# A MEASUREMENT OF ACOUSTICS, DENSITY, ACADEMIC ACHIEVEMENT AND TEACHERS' PERCEPTIONS IN PORTABLE CLASSROOMS AND IN-BUILDING CLASSROOMS

by

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## ABSTRACT

As school systems are faced with overcrowding, portable classrooms are a common resolution when time and funding for new construction are not available. This study focused on differences between the portable classroom environment and the in-building classroom environment. Documentation of the differences between student academic achievement in portable classrooms as compared to in-building classrooms could not be found in the literature. As portable classrooms are being used in greater numbers, pupil density and acoustical quality of these environments must be examined to determine relationships to student learning.

Eight elementary schools from a suburban school system agreed to allow site visits for data collection. The researcher gathered test data, measured square footage of the classrooms, measured space taken by permanent objects, and measured background noise in decibels. Useable square footage was calculated by subtracting space taken by permanent objects from the total square footage of the classroom. Teachers of these classrooms responded to a questionnaire. Of the 43 distributed, 38 were returned.

No significant difference was found between teachers' perceptions of the two environments. Independent variable t-tests found no significant differences between the two environments in the areas of standardized test scores and pupil density. While there was no significant difference in pupil density between the two environments, a negative correlation between pupil density and standardized test scores was found. Thus, from this data set, as pupil density increased, standardized test scores decreased. Additionally, when the two environments were compared, a significant difference was found in background noise. Portable classrooms had a significantly higher level of background noise than in-building classrooms leading to the hypothesis that students in portable classrooms have difficulty in clearly hearing teacher presentations and discussion items throughout the day; therefore according to the results of this study, students in the portable classroom environment should score lower on standardized tests than those in a school building. In addition, a negative correlation between background noise and standardized test scores was found.

INDEX WORDS: Density, Portable Classrooms, Modular Classrooms, Academic Achievement, Teachers' Perceptions, Learning Environment

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IN MEMORY OF:

Laura Anne Garner
1968 – 2000

Gone from our sight, but never our memory…

Gone from our touch, but never our hearts.

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# INTRODUCTION TO THE PROBLEM

## Introduction

Currently in the state of Georgia, there are school systems that are experiencing a rapid increase in enrollment. According to Wesley Smith, construction supervisor of Brady Hill Public Schools, of the 157 portable classrooms currently owned by Brady Hill, 80% are a result of growth in the area, while 20% are a result of remodeling projects (personal communication, August 16, 2001). This trend parallels an increase in public school enrollment in Georgia of approximately 24% from 1,151,687 in 1990 to 1,422,762 in 1999 (Digest of Education Statistics, 2000; 2001). The increase in enrollment is expected to continue across the United States until 2005 when enrollment patterns will flatten (National Center for Education Statistics, 2000). In response to increasing enrollments, many school systems are resorting to the use of portable classrooms. In a survey conducted by the National Center for Education Statistics, 36% of the responding schools across the United States indicated a use of portable classrooms (Lewis, Snow, Farris, Smerdon, Cronin, & Kaplan, 1999).

Portable classrooms, as a solution to overcrowding, expedite relief for school systems when state funding is not immediately available. Funding for construction of new school buildings is based on student enrollment. Unfortunately, projected enrollment does not afford school systems funding from the state. In Georgia, funding is calculated based on the pupil enrollment reported in October of each school year. Consequently, school systems with expected or unexpected enrollment increases must provide classroom space for these students. Thus, the trend of renting, leasing or purchasing portable classrooms continues as a means to deal with swelling enrollments.

The portable trailer as a classroom environment is quite different from in-building classrooms. Among others, one significant difference is available space. In 1990, a survey conducted by Heise and Bottoms (1990) provided portable classroom teachers' perspectives and opinions of their classroom environment in grades one through six. When compared to permanent classrooms, the survey indicated that 38% of portable classroom teachers reported having less space. This lack of space is evident in Brady Hill Public School System. According to Smith, Brady Hill School System uses two types of portable classrooms; rectangular-shaped and square-shaped trailers are placed on school campuses (personal communication, August 16, 2001). The square portable classroom allows 678 feet of gross square footage, while the rectangular portable provides 672 square feet. This is the measurement from outside wall to outside wall and does not factor out furniture, storage closets, or wall space. This is significantly less than classrooms constructed in new buildings in Brady Hill, which provide 900 square feet. Portable classrooms provide a learning environment with approximately 350 square feet less space. In addition, these structures are significantly smaller than minimum requirements of the state of Georgia.

Reported in the construction guidelines, the Georgia Department of Education maintains a minimum of 750 square feet for classrooms in grades kindergarten through third and 660 square feet in fourth and fifth grades. According to Hawkins (1998), the recommended square footage for an elementary classroom is 900 square feet. This measurement is based on the increased use of computers and additional personnel for special education programs. This suggests an even larger deficit resulting from portable classroom use. With less space and the same number of students, portable classrooms provide a very dense learning environment, which warrants an examination of the possible impact this environment might have on student learning.

"Systematic knowledge about children and their interaction with the built environment can be used to improve the design of children's settings" (Weinstein & David, 1987, p.4). The study of environments and humans is not a new concept. Despite the importance placed on children and their education, as schools are planned and built, research on this topic is not often a consideration. Research indicates that the environment can and does directly influence the performance of those in that environment (Weinstein & David).

## Statement of the Problem

Any differences between student academic achievement in portable classrooms and in-building classrooms could not be found in the literature. As school systems in Georgia continue to use portable classrooms in greater numbers, the differences in pupil density and the acoustical quality of these environments must be examined to determine if these environments are acceptable or detrimental to student learning.

## Purpose of the Study

This study examined the differences in standardized test mean scores over a one-year period between classes instructed in portable classrooms and those instructed in in-building classrooms when pupil density and acoustical quality were considered. In addition, teachers' perceptions of the portable classroom environment as this environment pertains to student learning are studied. Research examining portable classrooms is a necessary response to the overwhelming number of these structures being used across the state of Georgia. Although portable classrooms are used throughout most school systems in Georgia, as of September, 2001, the Georgia Department of Education was not able to provide a specific number of portable classrooms being used in Georgia, nor could this agency provide a state policy governing the use of portable classrooms. Excessive growth in some areas and delayed funding from the state has forced many school systems to incorporate the use of portable classrooms on their school campuses.

## Null Hypotheses

The null hypotheses focused on student achievement, acoustical differences, pupil density, as well as teachers' perceptions of the two learning environments, in-building classrooms and portable classrooms.

1. As standardized test scores were examined, it was hypothesized that no significant difference in Criterion Reference Test class mean scores in reading and mathematics exist between students instructed in an in-building classroom setting and those instructed in the portable classroom environment.
2. It was hypothesized that no significant difference in pupil density exists between the two environments.
3. It was hypothesized that no significant difference in acoustical quality exists between the portable classroom environment and the in-building classroom environment as measured by background noise with HVAC units in the on position.
4. It was hypothesized that no significant correlation exists between standardized test scores and acoustical measurements in the two environments.

