the U.S. Department of Agriculture (2002). First, all city and county school districts were identified in the state of Georgia then, using the Georgia state map, provided by the 2000 Census, each district was placed into one of the three categories: rural, urban-rural or urban. This map is available to the public, on the Internet. After each school district was documented and categorized, individual middle schools, grades 6-8, were identified in each district. Using the total number of middle schools and the total in each geographic category, the sample size for each category was determined. With a total sample size equaling 100, the researcher selected 38 rural schools, 17 urban-rural schools and 45 urban schools using a systematic random sampling method. Schools were chosen to represent the 159 counties and 180 school districts in the state of Georgia. Table 3.1 provides information regarding this process.

Table 3.1 Sampling Information for Selecting Middle Schools

Classification	Rural	Rural-Urban	Urban	Total
# City School Districts	12	0	9	21
# County School Districts	119	20	20	159
Total # Districts	131	20	29	180
Total # of Schools in Each Classification	152 (38%)	68 (17%)	177 (45%)	397

An alphabetized listing of Georgia schools and districts was used to select the sample. A coin toss determined that the first eligible school in each rural district would be chosen until a total of 38 schools were achieved (assuming at least two schools in the district – otherwise, no toss was necessary). Another coin toss determined the second eligible school in each urban-rural district would be chosen until the goal of 17 schools had been attained. A third coin toss determined the third eligible school in each of the urban districts would be chosen until 45 schools had been identified. Every 4th school was selected, based on the ratio between number of schools in each classification and the total. To be eligible for the study, the middle school was required to serve grades 6-8. If the randomly assigned school did not meet the criteria the researcher advanced to the next eligible school in that district and rolled forward using the same systematic process. If the end of the alphabetized 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.

Each school principal in the chosen sample received a cover letter and survey (see Appendix A and B). The researcher then used the responses from the original 100 surveys to narrow the sample to 30 schools, in which 15 school principals reported having carpet in their classrooms and 15 school principals reported having hard floor

surfaces in their classrooms. At this time (Summer of 2002) a site visit was completed in order to execute a test of acoustics using a real time data logging decibel meter with an omni-directional microphone, manufactured by Extech model RS-232. This device was used to measure background noise. A reverberation time meter, manufactured by Goldline model DSP30 was used to measure the reverberation time of generated sounds. An average reading was computed using the data collected during these site visits to develop comparisons with the reported 2000–2001, eighth grade, student achievement scores for each individual school. The researcher also collected data concerning classroom dimensions, volume, surface area, and furniture arrangement, absorbent materials, floor covering, as well as the number of windows and the colors of the walls during the time of the visit. These data were used in conjunction with the principals' responses to select the schools to be analyzed for sound and student achievement.

Instrumentation

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 educators including teachers and administrators responded to the questionnaire to determine reliability. Table 3.0 exhibits correlations that range 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 Woodworth (1958) stated that a

reliability coefficient needed to 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 perspectives about objects in the physical environment; therefore the 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 Analysis of the Questionnaire

Category	Questions	Correlation Coefficient (n = 17)
Importance of Interior Design for learning, teacher Retention, and Students' 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 School and Classrooms	23-24	.8734 p = .001

Research grant funds from the Carpet and Rug Institute were used to purchase the standardized sound level meter, Extech model RS-232 and the reverberation meter,

Goldline model DSP30 which were used on the school site visits to test classroom acoustics. The researcher received special training in the proper use of and techniques for using these standardized devices in order to secure continuity of the testing procedure and accuracy of the test results. The acoustic test results from each school were compared to the standardized test scores of eighth graders in each school. The standardized test used for this study, in the state of Georgia, was the Stanford 9, which is administered to eighth graders each spring. The Stanford 9 test scores, from the 2000-2001 school year, were available through the Georgia Department of Education on the Internet and were used as correlates with acoustic scores obtained during the site visits. The reading and mathematical scores were highlighted in this correlation.

Data Collection

A random sample of 100 middle schools, in the state of Georgia, was surveyed using a questionnaire (see Appendix B). The principal of each school was asked to complete the questionnaire. Using the responses from these questionnaires, the sample was narrowed to 30 schools, half of which reported having carpet and half of which reported hard surfaces in their classrooms. In addition to survey results, data were collected concerning the eighth grade Stanford 9 test scores, ethnicity, and socioeconomic status of students within sample schools. Relevant information such as training experience, level of certification and ethnicity was collected on the faculty of each school in the sample. These data are located on The Georgia State Report Card, which is available on the Internet and through the Georgia Department of Education.

This study applied an analysis of covariance, to adjust test scores. The dependent variable was the standardized test score. The covariates included socioeconomic status,

ethnicity and the experience and training of the teacher. The acoustical measures obtained at each school served as the independent variables along with the aesthetic, comfort and safety data collected from the questionnaire. The measures of classroom dimensions and background noise were used as covariates for comparing sound levels (adjusted reverberation times).

Data Analysis

A spreadsheet of data for each school's Stanford 9 test results along with student and teacher information was developed. Frequency counts, percentages, analysis of covariance, and a multiple regression analysis were completed to develop a baseline for interpretation. An alpha of .05 was assumed for all data analyzed in this study. As noted earlier, eighth grade student achievement, as determined by the Stanford 9 standardized test, was the dependent variable.

The analysis of the data was completed according to the research questions. The perspectives of middle school principals concerning the influence of interior design, including 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 were first analyzed by frequency counts. These data provided descriptive statistics, which were then compared to the national teacher study conducted by Schapiro (2000). The descriptive statistics were also instrumental in the selection of the sample of schools to be visited. Questions 16, 17, 28 and, 30 from the Georgia Principal's Survey (see Appendix B) were used to help determine which schools were carpeted and which schools were not. The general condition of the flooring in the building was also noted as a possible factor in selecting which schools would be visited.

The descriptive statistics answered the questions concerning the middle school principal's perspectives concerning the comfort and safety and the aesthetics of the classroom. These statistics also revealed preferred floor coverings for the middle school classroom environment.

The final component of the study dealt with how student achievement was related to the acoustics in the classroom-learning environment and which floor covering provided the best acoustical environment when student achievement was considered. To answer questions in this component, a one-way analysis of variance, controlling for the socioeconomic status and teacher training and experience, was conducted. An alpha level of .05 was applied to all statistical tests. Reverberation times were adjusted according to dimensions of the classroom and level of background noise in each classroom. In summary, the data analysis concerned with student outcomes consisted of adjusted student scores compared to adjusted reverberation times.

CHAPTER 4

PRESENTATION AND ANALYSIS OF DATA

Data Collection

Data were collected using a mail out questionnaire. (See Appendix B) The questionnaire was sent to 100 randomly selected middle school principals in the state of Georgia. Principals and their schools qualified for the study if their buildings served middle school students, grades six through eight. Of the 100 surveys distributed, 67 were returned. Using questions concerning floor covering and acoustics, thirty middle schools were chosen for a site visit and acoustic test. A second set of data were collected including the eighth grade Stanford 9 test scores for each selected school. These data were obtained from the Georgia Department of Education School Report Card posted on the Internet. Additionally, information about school size, student information concerning ethnicity, student socioeconomic status and teacher training, years of experience, certification level and ethnicity were collected from the Georgia School Report Card. These data were used as covariates to minimize bias in the findings.

Site visits and acoustic testing took place in 8^{th} grade classrooms during the summer of 2002. The researcher calculated the volume and surface area of the room and made specific notations concerning ceiling material, wall material, type of floor covering, condition of floor covering, furniture arrangement, sound absorbing materials such as bookcases and windows using the checklist located in Appendix D. These data were

used in determining adjusted reverberation times in carpeted and non-carpeted classrooms.

An initial background noise measurement was taken using an omni-directional microphone and decibel meter manufactured by Extech. The measuring device chosen for this task was a digital sound level meter/data logger model RS-232 and the decibel meter was set at a 30–80 decibel range on the slow setting as directed by the manufacturer. The decibel meter was placed in the center of the room with three feet of clearance in all directions to avoid sound bouncing off nearby objects. Following this measurement, the decibel meter was removed and the reverberation time meter was placed in the same location. The reverberation time meter was manufactured by Goldline model DSP30. According to manufacturer specifications, the meter was set for a sensitivity of a frequency level of 500 hertz. Two sounds were produced from the center of the main teaching area in the front of the room. The first sound was created from popping a paper lunch bag and the second by a starter pistol, manufactured by JEX model 202 commonly used in track and field events. This particular starter pistol used caps to generate noise. The paper bag was inflated to capacity and popped manually by the researcher. The reverberation time meter registered the sound and the time was recorded. The same procedure was followed using the starter pistol.

Following the visits to the 30 schools, all data were entered into a spreadsheet database. This database identified each school by a previously assigned code number, thereby making Georgia middle school principals and schools anonymous. These procedures and methods of data collection were used to answer the following research questions:

1. What perspectives do Georgia middle school principals have concerning the influence of interior design elements such as floor covering, lighting, flexibility, acoustics, color texture, patterns, cleanliness and maintenance on student achievement, teacher retention and student attendance?
2. What are the Georgia middle school principals' preferred floor coverings for the middle school classroom environment?
3. How does the acoustics of the environment relate to student achievement?
4. What floor coverings create the best acoustical environments when student achievement is considered?
5. Does the floor covering in the classroom relate to student achievement?

Perspectives of Middle School Principals

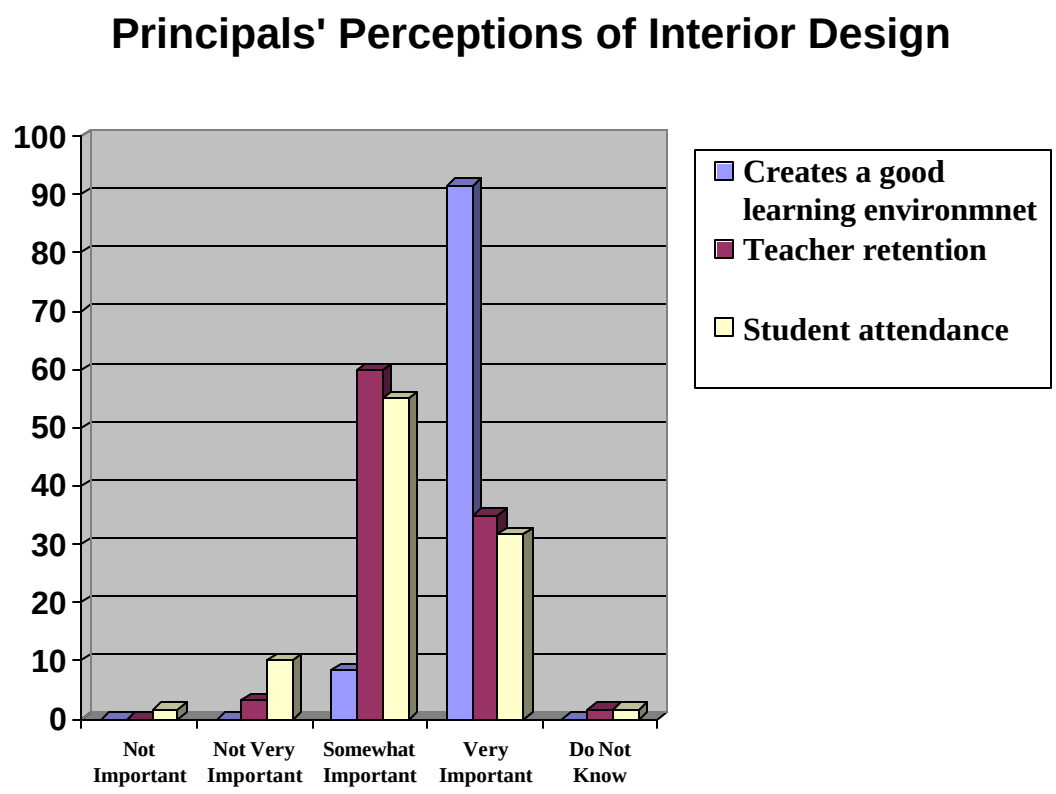
The beginning focus of this study centered on the following research question: What perspectives do Georgia middle school principals have concerning the influence of interior design elements such as floor covering, lighting, flexibility, acoustics, color texture, patterns, cleanliness and maintenance on student achievement, teacher retention and student attendance? Using the survey results, frequency counts were performed.

Questions #1–3 on the principal's survey were directed to how principals viewed interior design elements as an important factor in the learning environment. Table 4.1 and Chart 4.1 indicate that 100% of principal's surveyed agreed that interior design had a somewhat to very important impact on a learning environment. The effect of interior design on teacher retention was viewed as somewhat to very important by 95% of respondents. Approximately 87% of respondents noted that the interior design of a facility was somewhat to very important in the area of student attendance.

Table 4.1 Responses to Questions #1-3

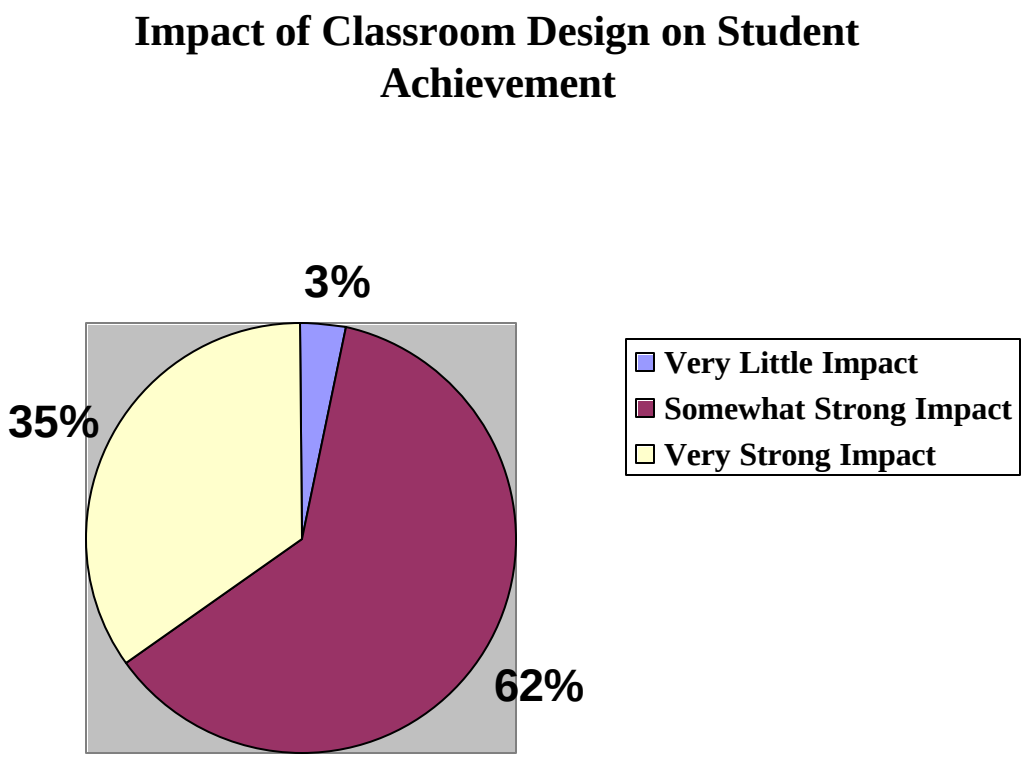
Question	1-Not at all important	2- Not very important	3- Somewhat Important	4- Very Important	5- Do not know
1. Importance of school's interior design for creating a good learning environment	0%	0%	8.3%	91.7%	0%
2. Importance of school's interior design for teacher retention	0%	3.3%	60%	35%	1.7%
3. Importance of school's interior design for student attendance	1.7%	10%	55%	31.7%	1.7%

Chart 4.1 Importance of Interior Design



The next section of survey questions identified particular design elements in a classroom and asked principals to indicate how they impact student achievement. An overwhelming 97% of the principals surveyed indicated that classroom design had a somewhat to very important impact on student achievement. Only 3% of principals recognized very little impact. Chart 4.2 outlines question #4 from the survey concerning principal's perceptions of how much impact the interior design of classrooms has on student achievement.