5. It was hypothesized that a significant correlation does not exist between standardized test scores and pupil density.
6. It was hypothesized that no significant difference exists in the perceptions of teachers' teaching in the portable classroom and in-building classroom environments concerning pupil density and acoustical quality as demonstrated by instructional differences, student focus, student discipline, poor acoustics as a result of background noise, and resources.

## Definition of Terms

For the purpose of this study, the following definitions were used:

Acoustical Quality- The quality of sound within an environment determined by the background noise, reflections of sound, and the ratio of wanted sound and unwanted sound.

Pupil Density- The usable space, measured in square feet, of a classroom divided by the number of students in that classroom.

In-building Classroom- A permanent classroom that is a part of the building structure at the time of construction or renovation. These classrooms are not relocatable.

Portable Classroom- A temporary, prefabricated classroom or trailer placed on school campuses and use for classroom space. A portable classroom is on wheels for ease with relocation.

Usuable space- The total architectural square feet minus square footage of permanent objects such as storage closets and heating and air conditioning units.

## Significance of the Study

A study of this nature was necessary as the use of portable classrooms continues to increase. Prior research directly related to this field is quite limited; therefore, school systems have no relevant research to examine the effects of these environments on student academic achievement. This study was designed to provide school systems with information as decisions are made to resolve the problem of lack of classroom space. Eventually, if portable classrooms can be shown to relate to student performance, state-funding policy might be changed to allow more leeway in school construction.

## Limitations

The following were limitations for the study:

1. The sample was selected based on agreement to participate; therefore, the sample size is small.
2. The sample was chosen from one suburban school system.
3. The study examined fourth grade classrooms and their teachers exclusively.
4. The socioeconomic status of the classes involved was not controlled (See Table 2).
5. The age of the school buildings yielded smaller in-building classrooms than expected.
6. Acoustical quality was measured through only one method, which consisted of recording background noise in decibels.

# CHAPTER II

# REVIEW OF RELATED LITERATURE

The modular classroom as an environment for student learning is questionable when factors such as space and acoustics are considered (Heise & Bottoms, 1990). As the literature is reviewed, background research in the areas of density and classroom acoustics are also examined.

## Density

A combination of limited space in modular classrooms and class sizes equal to in-building classrooms creates situations of dense classrooms. Density is calculated by the amount of space available and the number of students in that space (McAndrew, 1993). Social density refers to conditions in which the size of groups differ while the available space remains the same (Weinstein, 1979). In contrast, spatial density refers to conditions, which involve the same size groups while the environmental space differs (Weinstein, 1979). Lastly, the density factor is the ratio of students to the amount of usable architectural square footage. The architectural square footage of a given space is the area of floors, measured horizontally in a plane to the interior faces of the perimeter walls. It is this space that is called a classroom.

With swelling enrollments, the use of modular classrooms is likely to continue and to increase as schools continue to lag behind in building new schools. The Georgia Department of Education was not able to provide an exact number of modular or portable classrooms in use by Georgia public schools. In addition, according to Dan Cromer, a facilities consultant for the Georgia Department of Education, a modular classroom use policy does not exist either (personal communication, September 5, 2001). With such discrepancies in space, the educational impact of this learning environment must be examined. Through a review of literature, density is discussed as well as and its effects on individuals and the classroom environment. Crowding, classroom instruction, task performance under dense conditions, and student behavior will also be examined.

Crowding

Many studies have shown adverse impacts of density on the classroom environments of schools and that increased density has a direct impact, crowding (Stokols, 1972; Weinstein, 1979). According to McAndrew (1993), "Crowding is a subjective psychological state that results in negative feelings" (p. 146). Individuals within that environment have negative feelings as a result of the number of students in the classroom (McAndrew).

Negative feelings caused by crowded conditions lead to other problems in the classroom. According to Wohlwill (1985), crowding causes individuals to withdraw from involvement with others and increases levels of competition. This competition is especially a problem in the classroom as students move about to access resources within the classroom as explained in a study by Weldon, Loewy, Winer, and Elkin, (1981). Weldon, et al. (1981) explain that the activity influences students' perception of crowding as the activity lends itself to the need for limited resources. The limited resources heighten the competition levels in a crowded classroom.

Loo and Smetana (1978) conducted a study on 10-year-old boys. This study examined the effects of spatial density, which involves placing the same number of individuals in varying amounts of space, on 10-year-old boys. At the time of this study, Loo and Smetana felt it was important to study the effects of crowding on boys at this age, as this age child had not been previously studied under dense conditions. The low-density room allowed 52.1 square feet per child, while the high-density room allowed 13.6 square feet per child. From this study, Loo and Smetana determined that these spatially dense environments did not affect the anger and aggression of the young boys; however, avoidance and discomfort were apparent. These findings on aggression contradict other studies of this nature. Loo and Smetana attribute this finding to the abundance of toys and other resources. As previously indicated, it is this lack of resources that has been linked to aggression in dense environments.

Aiello, Nicosia, and Thompson (1979) conducted a study examining the effects of short term crowding on fourth, eighth, and eleventh grade students. These students were placed in same-sex, same-age groups of four in higher and moderate spatial density situations. Aiello, et al. (1979) found that males across the three grade levels expressed the highest levels of frustration, tension, and annoyance. These negative perceptions, expressed through a student questionnaire, provided some insight into the effects of crowding.

The negative perception associated with crowding in dense classrooms is a result of violations of personal space (Weldon, et al., 1981). In this experiment, Weldon, et al. identify crowding as a stress that is caused by infringed space. Personal space is defined by Sommer (1969) as "an area with invisible boundaries surrounding a person's body into which intruders may not come" (p. 26). Baum, Fisher, and Bell (1984) suggested that 4 to 12 feet of personal space for impersonal acquaintances was needed and that 1 ½ to 4 feet for close friends and everyday contacts was an ideal personal space. The everyday interaction of children in a classroom is illustrative of the personal space in which children could become overloaded. Baum, et al.(1984) report that when this personal space is not provided, an overload occurs. An overload occurs when attention is given to some sources while others are ignored. Paulus, Annis, Seta, Schkade, and Matthews (1976) refer to personal space as interpersonal proximity. In this study, consisting of three experiments, Paulus, et al. (1976) attempted to challenge previous studies. In the first experiment, the effects of short term crowding were examined. They found that individuals placed in a small room condition made more errors when asked to complete a maze. In another experiment, proximity was reduced, and in these close conditions an increase in errors occurred. Overall, Paulus, et al. study found that reducing interpersonal proximity, while increasing group size and decreasing room size, were linked to decrements of task performance.

Dense classrooms, those classrooms with a higher number of students than space, can lead to classrooms full of students experiencing crowding. Dense classrooms do not allow for personal space, thus sparking other behaviors (e.g., aggression) due to overload. Students instructed in portable classrooms, as opposed to in-building classrooms, are instructed each day under some of the same conditions that constitute overload.