Chart 4.2 Impact of Classroom Design



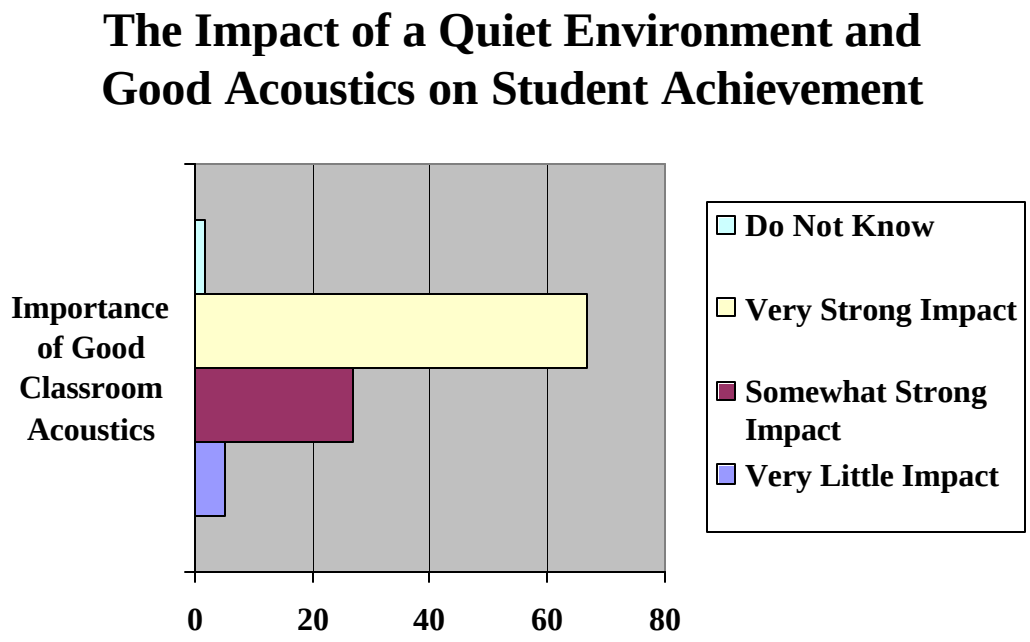
Middle school principals reported the impact of classroom lighting and flexibility in arranging a classroom in questions #5–7 on the survey. As shown in Table 4.2, only 6.7% of principals view natural lighting as having very little impact whereas 92% noted natural light was somewhat to very important to student achievement, in a classroom.

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 of natural lighting on student achievement	0%	6.7%	45%	46.7%	1.7%
6. The ability to control lighting and student achievement	0%	16.7%	41.7%	41.7%	0%
7. Flexibility in arranging a classroom and student achievement	0%	1.7%	41.7%	55%	1.7%

On question eight, initially, 35% of principals indicated carpeted classrooms have a somewhat to very important impact on student achievement. However, in question # 9, responders indicated that a quiet environment and good acoustics in the classroom were somewhat to very important, by an impressive margin of 93%. (See Chart 4.3)

Chart 4.3 The Impact of Acoustics



Questions #10–12 also referred to the classroom flooring. Principals responded positively to the suggestion of minimizing accidents, cleanliness, and comfortable seating as an important part of the classroom learning environment. For example, Table 4.3 notes that 95% of principals surveyed implied that a classroom that minimizes the risk of accidents has a somewhat to very important impact on student achievement.

Table 4.3 Responses to Questions #10-12

Question	1-No Impact At All	2- Very Little Impact	3- Somewhat Strong Impact	4- Very Strong Impact	5- Do Not Know
10. Minimizing the risk of accidents and student	0%	5%	28.3%	66.7%	0%

achievement					
11. Classroom maintenance and student achievement	3.3%	21.7%	41.7%	33.3%	0%
12. Comfortable seating and student achievement	0%	0%	26.7%	73.3%	0%

Concerning the issues of floor coloring, texture and patterns principals replied with slightly less interest. Table 4.4 illustrates questions #13-15. Only 55% of respondents indicated that floor color has a somewhat to very important impact on student achievement. Principals proved less concerned with floor texture by a showing of 60% agreeing texture had little or no impact and 13% having no knowledge as to it's effect on student achievement. Furthermore, 60% connoted that floor patterns had little or no impact on student achievement.

Table 4.4 Responses to Questions #13-15

Question	**1-No Impact At All**	**2- Very Little Impact**	**3- Somewhat Strong Impact**	**4- Very Strong Impact**	**5- Do Not Know**
13. Color of flooring and student achievement	1.7%	38.3%	40%	15%	5%
14. Texture of flooring and student achievement	11.7%	48.3%	25%	1.7%	13.3%

15. Pattern of flooring and student achievement	6.7%	53.3%	26.7%	1.7%	11.7%

In reference to question 16 and 17, the maintenance and cleanliness of flooring in their schools, 80% of middle school principals reported well-maintained and very well maintained flooring. These identical responses suggested that principals perceived no difference in maintenance and cleanliness of floor coverings.

In Table 4.5 data regarding questions #18–20 and # 22, middle school principal's perceptions concerning carpeted flooring in the learning environment are summarized. Of the principals surveyed, 93% agreed that carpeting absorbs noise and makes the classroom quieter and 56% agreed that carpeted flooring helps to prevent falls and decreases the risk of injury. In addition, 70% of respondents noted that carpet added flexibility to the classroom and 78% agreed that carpet is more comfortable to stand on.

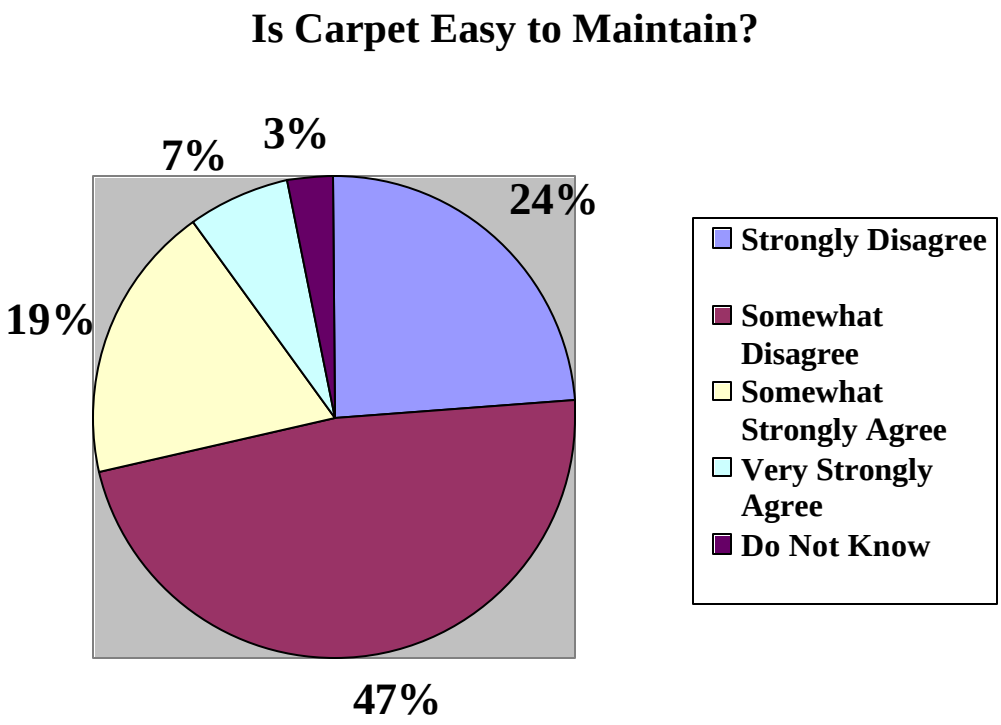
Table 4.5 Responses to questions #18–20, 22

Question	**Strongly Disagree**	**Somewhat Agree**	**Somewhat Strongly Agree**	**Very Strongly Agree**	**Do Not Know**
18. Carpet absorbs noise	0%	5%	41.7%	51.7%	1.7%
19. Carpet prevents falls and injuries making the classroom safer	3.4%	25.4%	37.3%	18.6%	15.3%
20. Carpet provides classroom flexibility to the teacher	1.7%	22%	39%	30.5%	6.8%
22. Carpet is					

more comfortable to stand on while teaching	0%	15.3%	28.8%	49.2%	6.8%

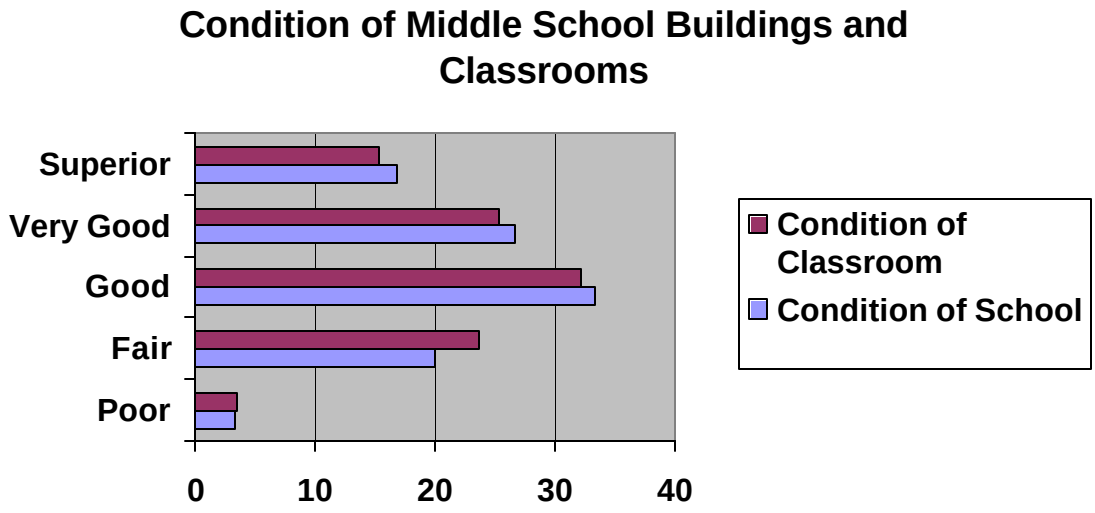
Question #21 specifically pertained to the ease of maintenance associated with carpet in the learning environment and is demonstrated in Chart 4.4. Although a preponderance of principals surveyed recognized the benefits of carpeting in the classroom specifically noise absorption, reducing falls and injury, flexibility of the learning space and comfort related to standing, only 26% agreed that carpet is easy to maintain.

Chart 4.4 Maintenance of Carpeted Flooring



Questions #23–24 concentrated on the overall condition of the school building and classrooms. Principals reported, as shown in Chart 4.5, that 23% of their schools were in poor to fair condition, 60% were in good to very good condition and only 17% reported their buildings to be in superior condition. Principal responses as to the condition of the classrooms in their building were similar with 27% stating classrooms were in poor to fair condition, 58% in good to very good condition and 15% in superior condition. (See Chart 4.5)

Chart 4.5 Responses to Questions #23-24



According to questions #25 and #26, the principals surveyed with 21 years or more experience in education was 70%. (See Table 4.6) This experienced group of educators provided valuable information to this study about their buildings and classrooms. Regarding the age of schools, in the 0–10 years old category 35% reported and in the 40+ years old category 36% reported whereas 10.3% were 11-20, 6.9% were 21-30 and

12.1% were 31-40 years old. This information was presented in question #26 and is represented in Table 4.7.

Table 4.6 Responses to Question #25

Question	0-5 Years	6-10 Years	11-15 Years	16-20 Years	21+ Years
25. Principal's Experience	0%	5%	16.7%	8.3%	70%

Table 4.7 Responses to Question #26

Question	0-10 Years	11-20 Years	21-30 Years	31-40 Years	40+ Years
26. Age of School Building	34.5%	10.3%	6.9%	12.1%	36.2%

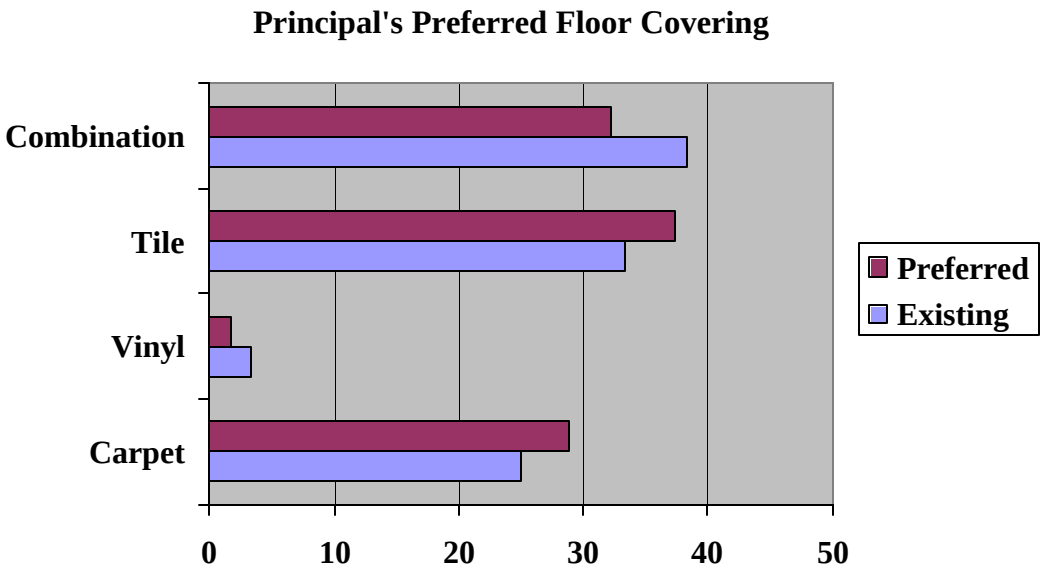
In the next section of the survey principals were asked to grade the overall design of the classrooms in their building. Principals rated their classrooms average with 28.3% giving them a C rating and above average with 43.3% of respondents giving classrooms a B rating. Table 4.8 illustrated these responses.

Table 4.8 Responses to Question #27

Question	A	B	C	D	F
27. Overall classroom design grade	13.3%	43.3%	28.3%	10%	5%

In an effort to identify needs and preferences of Georgia middle school principals the following question was asked of them: What are the Georgia middle school principals' preferred floor coverings for the middle school classroom environment? This is the second research question addressed in the Georgia principal's survey. Survey questions #28 and #29 described the existing floor in the surveyed schools and compared those responses to the principal's preferred type of flooring. Twenty-five percent of principals reported having carpet in their classrooms, 3% had linoleum/vinyl, 33% had tile and 38% had a combination type flooring. When asked about preference in flooring, 28% preferred carpet, 1.7% preferred linoleum or vinyl, 37% preferred tile and 32% would prefer a combination, when given the choice. Chart 4.6 compares the responses to these two questions.

Chart 4.6 Preferred vs. Existing Floor Covering



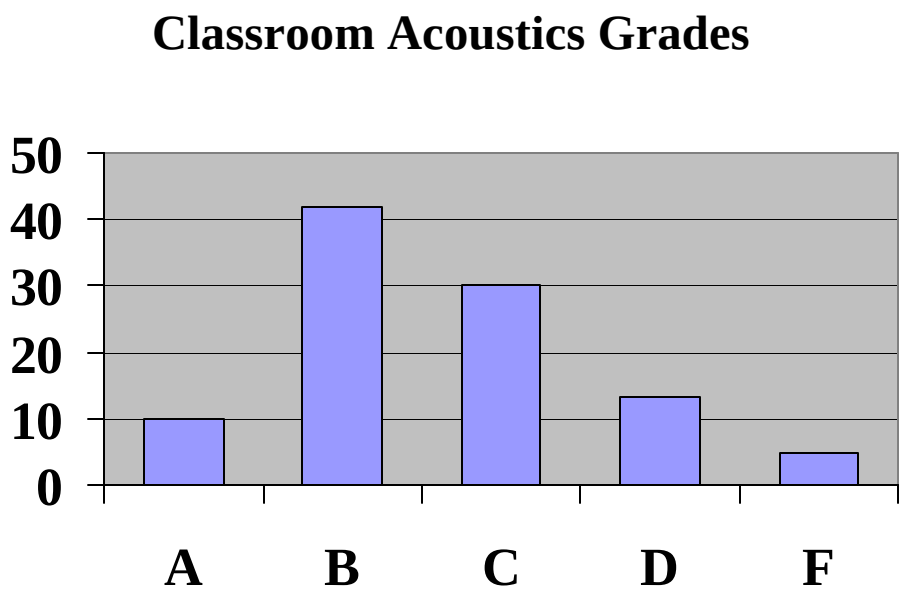
The color of carpeting or other floor covering was also approached in the survey. Forty-six percent of principals reported having neutral colored floors, 33.9% had light colored floors and 20.3% had dark colored floor coverings. Table 4.9 displays the data concerning shade and color of floor coverings in the schools surveyed.

Table 4.9 Responses to Question #31

Question	**Light**	**Neutral**	**Dark**	**Very Dark**
31. Color of classroom flooring	33.9%	45.8%	20.3%	0%

To complete the principal's survey, principals gave their school a grade in reference to the overall acoustic environment of their building and classrooms. Seventy-two percent of principals gave their school an average to above average grade, that is a "B" or a "C". An "A" grade was considered excellent, only 10% of respondents gave their buildings an excellent rating. Almost twice that number, 18% rated their buildings below average and poor, "D" and "F" respectively. The following image illustrates these responses. (See Chart 4.7)

Chart 4.7 Acoustic Grades



Acoustics and Student Achievement

A total of 30 schools were visited to test classroom acoustics and assess the physical condition of classroom floor coverings. Since only 12 schools in the sample did not have carpet, the sample was reduced to 12 schools having carpet and 12 without carpet. This reduction was accomplished by randomly eliminating schools having carpet. It was hypothesized that equal numbers of carpeted and non-carpeted schools would minimize biased data.