<u>Instruction and Student Learning</u>

Research on the effects of density on instruction delivered by the teacher is quite limited. Weldon, et al. (1981) conducted research that found densely populated classrooms are not conducive to learning. This conclusion is attributed to the loss of individualized instruction, which becomes impossible in dense classrooms. In addition, Weldon, et al. attribute poor academic performance in dense environments to the stress placed on the teacher resulting in less effective teaching practices. This would suggest that portable classrooms with limited space would have a negative impact on the instructional strategies and practices used in that environment. Further research is necessary in this area.

"Nowhere else are large groups of individuals packed so closely together for so many hours, yet expected to perform at peak efficiency on difficult learning tasks and to interact harmoniously" (Weinstein, 1979, p. 585). Many studies have been conducted on the performance of students under dense conditions. Results vary, but findings are consistent in many ways. Weinstein (1979) reported on a study by Loewy (1977) from which it was determined that students in dense classrooms are distracted by other students in that environment. During this study, Loewy (1977) also reported that the impact on students depends on the approach taken by the teacher. It was found that density in discussion groups yielded a decline in achievement, while density during lecture, produced no effect from density. This information would be beneficial for teachers of portable classrooms teaching under dense conditions.

In a portable classroom user survey, Heise and Bottoms (1990) found that 41% of responding teachers in grades 1 through 6 reported less flexibility with classroom seating. For example, Research on density has been conducted in the business sector. McAndrew (1993) points out that the size of the room limits the arrangement possibilities to a traditional arrangement, and that this traditional arrangement is not conducive to today's work force requirements involving collaboration. According to Loewy (1977), McAndrew's reference to collaboration required for today's work force is not supported by the dense portable classroom environment, which would best be suited with a lecture to minimize the impact of the dense environment.

Dense classrooms pose problems for students physically as well. Baum, et al.(1984) refer to the overload concept. This concept suggests that the adverse conditions produced by density are a result of an overload of sensory input. This condition would cause students difficulty in deciphering between relevant information and other sensory input. Baum, et al. report that, "High density leads to arousal, which is a heightening of brain activity by reticular formation within the brain causing increased heart rate, high blood pressure, conditions experienced by individuals in learning environments would make learning difficult"(p. 179). Krantz and Risely (1972) found that kindergartners involved in an activity were less attentive while crowded around the teacher than if they were arranged in a semicircle. Students in portable classrooms may be experiencing these situations and adverse physical reactions.

Task Performance

Density and the effects it has on task performance have been studied repeatedly, and repeatedly it has been determined that density has no bearing on simple tasks (Freedman, Klevansky, & Elhrlich, 1971; Paulus, et al., 1976; Weinstein, 1979). According to Weinstein (1979), the impacts of density occur when density results in crowding. This crowding is a personal perception by those in the environment and varies depending on past experiences, personal space preferences, familiarity with others in the environment, and the type of activity individuals are involved (Weinstein, 1979). It is this perception of crowding that leads to difficulty with complex tasks.

Task performance and dense conditions have been studied at length. The findings are similar yet differ in some ways. Several studies have found that the negative effects depend on the activity (Heller, Groff, & Soloman, 1977; Weldon, et al., 1981). Activities requiring high interaction by the individuals involved have been shown to be more difficult under dense conditions (Heller, et al., 1977). In the study conducted by Heller, et al., density and task performance were studied by looking at other variables. Physical interaction among the individuals involved was examined. Subjects were asked to sequence events and compute addition problems. Individuals were successful in environments with low density – high interaction. Individuals in high density – high interaction conditions committed more errors. “These decrements were due to increased goal blocking and an increased need to process and attend to information from the environment” (Heller, et al., p.185). This directly relates to the overload concept (Baum, et al.,1984) resulting from crowded conditions. Students are unable to block out other occurrences in the environment.

Along with research on the effects of crowded conditions on task performance, many studies offer recommendations for decreasing these impacts. Weldon, et al., (1981) suggest reducing the incidents of personal space violations by decreasing traffic, reducing the number of doors, and using partitions in the classroom. Activities that turn the attention of the students away from other students are another way to reduce the occurrences of personal space violations (Weldon, et al.). As previously mentioned, Loo and Smetana (1978) found that an abundance of resources in the classroom reduce competitiveness and aggression between individuals in dense and crowded classrooms.

## Aggression

Banning(1990), cited in Herbert (1998) asserted, "The belief that the physical environment has an impact on students' behavior is clearly grounded in empirical evidence" (p.56). This evidence is apparent as the literature related to density is reviewed. While this research is in abundance, conflicting results are present.

Many findings conclude that density leads to aggression (Ginsburg, Pollman, Wauson, & Hope, 1977; Heller, et al., 1977; Hutt & Vaizey, 1966; Loo & Kennelly, 1979; Shapiro, 1975; Weinstein, 1979). As previously mentioned, a study conducted by Loo and Smetana (1978), found that density, with an abundance of resources, does not produce higher levels of aggression. These conflicting findings sparked a study by Loo and Kennelly (1979) who examined the behavior and perceptions of five-year old children. Unlike studies of the past, this study carefully distinguished between spatial and social density and incorporated the perceptions of children. This study considered behavior and perceptions as students were placed in groups of four and groups of eight. In addition to behavior, this study considered gender-related tendencies and personal space preferences of those involved.

For the purposes of this study, "Aggression is defined as physical behavior in which the child hit, kicked, pushed, or beat another child or physically behaved in a way in which he/she intentionally caused hurt, pain, discomfort, or frustration to another"(Loo & Kennelly, 1979, p. 135). The results of this study attributed aggressive behaviors of five-year old children to social density. The higher density situations produced children that were more aggressive, distressed, and non-playing. In addition, boys exhibited a majority of these behaviors.

Under dense conditions, “The teacher will find more disruptive behavior and increased difficulty in establishing discipline and control” (Loo & Kennelly, 1979, p. 145). Weinstein (1979) reported that conditions of social density increased aggression in the classroom environment, while spatial density showed no effect. Loo (1978) conducted a study regarding the effects of density and crowding on preschool children with previously identified behavior problems. Students labeled as high anxiety students demonstrated emotional helplessness, while those low anxiety students reduced mobility and increased facing out positions. Those hyperactive and distractable students became more active under dense conditions. Students labeled as hostile and aggressive did not behave any differently than the other students.

The causes of an increase in aggressive behavior in dense environments have varied from study to study. Stokols (1972) attributed these aggressive behaviors to the reduction of behavioral freedom or behavior constraint. Baum and Valin (1972), as cited in Baum, et al. (1984), concluded that the dense conditions increased the amount and frequency of unwanted physical contact without the individual having control over these interactions. As previously noted, a scarcity of resources has been linked to aggressive behaviors in many instances (Loo & Smetana, 1978; Rhoe & Patterson, 1974; Weldon, et al., 1981).