Before an analysis of data regarding floor coverings, acoustical environments, and student achievement could be completed, the achievement scores on reading,

mathematics, and complete test battery were adjusted. The covariates used in the adjustment were socioeconomic status of the students, level of education of the teachers, and the number of years of experience of the teachers. Table 4.10 reveals the statistical analysis regarding the adjusted test scores. In all cases the adjusted R Squared was greater that .81, indicating that a significant amount of variance in scores was accounted for by the covariates.

Table 4.10 Linear Model for Adjusted Test Scores

A. Descriptive Statistics

	Mean	Std. Deviation	N
Total Reading	51.4583	11.3443	24
Total Math	45.0417	14.4116	24
Complete Battery	50.0417	10.6301	24

B. Tests of Between-Subjects Effects

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	Total Reading	2472.053	3	824.018	33.778	.000
	Total Math	3899.123	3	1299.708	29.612	.000
	Complete Battery	2208.513	3	736.171	37.709	.000
Intercept	Total Reading	1885.611	1	1885.611	77.294	.000
	Total Math	707.084	1	707.084	16.110	.001
	Complete Battery	1432.354	1	1432.354	73.370	.000
Socioeconomic Status	Total Reading	1997.606	1	1997.606	81.885	.000

	Total Math	2369.988	1	2369.988	53.996	.000
	Complete Battery	1632.587	1	1632.587	83.627	.000
Teacher Education	Total Reading	27.801	1	27.801	1.140	.298
	Total Math	263.486	1	263.486	6.003	.024
	Complete Battery	50.189	1	50.189	2.571	.125
Teacher Experience	Total Reading	40.396	1	40.396	1.656	.213
	Total Math	147.092	1	147.092	3.351	.082
	Complete Battery	68.923	1	68.923	3.530	.075
Error	Total Reading	487.906	20	24.395		
	Total Math	877.835	20	43.892		
	Complete Battery	390.445	20	19.522		
Total	Total Reading	66511.000	24			
	Total Math	53467.000	24			
	Complete Battery	62699.000	24			
Corrected Total	Total Reading	2959.958	23			
	Total Math	4776.958	23			
	Complete Battery	2598.958	23			

a R Squared = .835 (Reading)
b R Squared = .816 (Mathematics)
c R Squared = .850 (Complete Battery)

As with the student test scores, the measures of acoustics were also adjusted. The covariates for adjusting reverberation times of the starter pistol, and the “popped” paper bag were the initial background noise in decibels, length of the classroom, width of the

classroom, height of the classroom, volume of each classroom, and the surface area. Table 4.11 shows that the R Squared for the reverberation time of the starter pistol was .511, while the R Squared for the paper bag was .250. These reverberation times were influenced by the way the furniture was arranged and other variables such as wall coverings, ceiling materials, and the number of windows in each classroom.

Table 4.11 Reverberation Times for Carpeted and Hard Surfaced Classroom Floors

A. Descriptive Statistics

	actual floor covering	Mean	Std. Deviation	N
Starter Pistol Reverberation	Carpet	1.2425	.2092	12
	Hard Surfaces	1.2950	.2195	12
	Total	1.2687	.2114	24
Bag Reverberation	Carpet	1.0217	.3154	12
	Hard Surfaces	1.1050	.1855	12
	Total	1.0633	.2566	24

B. Tests of Between-Subjects Effects

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	Starter Pistol Reverberation	.525	7	7.498E-02	2.385	.071
	Bag Reverberation time	.378	7	5.406E-02	.761	.627
Intercept	Starter Pistol Reverberation	2.512E-02	1	2.512E-02	.799	.385
	Bag Reverberation	3.353E-02	1	3.353E-02	.472	.502
Room Volume	Starter Pistol Reverberation	1.531E-02	1	1.531E-02	.487	.495
	Bag Reverberation	1.118E-02	1	1.118E-02	.157	.697
Surface	Starter Pistol	1.100E-	1	1.100E-	.035	.854

Area	Reverberation	03		03		
	Bag Reverb	4.264E-03	1	4.264E-03	.060	.810
Background Noise	Starter Pistol Reverberation	.269	1	.269	8.573	.010
	Bag Reverberation	.157	1	.157	2.217	.156
Room Length	Starter Pistol Reverberation	1.820E-02	1	1.820E-02	.579	.458
	Bag Reverberation	2.560E-02	1	2.560E-02	.360	.557
Room Width	Starter Pistol Reverberation	1.330E-02	1	1.330E-02	.423	.525
	Bag Reverberation	1.730E-02	1	1.730E-02	.244	.628
Room Height	Starter Pistol Reverberation	8.546E-03	1	8.546E-03	.272	.609
	Bag Reverberation	2.477E-02	1	2.477E-02	.349	.563
Actual Floor Covering	Starter Pistol Reverberation	8.619E-04	1	8.619E-04	.027	.871
	Bag Reverberation	3.285E-02	1	3.285E-02	.462	.506
Error	Starter Pistol Reverberation	.503	16	3.144E-02		
	Bag Reverberation	1.137	16	7.103E-02		
Total	Starter Pistol Reverberation	39.661	24			
	Bag Reverberation	28.651	24			
Corrected Total	Starter Pistol Reverberation	1.028	23			
	Bag Reverberation	1.515	23			

a R Squared = .511 (starter pistol)
b R Squared = .250 (paper bag)

Regarding research question three, the relationship of classroom acoustics to student achievement, a Pearson correlation was completed by using the adjusted (predicted) scores and reverberation times. Variables included the total reading score,

mathematics score, complete test battery, the reverberation time of the starter pistol, and the reverberation time of the paper bag. Table 4.12 reveals that the correlation between the reverberation time of the paper bag and mean reading score was -.434 (p = .03). All correlation between achievement and reverberation time produced by the popped paper bag were negative and statistically significant at the .05 level; however the levels of significance for the starter pistol were .344, .165, and .273 for scores on the reading, mathematics, and the complete test battery, respectively. In all comparisons, the correlation between student achievement scores and reverberation times were negative, indicating that as mean reverberation time was increased, the mean student achievement score decreased.

Table 4.12 Correlations between Reverberation Times and Student Achievement Scores

A. Descriptive Statistics

	Mean	Std. Deviation	N
Predicted Value for Starter Pistol Reverberation	1.2687	.1511	24
Predicted Value for Bag Reverberation	1.0633	.1283	24
Predicted Value for Reading Score	51.4583	10.3681	24
Predicted Value for Mathematics Score	45.0417	13.0203	24
Predicted Value for Complete Battery Score	50.0417	9.7991	24

B. Correlations

		Predicted Value for Reading Score	Predicted Value for Mathematics Score	Predicted Value for Complete Battery Score
Predicted Value for Starter Pistol Reverberation	Pearson Correlation	-.202	-.296	-.233
	Sig. (2-tailed)	.344	.160	.273
	N	24	24	24
Predicted Value for Bag Reverberation	Pearson Correlation	-.434	-.479	-.443
	Sig. (2-tailed)	.034	.018	.030
	N	24	24	24

Floor Covering and Acoustics

Table 4.13 indicates that there were no statistically significant differences in reverberation times for either test (starter pistol or paper bag) when compared to floor covering (alpha = .05). However, in all classrooms the reverberation time exceeded the ASA standards of .4 to.6 seconds. In addition, the decibel readings of the background noise in each classroom also exceeded ASA standards of 35 decibels. Reverberation times and background decibel readings were consistently lower in carpeted classrooms. The mean reverberation time for the starter pistol in carpeted classrooms was 1.2425 seconds and 1.2950 seconds in hard surfaced classrooms. The mean decibel reading in hard surfaced classrooms with the HVAC system turned off was 37.5 when the HVAC system was turned on the decibel level rose to 44.5. The mean decibel reading in carpeted classrooms, with the HVAC system off was 36.3 and when the HVAC system was turned on, 42.9. While carpeted classrooms had lower decibel readings and

reverberation times, neither met ASA standards in these categories. Charts 4.8 and 4.9 illustrate these data.