## The Acoustical Environment

“The acoustical environment is defined as that mixture of background noise and useful sounds in which we continually find ourselves” (Borrild, 1978, p.147). The acoustical characteristics of an environment can be crucial depending on the activities of that environment (Jones & Broadbent, 1991). The classroom environment is one environment in which the acoustics are influential. A classroom is a place where a group of 20 or more children and 1 adult gather and engage in learning activities requiring listening. Siebert (1999) reported that teachers spend 6.3 hours each day talking, while Berg (1993) reported that 45% of the day student activities at school require listening. Without an adequate acoustical environment, learning activities can be hindered. Noise, reverberation, signal-to-noise ratio, task performance and recommendations for improvement will be reviewed as the literature on room acoustics is presented. Through this review and a teacher questionnaire, the researcher hoped to determine whether portable classrooms provided acoustically adequate environments for learning.

Noise

Elementary school classrooms can be noisy places. As teachers instruct and children move about involved in activities or otherwise, the acoustical environment in a classroom can be quite noisy. This noise typically is a result of ventilation systems, poor insulation, hard surfaces that reflect noise, and outside noise (Anderson, 2001). According to the American Speech, Language, and Hearing Association (ASLHA, 1995), sources of noise inside classrooms include students talking, desks and chairs sliding on the floor, and books and papers shuffling. It is this noise that is most detrimental to learning because of the similar frequency of the teacher's voice, known as the signal (ASLHA, 1995). Students are exposed to noise in addition to the noise found inside classrooms. Classrooms are exposed to external noise such as airplanes and cars, and internal noise such as hall traffic and playgrounds in addition to the noise produced inside the classroom (Crandell & Smaldino, 2000). The combination of these three types of noise produces classrooms that exceed recommended noise levels.

“It is not only the pressure level of sound, expressed in decibels, which is important in evaluating the sound situation at a school, but also the kinds of sounds” (Hammon, 1970, p.14). There are generally three types of classroom noises identified: Background noise, internal noise, and external noise (ASLHA, 1995; Borrild, 1978; Crandell & Smaldino, 2000; Crum & Matkin, 1976). In addition to these, Glass (1985) identified to useful noise such as the teacher speaking, known as a signal. Noise, other than the signal or desired noise, which interferes with the child’s need to hear and understand, is known as background noise (Crandell & Smaldino, 2000).

Background noise is steady in nature and can consist of heating and air conditioning systems, automobile traffic, or a cafeteria full of students (Berg, 1993). In a study by Sanders (1965), he analyzed 15 schools and 47 classrooms in an attempt to generalize about noise levels in classrooms. Sanders reported background noise of the average classroom as equal to the level of the teacher’s voice. As the teacher raises her voice, attempting to overcome background noise, overall stress levels of students and the teacher increase (Anderson, 2001).

In addition to background noise, Berg (1993) refers to sudden, temporary noises such as footsteps, a jet passing by, or playground yells as intruding noise. These noises are spontaneous and unpredictable. Finally, internal noises are those noises generated within the classroom such as talking, chair and table movement, and student movement (Berg, 1993). Noise of this nature has been shown to contribute to a constant state of aggravation (Glass, 1985) and restlessness, increased activity levels, and increased self-generated noise (Anderson, 2001). These types of behaviors do not lend themselves to learning.

Several studies have been conducted measuring sound levels in classrooms at various times. For example, Sanders (1965) reported on 47 classrooms in 15 schools. He concluded that noise levels remained below 65dB for 60% of the school day. Kindergarten classes were found to have slightly higher noise levels as a result of the type of activities of a kindergarten classroom (Sanders, 1965). In a more recent study by Berg (1993), unoccupied classrooms, at night, measured at 30-35dB, while with the HVAC system on, levels raised to 40-50dB. This level is raised to 55-75dB with a teacher and 25 students in the classroom (Berg, 1993). Levels of noise in classrooms are reported at 15-20dB higher than the recommended levels of 40-50dB (Crandell & Smaldino, 1994; Berg, 1993). A useful noise, such as the teacher speaking, is measured at approximately 35dB-60dB which can be easily masked by the other sources of noise (Glass, 1985). As will be discussed, these levels are detrimental to student learning.

Signal-to-Noise Ratio and Reverberation

The acoustical environment of a classroom is measured in two ways: Signal-to-noise ratio and reverberation time. By examining these two measurements, the environment can be evaluated. Signal-to-noise ratios and reverberation times have repeated shown an impact on the intelligibility of speech, which is vital in a classroom setting.

A signal-to-noise ratio is a difference between the intensity of a signal and the intensity of the background noise (Berg, 1993; Crandell & Smaldino, 2000; Erdreich, 1999). This ratio can be found by subtracting the background noise, in decibels, from the signal reading in decibels. A ratio of 9dB or greater will yield an environment for acceptable speech intelligibility, while 3dB or less create an unacceptable listening environment (Erdreich, 1999). "Speech intelligibility is the ability of a student to hear and correctly interpret instruction or discussion" (Johnson, 2001, p.28). The signal or speech of the speaker and the source of noise are the two crucial factors of a signal-to-noise ratio. To improve this ratio, the signal must be increased or the noise decreased (Erdreich, 1999).

Reverberation is another indicator of the speech intelligibility of a classroom. Reverberation refers to time, in seconds, it takes for a sound from a source to decrease 60dB once the source of sound stops, or more technically, "the persistence or prolongation of sound within an enclosure as sound waves reflect off hard surfaces" (Crandell & Smaldino, 2000, p. 365). Reverberation has also been referred to as reflected sound that is delayed in reaching the receiver (Finitzo-Hieber & Tillman, 1978). Reverberation, or repeated reflection of sound, is found by multiplying volume(length x width x height) by 0.05 and dividing that product by the total absorption (Berg, 1993). The surface absorption of objects in the room has the most influence on the reverberation time of sounds in that room (Berg, 1993). Typical reverberation times within a classroom are 0.35 to 1.20 (Crandell & Smaldino, 1994), while the recommended reverberation time is 0.4 seconds or less (Finitzo-Hieber & Tillman, 1978; Crandell & Smaldino, 2000).

Student learning is affected by high reverberation times and low signal-to-ratio signals because of the lack of speech intelligibility (Borrild, 1978; Crandell & Smaldino, 2000; Finitzo-Hieber & Tillman, 1978). Reverberation can cause a build up of sound, which results in a lower signal-to-noise ratio (Erdreich, 1999). This build up affects speech intelligibility by masking sounds within words. "Vowel sounds are 10dB-15dB louder than consonant sounds" (Berg, 1993, p.32). Long reverberation times cause speech to blur as these vowel sounds in words mask consonant sounds (Erdreich, 1999; Berg, 1993; Crandell, Smaldino, & Flexer, 1995). Syllables of words are 1/5 of a second, while rests between words are 1/3 of a second (Glass, 1985). These too can be masked by reverberation (Crandell, et al., 1995). In a learning environment, where listening is crucial, a situation in which parts of speech are masked is detrimental.