Chart 4.8 Comparison of Mean Reverberation Times with ASA Standards

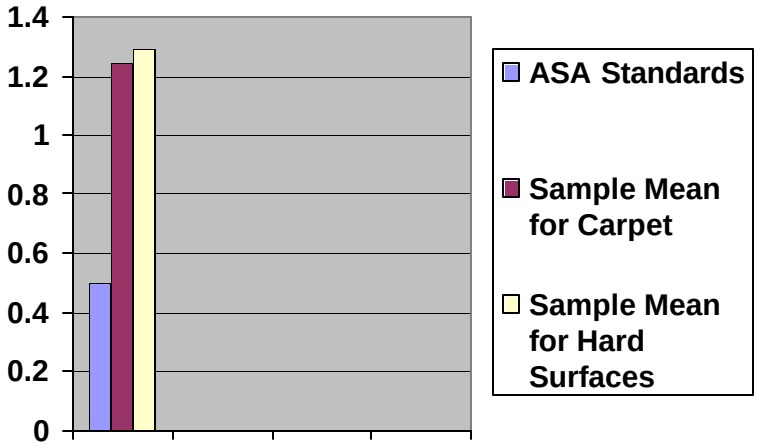


Chart 4.9 Comparison of Mean Decibel Readings and ASA Standards

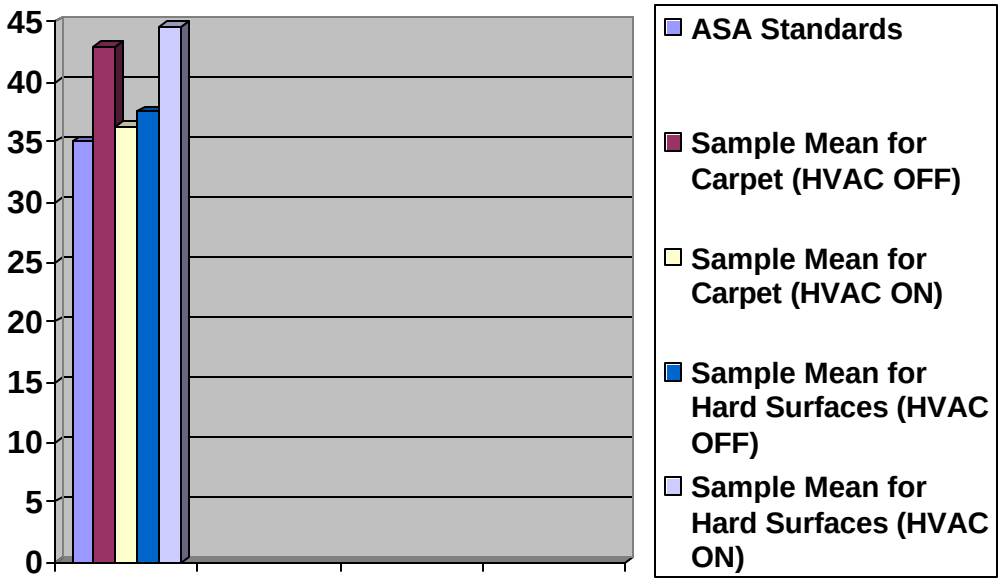


Table 4.13 Comparison Between Reverberation Times in Carpeted and Hard Surface Classrooms

A. Descriptives

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
						Lower Bound	Upper Bound		
Predicted Value for Starter Pistol Reverberation	Carpet	12	1.2425	.1024	2.955E-02	1.1775	1.3075	1.07	1.40
	Hard Surface	12	1.2950	.1890	5.457E-02	1.1749	1.4151	.89	1.53
	Total	24	1.2687	.1511	3.084E-02	1.2050	1.3325	.89	1.53
Predicted Value for Bag Reverberation	Carpet	12	1.0217	7.924E-02	2.288E-02	.9713	1.0720	.91	1.15
	Hard Surface	12	1.1050	.1560	4.503E-02	1.0059	1.2041	.78	1.32
	Total	24	1.0633	.1283	2.618E-02	1.0092	1.1175	.78	1.32

B. One-Way ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Predicted Value for Starter Pistol Reverberation	Between Groups	1.654E-02	1	1.654E-02	.716	.407
	Within Groups	.508	22	2.311E-02		
	Total	.525	23			
Predicted Value for Bag Reverberation	Between Groups	4.167E-02	1	4.167E-02	2.722	.113
	Within Groups	.337	22	1.531E-02		
	Total	.378	23			

Floor Covering and Student Achievement

When assessing the final research question, a comparison of student achievement according to floor type (carpet or hard surfaces) was made for reading, mathematics, and the complete test battery. There were no statistically significant differences at the.05 level when floor coverings were compared to student achievement. This information is detailed in Table 4.14.

Table 4.14 Student Achievement and Floor Coverings

A. Descriptives

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
						Lower Bound	Upper Bound		
Predicted Value for Reading Scores	Carpet	12	54.3333	9.9200	2.8637	48.0305	60.6362	33.98	68.73
	Hard Surface	12	48.5833	10.4080	3.0045	41.9704	55.1963	27.05	64.09
	Total	24	51.4583	10.3681	2.1164	47.0803	55.8364	27.05	68.73
Predicted Value for Mathematics Scores	Carpet	12	48.0833	12.1500	3.5074	40.3636	55.8030	22.95	65.31
	Hard Surface	12	42.0000	13.6623	3.9440	33.3194	50.6806	14.71	59.36
	Total	24	45.0417	13.0203	2.6578	39.5437	50.5396	14.71	65.31
Predicted Value for Complete Battery Scores	Carpet	12	52.5833	9.2526	2.6710	46.7045	58.4621	33.55	65.92
	Hard Surface	12	47.5000	10.0534	2.9022	41.1124	53.8876	26.99	62.26
	Total	24	50.0417	9.7991	2.0002	45.9039	54.1795	26.99	65.92

B. ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Predicted Value for Reading Score	Between Groups	198.375	1	198.375	1.919	.180
	Within Groups	2274.063	22	103.366		
	Total	2472.438	23			
Predicted Value for Mathematics Score	Between Groups	222.042	1	222.042	1.328	.261
	Within Groups	3677.086	22	167.140		
	Total	3899.127	23			
Predicted Value for Complete Battery Score	Between Groups	155.042	1	155.042	1.661	.211
	Within Groups	2053.493	22	93.341		
	Total	2208.535	23			

CHAPTER 5

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

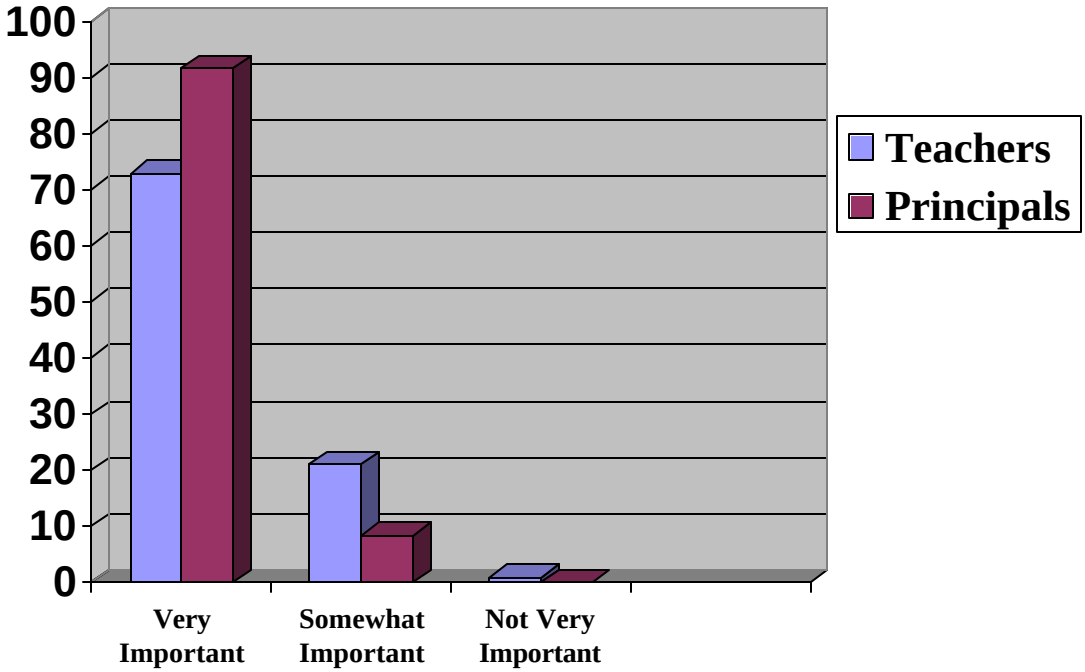
One goal of this study was to examine the perspectives of middle school principals concerning school design and the relationship of school design elements on student achievement. Another goal was to study the relationships among acoustics, floor covering, and student performance.

Chapter 1 of this study described the problem, purpose and importance of the study as well as a list of terms. The review of literature, in Chapter 2, laid the foundation for the study through an examination of previous research. Chapter 3 detailed the collection of data and procedures used to analyze the data. In Chapter 4, data were analyzed and presented in charts, graphs and tables. The final chapter, Chapter 5, is intended to summarize the findings from this study and suggest recommendations for further study in the area of school design and classroom acoustics.