The impact of various reverberation times has given researchers valuable information about ideal environments. In a study conducted by Crandell and Smaldino (2000), children placed in an environment with a signal-to-noise ration of +6dB and a reverberation time of 0.4 seconds recognized 71% of the stimuli. As the signal-to-noise ratio decreases and the reverberation time increases, student intelligibility decreases. In an environment with a signal-to-noise ratio of 0dB with a reverberation time of 1.2 seconds, students recognized less than 30% of the stimuli (Crandell & Smaldino, 2000).

Finitzo-Hieber and Tilman (1978) examined the affects of reverberation times on normal and hearing-impaired children. Groups of 12 hearing impaired and 12 normal hearing children, ranging in age from 8 years, 8 months to 13 years, 9 months, were exposed to reverberation times of 0.0, 0.4, and 1.2 seconds. Acoustically treated surfaces were used to alter reverberation times. As reverberation times increased, word discrimination decreased in both groups. The normal hearing group of children experienced an 18% decrease in word discrimination. Erdreich (1999) reported that minimally adequate classroom environments with competing noise become inadequate with as little as 1 second reverberation time. In another study, only 9 out of 32 classrooms, or 27%, had a reverberation time of 0.4 or less (Crandell & Smaldino, 1995).

While research shows the ill effects of high reverberation times, this seems to be the norm for classrooms.

Reverberation and signal-to-noise ratios are two components of the acoustical environment. These two, in combination, have profound effects on the ability of those in the environment to perceive speech. Ideal learning environments are those with a signal-to-noise ratio of 9dB or greater and reverberation time of 0.4 seconds.

Human Performance

Classrooms are places where students and teachers are expected to perform a variety of tasks. Berg (1993) reported that 45% of a child's day at school involves listening. "Listening is a required communication skill for students in all subjects taught in school" (Berg, 1993, p 119). Not only is listening or speech intelligibility impaired, but also task performance in the presence of noise can be affected as well. In combination, a majority of the activities conducted in a classroom are influenced by noise.

Many factors contribute to students' difficulties with speech intelligibility in the classroom. While ages vary slightly, 13 to 15 years of age, many researchers have found that young children have not fully developed the ability to decipher between speech and noise; a skill known as figure-ground discrimination (Anderson, 2001; Crandell & Smaldino, 2000; Crandell, et al., 1995; Nelson & Soli, 2000). In addition, Anderson (2001) identifies children as individuals with short attention spans and high distractibility. Not only are these developmental issues present, but also Flexer (1989) found that 30-43% of elementary students have minimal hearing impairment that is either permanent or fluctuating. Children of this age are susceptible to colds, ear infections, and allergies (Anderson, 1997). Finally, Palmer (1997, p. 215) notes, "Adults can fill in missing information using prior experiences.  Children are limited and therefore are not able to fill in as many missing pieces of a message."  With these limitations, elementary school children are at a disadvantage even in the best acoustical environment.

In a study conducted by Hougast (1981), the effect of noise conditions on speech intelligibility examined 20 teachers and 500 students under three noise conditions.  This study attempted to determine if a relationship existed between noise level and speech intelligibility.  As a point of reference, the first environment was free of reverberation and interfering noise.  The second condition involved reverberation, but was without interference.  The third condition placed students and teachers in an environment with both reverberation and interference of road traffic.  The results of this study found that for approximately 20% of teachers, speech intelligibility of students is affected when the outside noise reaches 50dB.

Teachers experience difficulties as a result of poor acoustical environments of a different nature than those of students.  Erdreich (1999) described the Lombard effect as the situation in which the teacher raises her voice to overcome the noise in the classroom only to have the classroom noise get louder requiring her to raise her voice even more.  Situations like these lead to voice disorders in teachers (Crandell, et al., 1995; Rittner-Heir, 2000).  In a study conducted by Ko (1979), the affects of background noise on teacher performance were examined.  Ko found that teachers faced with significant background noise were fatigued, tense and experienced discomfort compared to those teachers not exposed to background noise.  Teachers in Ko's study also reported that this background noise interfered with their teaching.  Barriers such as these make a difficult job even more difficult.

As teachers attempt to teach and students attempt to perceive this instruction, noise can be a difficult barrier to overcome, and "background noise affects students' abilities to perceive speech by making acoustic and linguistic cue in the teacher's spoken message (Crandell & Smaldino, 2000, p. 364). Without being able to fully understand the teacher's instruction, learning abilities are hindered (Nelson & Soli, 2000). Certain students are at higher risk in these environments. Students learning English as a second language, attention deficit disorder students, and those with undetected hearing loss fall even further behind when faced with issues of noise (Berg, 1993; Johnson, 2001; Nelson & Soli, 2000; Rittner-Heir, 2000). Thus, the problems of these students are compounded.

Instructional practices in poor acoustical environments may require changes. Anderson(2001) noted that in noisy classrooms, instructions must be repeated, group discussion is ineffective as students cannot hear each other's voices, and students learning to read have difficulty hearing the differences between words. In addition, the type of instruction used by teachers is worthy of consideration. Lecture-style instruction results in a 6-9dB drop in the level of the teacher's voice from the teacher to the back of the room (Siebein, Gold, Siebien, & Ermann, 2000). Alternative methods such as small groups or special desk arrangements can improve this rate (Siebein, et al., 2000). Poor acoustical classrooms cause students to have difficultly staying on task and decreased engagement (Berg, 1993).

Students receive two types of stimuli from the teacher in a classroom: direct sound and reflected sound (Berg, 1993). The child's location in the classroom determines the combination of the two sounds that the child receives and the acoustical quality of the classroom would determine the amount of reflected sound. Speech in classroom must be understood, not just merely heard (Glass, 1985). HVAC systems and other sources of background noise yield learning deficits, teacher fatigue, and off-task behaviors by students (Nelson & Soli, 2000). Jones and Broadbent (1991) reported, "the effect of noise is dependent on the type of noise and demands made by the task such as familiarity with the work and use of words required for the work" (p. 24.4).

"Steady noise does not interfere with human performance unless it inconsistently exceeds 90dB" (Glass, 1985, p.10). Even at 100dB, these continuous sounds, which tend to become familiar, do not affect simple task performance (Jones and Broadbent, 1991). While simple tasks are not affected by noise, complex tasks are more affected (Boggs & Simon, 1968; Jones & Broadbent, 1991). Jones and Broadbent defined a complex task disrupted by noise as one that is "cognitively burdensome, unpredictiable, or requiring an accumulation of evidence"(p. 24.4).

Fluctuations in noise yield inefficiencies proportional to the to change in sound (Jones and Broadbent, 1991). Even more than fluctuations, Jones and Broadbent found that sudden bursts of noise interrupt task performance for 2 to 3 seconds and up to 30 seconds, and these burst drastically affect tasks involving hand-eye coordination. They also found that inefficiencies resulting from noise are short-lived not extended. For example, noise was found to slow the rate of addition, but this impairment disappears after several problems (Jones & Broadbent). In addition to these factors, the child's attitude toward the noise determines the influence the noise has on performance. If the child feels in control and expects the noise, the interruption is much less. Speech, understood and irrelevant to the task at hand, even as low as 55dB, results in performance impairment (Jones & Broadbent, 1991).

While working in noisy conditions, if faced with multiple tasks, the child will limit efforts to the dominant task and dominant method of achieving this task (Jones & Broadbent, 1991). Jones and Broadbent used the example of memorizing a list in a noisy environment which would cause some students to use a method of repeated the list repeatedly aloud. As presented, there are a variety of ways noise can be influential or detrimental to a learning environment.

The acoustical environment can have a profound effect on a child's ability to perform in the classroom. Not only is the student affected, but also the teacher experiences difficulties as well.

Solutions

Currently, the U.S. Architectural and Transportation Barriers Compliance Board or Access Board has drafted guidelines to improve acoustics in classrooms (Anderson, Smaldino, & Crandell, 2000). As a standard of the Americans with Disabilities Act, the goal of this movement is to establish national standards for acoustics in classrooms. While standards are still under consideration and have not been finalized, developing a series of standards is a step in the direction of improving the acoustical environment of classrooms.

"Good acoustics in a building result from adequate planning and building designs" (Glass, 1985, p. 8). Crum and Matkin (1976) identified four major areas of concern when treating an environment acoustically: ceiling, floors, walls, and large areas of glass. Reflective surfaces must be designed to absorb more sound. Installing acoustical tile in the ceiling and carpet on the floor covers 60% of the surface area drastically decreasing reverberation, thus improving the listening environment (Crum & Matkin, 1976).

Treating the walls can be achieved by installing book shelves, dividers, acoustic wall panels, and draperies to absorb sound and decrease reflections of sound (Crum & Matkin, 1976). Decreasing background noise can be achieved by lining ductwork with acoustic liners (Johnson, 2001). Crum and Matkin identified the most difficult problem to correct is noise from adjacent areas. Castaldi (1994) recommended selecting a site with limited access to noise and arranging the layout of the school so that noisy places are isolated. Sound field amplification is another alternative to improve students' listening abilities (Anderson, 2001; Berg, 1993). According to Berg (1993), sound field amplification is the most cost-effective method of improving the listening environment. Anderson (2001) questions the budget allotment for acoustics of less than 1%. This percentage is less than the amount spent on landscaping. As this problem is recognized, changes in monetary allotments will be required to make classrooms adequate acoustical environments. Regardless of the method chosen, decreasing noise and sound reflections has been proven to benefit students in the classroom environment.

Noise, reverberation, signal-to-noise ratio, and task performance within noisy conditions provide an overall view of the impact of the acoustical environment on children. As school systems decide on learning environments for children, portable classrooms for example, these factors should be considered.

## The Affective Domain

A review of the current literature on affective assessment is necessary to select the best method for obtaining teachers' perceptions of student learning in the learning environment. The affective domain will be defined and various types of attitude assessment instruments will be presented. Through this review, the advantages and disadvantages of these instruments for assessing teachers' perceptions will be examined.

According to Wadsworth (1989), Piaget defined the affect as one's feelings, interests, desires, tendencies, values, and emotions. Throughout current literature, a variety of definitions of the affective domain exist. Ringness (1975) described the affective domain as tastes, preferences, attitudes, values, morals and character. Ringness adds that the affective domain includes an individual's guiding principles. Payne (1992) includes appreciation and motive to these definitions. The affective domain includes all behavior associated with feelings and emotions (Ringness, 1975).

According to Ringness (1975), the affective domain plays an important role in everyday life. The Taxonomy of Educational Objectives developed by Krathwohl, Bloom, and Masia (1964), as cited in Ringness (1975), outlined a continuum of internalization that individuals experience with regard to the affective domain. Beginning with receiving, in which individuals are aware of a concept, but do not have a preference, and moving to responding. At the point of responding, individuals form an opinion (Ringness). Following the responding stage is valuing during which individuals see a need and commit to a cause (Ringness). Organization occurs when individuals incorporate this opinion into their value system. Finally, characterization is the highest level of internalization and the stage at which individuals make a change in their way of life (Ringness). The movement through this continuum moves from interest to appreciation, attitudes, value, and finally to adjustment (Ringness). For the purposes of this review of literature, these will be examined as components within the affective domain.

Interests

Interests are on a much lower level than attitudes and values. Nunnally (1978), cited in Gable and Wolf (1993), described interests as "preferences for particular work activities" (p. 24) and include a target, direction, and intensity. The target of interest is the activity. The direction of interest consists of an individual's interest, positive direction, or disinterest, negative interest. Finally, according to Nunnally, the intensity of the interest may be high or low depending on the level of interest. High interests will motivate individuals to seek activity (Gable & Wolf, 1993). Aiken (1980) described interest as a feeling or preference for one's activities during which an individual does not incorporate moral judgment. Interests are less internalized than attitudes and values.

Attitude

Attitude can be defined in a variety of ways thus demonstrating that attitude is a complex and abstract concept as Mueller (1986) explained, "Attitude is a psychological construct and cannot be observed" (p.1). Allport (1935), cited in Gable and Wolf (1993), reported, "An attitude is a mental and neural state of readiness, organized through experience, exerting a directive or dynamic influence upon the individual's response to all objects and situations with which it is related" (p. 810).

Cognitive, affective, and behavior are components of attitude (Gable & Wolf, 1993). The belief or idea is cognitive, while the person's evaluation of the object is the affective component (Gable & Wolf, 1993). The behavioral aspect includes the individual's action toward the concept (Gable & Wolf, 1993). Payne (1992) defined attitude as, " a learned predisposition to respond positively or negatively to a certain object, situation, or person. It consists of cognitive, affective and performance components" (p. 23). Wagner (1965), cited in Ringness (1975), concluded, “An attitude is composed of affective, cognitive, and behavioral components that correspond, respectively, to one’s evaluations of, knowledge of, and predispositions to act toward the object of the attitude” (p. 7).

In addition to these varying definitions, attitude, which is more stable than tastes or preferences, is not considered neutral and tends to motivate individuals in a certain way; whereas, tastes and preferences are temporary and not internalized concepts (Ringness,1975). However, attitudes tend to be more consistent over time as they are exhibited through repeated behaviors in certain circumstances (Severy, 1974). While one’s attitude is not concrete, observation of behaviors (Aiken, 1980) and interviews can provide insight into one’s attitude toward a concept.