Comparison of Findings

The surveys sent to Georgia middle school principals were intended to identify their perspectives regarding school and classroom design elements and how they relate to student achievement. Exactly 100 % of principals reported that interior design is important for creating a good learning environment. In a recent national teacher survey by Shapiro (2000) 99% of teachers agreed that a school's interior design is important for creating a good learning environment. (See Chart 5.1)

Chart 5.1 Comparison of Teacher's and Principal's Perspectives of Interior Design



When comparing responses of teachers and principals on teacher retention, both teachers and principals concur, 89% (Shapiro, 2000) and 95% respectively, that interior design has a positive effect. Chart 5.2 compares teachers' and principals' responses to the importance of interior design in teacher retention. In relation to student attendance, principal's rated the school design factor a bit higher than teachers, 87% and 79%, respectively (Shapiro, 2000). This information is found in Chart 5.3.

Chart 5.2 Comparison of Teacher and Principal Perspectives on Teacher Retention

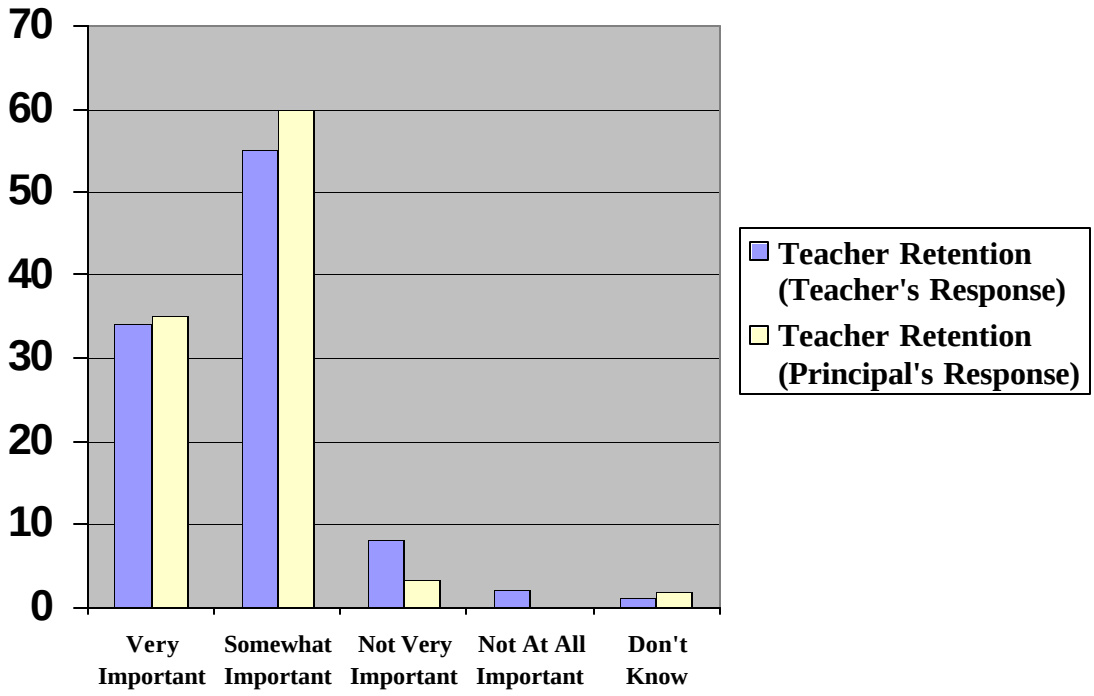
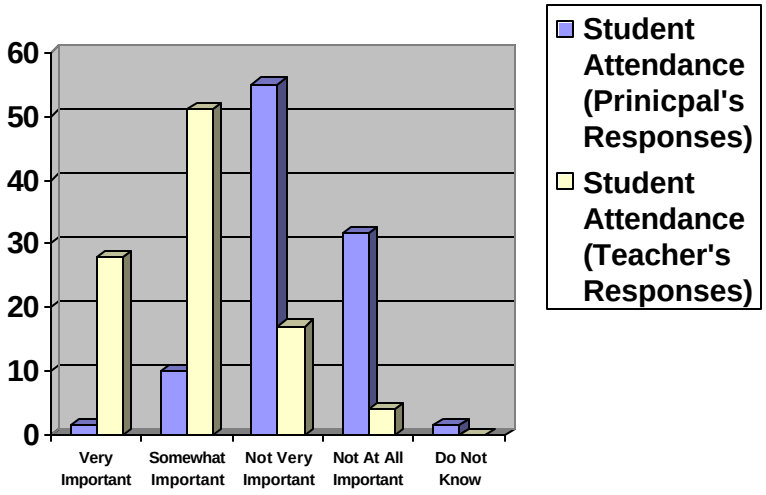
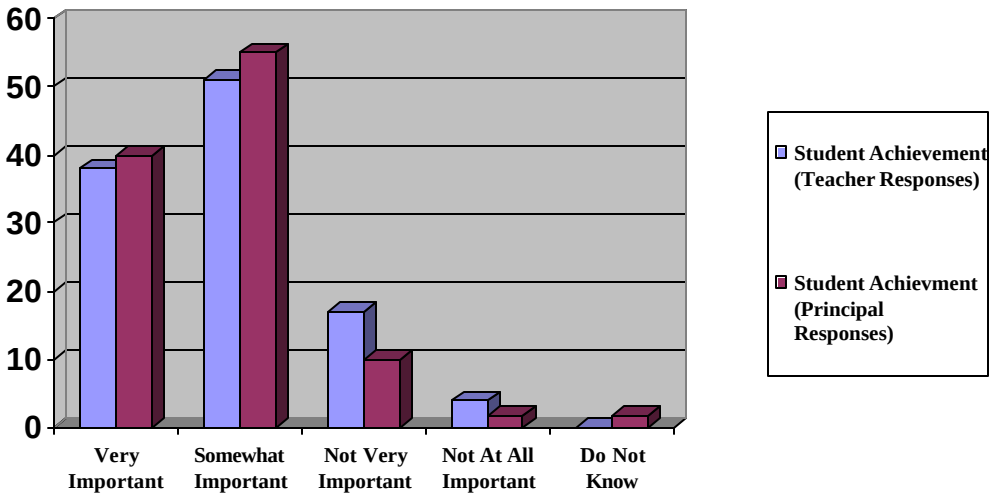


Chart 5.3 Comparison of Teacher's and Principal's Perspectives on Student Attendance



Classroom design has a strong impact on student achievement according to the principals surveyed. (See Chart 5.4) Shapiro (2000) reported 92% of teachers agreed classroom design does affect student achievement. Principals stated (92%) that classroom design elements such as natural lighting have a strong impact upon student achievement and 83% viewed the ability to control lighting in the classroom as a strong interior design element in relation to student achievement. Another high-ranking factor in student achievement is the flexibility in arranging the classroom, according to 97% of principals surveyed.

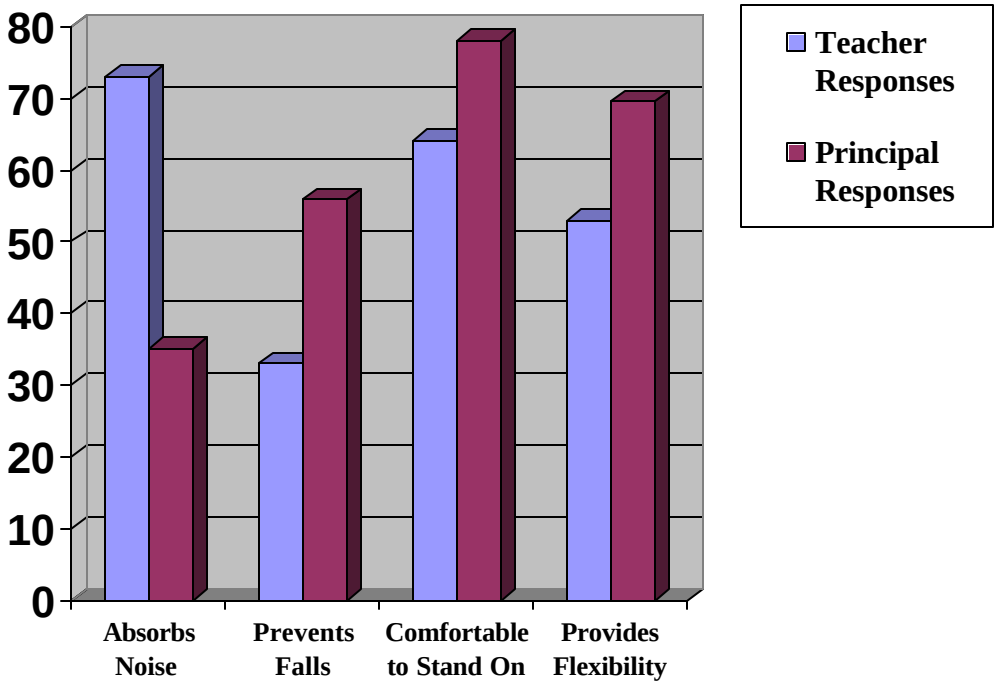
Chart 5.4 Comparison of Teacher and Principal Perspectives on Student Achievement