Values

Values are part of the affective domain. Rokeach (1973), as cited in Gable and Wolf (1993), defined a value as “an enduring belief that a specific mode of conduct or end-state of existence is personally or socially preferable to an opposite or converse mode of conduct or end-state of existence” (p. 5). Aiken (1980) described values as simple beliefs that are specific in nature and represent what an individual sees as important or worthy. Nunally (1978), as cited in Aiken (1980), described values as “… preferences for life goals and ways of life” (p. 5). According to Rokeach (1968), cited in Gable and Wolf (1993), values are standards and are stable over long periods of time. In addition, “values are more difficult to change than attitudes or interests” (Gable & Wolf, 1993, p. 34).

The affective domain is the emotional component of an individual. This area is developed over time and provides great insight through one’s opinions, attitudes, and values. The opinion of student learning, as perceived by the teacher, will provide information pertinent to the affects portable classrooms have on student learning as compared to the in-building classroom.

Attitude Assessment Instruments

As one prepares to collect data as a part of a study, a variety of methods of attitude assessment are available. Depending on the nature of the study, researchers may choose from a variety of techniques such as Thurstone's Interval Scale, Likert's Summated Rating Scale, a semantic differential technique, or a questionnaire. As each of these data collection methods are reviewed, the procedures associated with each as well as the advantages and disadvantages of each will be presented.

Thurstone's Attitude Scale

Louis Thurstone has been identified as the "father of attitude scaling" (Mueller, 1986, p. 34). Thurstone's attitude assessment method consists of three techniques: paired comparisons, equal appearing intervals, successive intervals or grade dichotomies (Mueller, 1986). Equal-appearing intervals is the most common technique of Thurstone's used by researchers. In developing an equal-appearing interval attitude assessment instrument, the researcher identifies the attitudinal object, develops a pool of forty to fifty opinion statements, and judges are employed to sort these attitude statements, directed at a target object, and categorize them, subjectively, an equidistance from each other (Mueller, 1986). Judges, a minimum of 10 to 15, examine the statements in favorable or unfavorable terms, not agreement or disagreement (Mueller, 1986). At this point, a scale value is obtained for each statement (Gable & Wolf, 1993). This value is used in the item selection process. Items are selected from the extreme highest and lowest within the ranking, with some neutral items included (Mueller, 1986). The final instrument includes 20 to 25 statements with median values equidistant from each other and respondents then agree or disagree with the statements as the attitude assessment is administered (Mueller, 1986).

Thurstone's attitude scale has advantages and disadvantages. Mueller (1986) describes Thurstone's equal-appearing interval scale as a plus due to the ease of constructing two scales that are equivalent. In addition, Thurstone's scale allows for a neutral attitude, unlike other scales such as Likert's scale (Mueller, 1986). The tedious work required in the development of this instrument is a disadvantage (Mueller). The use of judges to rate each attitude statement is costly and time consuming (Mueller). The Thurstone method also requires more items for an adequate reliability coefficient (Mueller, 1986). These advantages and disadvantages are worth consideration as one select an attitude scale for use in a research study.

Likert's Scale

Likert's Summated Rating Technique is a popular rating scale used to assess attitudes. In developing an instrument using this method, the researcher must first identify the object of focus (Mueller, 1986). With this object in mind, a pool of opinion statements is then generated containing twenty to thirty statements directed toward the object in a positive as well as negative way (Mueller). Neutral opinion statements are not included in this pool for a Likert Scale (Mueller). A five point rating scale is used with response formats including agreement, frequency, importance, likelihood and ranging from strongly positive to strongly negative (Gable & Wolf, 1993).

The use of a pilot study polling 6 to 10 times the number of people as the number of opinion items is necessary when developing a Likert Scale instrument (Gable & Wolf, 1993). When analyzing the results of the pilot study, a numeric value is assigned to each response. According to Gable and Wolf, positive responses are given higher numbers, negative responses, the lower value, and neutral responses, are given a zero value. Mueller reports that a sum is calculated for each respondent. Items are then categorized into a high, positive attitude group and a low, negative attitude group (Payne, 1992). Payne (1992) suggested that a mean rating is calculated from these two groups. The larger difference in the mean, the better the item is suited. The goal within this item selection is to include a range of attitudes within the twenty-five statements used (Payne,1992). Items receiving the same response from all respondents are not ideal items for the scale (Mueller, 1986). Mueller emphasizes that these statements "should be clearly positive or negative, not neutral" (p. 10).

Advantages and disadvantages exist for Likert's Summated Rating Scale. Gable and Wolf (1993) described this scale as one that is easy to construct, highly reliable, and adapts to various needs with ease. While this common scale is advantageous for researchers, disadvantages exist as well. Aiken (1980) points out that various patterns of responses can produce the same score when summed. Therefore, Aiken believed there was a lack of meaning inferred from the score as a disadvantage. Depending on the nature of the study, these advantages and disadvantages may encourage or deter researchers.

Semantic Differential

Charles Osgood developed the semantic differential technique. According to Payne (1992), this is a rating scale in which respondents rate concepts, and identifying these concepts is the first step in developing a semantic differential scale (Payne, 1992). Payne recommended that homogeneous concepts are best, while Gable and Wolf (1993) recommended that selecting adjective pairs from a comprehensive list. The selected bipolar scales should be selected carefully based on "relevance and representativeness" (Payne,1992, p. 445). The scale used for rating consists of a concept and a list of pairs of bipolar adjectives (Gable & Wolf, 1993). On a five or seven point scale on which respondents place a check on a space that "expresses intensity and direction of affect" (p. 72) felt toward the targeted concept (Gable & Wolf,1993). Payne identified three major dimensions used for this instrument type: Evaluation, potency, and activity, Payne identified evaluation as the strongest feelings, potency may be a rating of strong or weak, and activity may rate an object as fast or slow. In designing the instrument, Payne recommended including ten concepts with ten to fifteen scales for each concept, placing one concept per page, and placing the concept at the top of the page.

In addition, Payne noted that instructions to the respondent should be included and should consist of a purpose for the rating scale and procedures for responding. Along with directions for responding, respondents should be directed to respond quickly thus recording first thoughts (Payne, 1992). A pilot study using a group similar to group to be surveyed will aid the researcher in selecting the best items for the instrument (Gable & Wolf, 1993). This instrument is scored by assigning a value to each number on the scale.

Assigning a value of 10, a 7 point scale would yield a minimum score of 10 and a maximum score of 70 (Payne, 1992).

As with the Thurstone scale and Likert scale, the semantic differential technique has advantages and disadvantages. This type of scale tends to be "less obtrusive to individuals" (Aiken, 1980, p. 8). In addition, Payne (1992) notes that anonymity is not required due to the non-threatening nature of the rating scale. This instrument is "easy to construct", "administered quickly", and "highly reliable" (Mueller, 1986, p. 54), but Mueller reported that this scale is easy for respondents to figure out, thus interfering with the validity of the assessment. Another disadvantage identified by Mueller was the respondent's willingness to respond to certain items that may seem personal in nature.