On the issue of floor covering in classrooms, only 35% of principals agreed that carpet impacts student achievement whereas 93% recognized the importance of carpet in the classroom to decrease noise levels, therefore positively affecting student achievement. In addition, 55% identified carpet as a key factor in student achievement as it reduces

accidents such as slips or falls. Carpeting is acknowledged by 78% of principals as being a more comfortable surface for students and teachers to stand on. Additionally, almost 70% of respondents agreed that carpeted classrooms provide more flexibility to teachers. Other interior design factors strongly impacting student achievement in the middle school classroom, as reported by Georgia middle school principals, were comfortable seating (100%) and ease of classroom maintenance (75%). Items viewed as having little or no impact on student achievement were floor texture (60%) and floor patterns (60%), and floor coloring (55%). Chart 5.5 exhibits a comparison of the principal's responses to Shapiro's (2000) national survey of teachers in regarding carpet.

Chart 5.5 Comparison of Teacher and Principal Perspectives Regarding Carpet



In terms of carpeted floor covering, 80% of principals reported their carpet was well to very well maintained and cleaned. Principals stated that carpet gives teachers the flexibility to utilize learning space in the classroom (69%) and is more comfortable for teachers to stand on (78%). However, even with all of the admitted benefits of carpet 75% of principals declared carpet was hard to maintain.

Regarding the overall condition of their school buildings, 60% of principals surveyed stated their buildings were in good to very good condition while 58% stated their classrooms were in fair to good condition. In these classrooms, 46% had neutral toned floors. Overall, 43% of principals graded their classrooms with a "B" and 28% gave their rooms a "C". In reference to the classroom acoustics in their building Georgia middle school principal's rated their classrooms as follows: Seventy-two percent of principals gave their school an above average rating of "B" while only 10% gave their classrooms an excellent rating of an "A".

When principals were asked about what type of flooring they preferred in classrooms, 37% preferred tile, 32% preferred a combination and only 28% preferred carpet. Since carpet had previously been labeled as difficult to maintain this may have contributed to the low preference rating, despite the positive responses to the value carpet adds to the noise level of a classroom.

Research questions 3, 4, and 5 were analyzed with data collected from school site visits. First, research question 3, "Do the acoustics of the environment relate significantly to student achievement?" A significant difference was found between carpeted classrooms and hard surfaced classrooms. In all comparisons, correlations between student achievement scores and reverberation times were negative, indicating

that as mean reverberation time increased, mean student achievement scores decreased. Nixon (2002) stated, "Children are especially vulnerable to interference of the acoustical signal, with reverberation and background noise being the most notable culprits." (p. 23).

Research question number 4 addressed which floor coverings create the best acoustical environments when student achievement is considered and was also examined through data collected on site visits. Reverberation times were consistently lower in carpeted classrooms visited for this study. It is important to note that reverberation in a classroom can significantly decrease a student's ability to distinguish words during teacher lessons. Carpet is a cost-effective way to improve learning in schools by improving the acoustical environment and should be evaluated (Day, 1999). Carpet does decrease the reverberation time in a classroom by adding absorption material to the floor.

The final research question for this study asked if the floor covering in the classroom relates to student achievement. There were no statistically significant differences when floor coverings were compared to student achievement (alpha = .05). While the mean reverberation times and background decibel levels in every classroom in this study exceeded ASA standards there was no statistically significant link between the effect of floor covering on student achievement at the .05 level of significance – the standard established for this study.

These differences, however, were significant at the .18 (reading), .26 (mathematics), and .21 (complete test battery) levels. These levels indicate that in all cases (reading, mathematics, and complete test battery) students in carpeted classrooms scored higher on achievement tests than students in non-carpeted classrooms (see Table 4.14). Although these three levels may be high for standard experiments, it is important

to note that at the .05 level, only 5% of the cases are expected to fall outside the normal range (rejecting the truth, or outside the 95% confidence level), while with a significance level of .18, 18% of the cases are expected to fall outside the normal range(rejecting the fact that a student makes a higher score in a carpeted classroom). That is, the confidence level is reduced from 95% to (1.00 - .18) = 82%, 74%, and 79% respectively, for the three levels found in Table 4.14. It is therefore left up to the reader as to which statistic he or she will accept regarding this issue.

Conclusions

There were not any causal relationships ascertained in this study regarding floor covering and student achievement. National standards established for reverberation times and background noise levels in classrooms were instrumental in determining that all Georgia middle school classrooms (in this study) were in violation of accepted acoustical conditions. Sound absorbing surfaces, such as carpet have been established, in previous research, as a substantial benefit in reducing acoustical problems in the classroom. These findings are supported by previous research by the Acoustical Society of America (2000) and the Carpet and Rug Institute (2000a, 2000b, 2001). Based on the survey and the literature, planners, decision-makers, and architects should pay special attention to acoustical concerns discussed in this study.

Recommendations

In an effort to promote more accurate conclusions some recommendations for change are necessary. This study took place during student holidays. For a more accurate prediction of the acoustic atmosphere it is suggested that a normal classroom atmosphere and furniture arrangement should exist. When visiting classrooms the

researcher should have a more definitive method of quantifying absorbent materials such as corkboards and bookcases as these may affect the acoustics of a room. Also, a more precise method of measuring the condition of carpet should be instituted. Therefore the condition and quality of the carpeting can be added into the analysis of data. More research on carpet, types of carpet and carpet padding would be beneficial as well.

When measuring acoustics in a classroom, it is recommended that a white noise generator with omni-directional speakers be used to create a consistent noise in each environment. White noise is most similar to the noise made by human speech. Speech intelligibility software with omni-directional microphones are available to measure the sound and reverberation with a computer rather than a hand held measuring device and the use of a starter pistol and paper bag. This would provide more precise and consistent results by measuring different octaves and frequency ranges and reducing the variation in reverberation times. In this case, students would not need to be present.

In reference to the survey, shortening and simplifying the survey may increase the return and provide more information regarding specific classrooms and grade levels. For example removing the "combination" option in the type of flooring category, questions #28-29. Also, focusing the survey toward specific rooms in same grade levels and with similar dimensions would increase the likelihood of selecting schools that are comparable.

This study was conducted in the state of Georgia. Another suggestion is to go beyond the existing scope of this study and include other states. While extending the study nationally would be a daunting task involving massive data reporting, this recommendation would align the study more with Shapiro's (2000) national study of

teachers. Expanding the study would reveal principal attitudes regarding floor covering from various parts of the United States where weather and climate are not similar to Georgia. Other differences may also factor into the end results.

It is earnestly recommended to teacher training institutions and higher learning facilities to place a finer emphasis on the importance of the physical environment and the effect it has on student achievement. Because the mean reverberation times and decibel readings in this study were higher than standards allow, the final recommendation is for policy regarding classroom acoustics to be implemented by state and local boards of education. This policy should address noise control, background noise levels, and reverberation times.

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APPENDIX A

LETTER TO PRINCIPALS

Mr. Principal
Middle School
Town, GA 30602

Dear Mr. Principal:

According to a recent national survey, many of our schools' physical environment is 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 middle 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 envelop within fifteen days of the date of this letter. Responding to this questionnaire should take no more than 10 minutes of your time. The results of your responses will remain confidential. 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 website {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
310 River's Crossing
Athens, GA
706-542-4067

Cathy Folden
Research Assistant

For questions or problems about your rights please call or write: Chris A. Joseph, Ph.D., Human Subjects Office, University of Georgia, 606A
Boyd Graduate Studies Research Center, Athens, Georgia 30602-7411; Telephone (706) 542-6514; E-Mail Address IRB@uga.edu.

APPENDIX B

GEORGIA PRINCIPAL'S SURVEY

Georgia Principal's Survey

Please respond to the following questions and return them in the self-addressed envelop 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 on floors has on students' achievement?

---

1 2 3 4 5
Very poorly /Poorly /Well /Very well /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 coverings in your school are 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?

___18. 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 over physical condition of your school?

___24. What is the over 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			