Questionnaire

"A questionnaire is a series of predetermined questions that can be either self-administered, administered by mail, or asked by interviewers" (Berdie, Anderson, & Niebuhr, 1986, p. 1). Berdie et al. (1986) described questionnaires as inexpensive, time efficient, and providers of useful data. A questionnaire that provides accurate data is considered to be a valid questionnaire (Berdie et al.). In addition, a questionnaire that has the "same meaning to all people in the population being surveyed" (p. 2) is considered to be a reliable questionnaire (Berdie et al.). When preparing to develop a questionnaire, a researcher should decide on goals, know the topic, and know the people to be surveyed (Berdie et al.). Berdie et al. advise researchers to request information that is reasonable and attainable.

The sample selected to receive a questionnaire determines how well the sample represents the actual population (Berdie et al., 1986). Samples may be random or nonrandom samples such as convenience samples (Berdie et al.). Sample size depends on the population to be surveyed and can be determined with a formula in some cases (Berdie et al.).

Questionnaires can be administered in a variety of ways. "Mail surveys allow people to complete them at their leisure" (Cahalan, 1951 cited in Berdie et al., 1986, p. 15). Berdie et al. notes that if a questionnaire administered as an interview requires more than ten or fifteen minutes of the respondent's time, the questionnaire should be mailed. Berdie et al. adds that if ratings are a part of the questionnaire, interviews are difficult and the researcher might consider mailing the questionnaire.

"Questions should be directly related to stated purposes" (Berdie et al., 1986, p. 23). Erdos (1957) and Robinson (1952), cited in Berdie et al., recommend that questionnaires begin with a few interesting questions, and Levin and Gordon (1958) cited in Berdie et al., advise that important items should not be placed at the end of the questionnaire. A questionnaire can include dichotomous questions in which respondents select one of two responses, open-ended questions to be answered in the respondent's wording, multiple-choice, and ranking questions (Berdie et al.). Questionnaire developers must use familiar language and take caution not to write persuasive questions (Berdie et al.). Levin and Gordon (1958) and Robinson (1952), cited in Berdie et al., suggest grouping questions or items into sections.

The questionnaire should be "appealing to the eye" (Berdie et al., 1986). The title should be on the first page in bold print along with clear concise instructions in bold print as well (Berdie et al.). High quality paper and printing as well as colored inks and paper improve the appearance of questionnaires (Berdie et al.). The pages of the questionnaire should not be overcrowded and questions requiring detailed or difficult instructions should be avoided (Berdie et al.). Berdie et al. recommends that only items that are necessary be used in the questionnaire. In addition, a cover letter will provide information to the respondent that may comfort or ease concern and thus increase the chances of return (Berdie et al.).

As respondents complete the questionnaire, a carefully developed format will improve the quality of responses. Often the length of the questionnaire is a concern. “More important than length of the questionnaire is content” (Berdie et al., 1986, p. 53). Berdie et al. advised that all possible responses be allowed for and allow respondents to mark a place indicating a lack of answer. If rating scales are used, they should be balanced on each side of the middle position (Berdie et al.). Spaces for respondents to mark responses should be aligned vertically to avoid confusion (Berdie et al.). Conducting a pretest with a similar group of respondents similar to the target group provides valuable feedback that can be used to improve the questionnaire before actual administration (Berdie et al.).

The response rate for a mailed survey can be a problem for the researcher. To increase response rate, Berdie et al. (1986) suggested carefully planning and developing the questionnaire, personalizing the questionnaire, guaranteeing anonymity or confidentiality, eliminating personal items that might offend respondents, and sending questionnaires to a sample that is knowledgeable and correlates to the topic. Including a one-page cover letter briefly explaining the study will put respondents at ease (Berdie et al.). The researcher should provide a phone number and address for respondents to direct questions (Berdie et al.). In addition, Berdie et al. suggest sending the questionnaire to the location at which the respondent is most likely to complete the survey and sending reminders through registered or certified mail. Berdie et al. recommend including a return envelope along with the pre-folded questionnaire to encourage participants to return the questionnaire.

Questionnaires are valuable due to the ability they provide the researcher to get information from large or small groups, and questionnaires can be developed in a timely fashion (Payne, 1992). While these characteristics make questionnaires sound appealing, there are drawbacks to the use of a questionnaire as a method of data collection. "The unstructured free-response questionnaires will use large amounts of time for content analyses of the responses" (Payne, 1992, p. 449). Responses provided may not always be clearly or completely answered, thus making interpretation difficult (Payne, 1992). Payne concludes, "Unfortunately, questionnaires are often haphazardly constructed, without proper concern for the phrasing of questions, the means of summarizing and analyzing data, or pilot testing (p. 449).

Depending on the nature of the study, anonymity and confidentiality may be issues of concern. According to Berdie et al. (1986), an anonymous questionnaire is one that is completed without any one else, including the researcher, knowing who completed it. Confidentiality is a situation in which the researcher is knowledgeable of the responder, but promises not to reveal or identify the source (Berdie et al.). Anonymity with mail surveys can be difficult. Berdie et al. suggested sending reminder notices to the entire sample or including a postcard to be returned separately as methods for providing anonymity. Regardless, anonymity and confidentiality are commonly influential factors.

The affective domain and affective assessment are increasingly popular and provide data for researchers. Depending on the nature of the study, a researcher may decide to develop an instrument using Thurston's Equal-Appearing Interval technique so neutral attitudes can be accounted for, or the easily constructed Likert Scale, or a semantic differential scale which is quickly administered, or even a questionnaire with a variety of questions. Researchers must carefully consider the advantages and disadvantages as they select a method of data collection.

As a result of these negative influences of density and poor acoustics, it is believed that the standardized test scores of students instructed in portable classrooms will show mean scores less than those of students instructed in the in-building classroom setting. It is also believed that teachers' attitudes, values, and interests will be presented as their perception of the learning environment, as demonstrated by the questionnaire, will be presented in regards to instruction, student focus, and discipline.

# CHAPTER III

## METHODS AND PROCEDURES

An overview of the design of the study is provided in this chapter. The population, participants, instrumentation, data collection methods, and strengths and limitations of the study are also presented.

### Population

Participants for this study came from a suburban school system in Georgia. This county reported an 11% increase in student enrollment, and is in need of additional classroom space and to this end, they have been forced to purchase and lease portable classrooms. The population for this study consisted of fourth-grade teachers from classes who were currently using portable classrooms and in-building classrooms.

### Sample

Schools from this suburban school system were selected based on their use of portable classrooms for fourth grade classes during the 2000-2001 school year. Class mean scores of the fourth-grade Criterion Reference Test were collected from 19 classes in portable buildings and compared to class mean scores of 24 in-building classes. Teachers of these fourth-grade classes at the selected schools received a questionnaire and a letter explaining the project. Participants were asked to complete a questionnaire focused on their perceptions of teaching and student learning in either a portable classroom or an in-building classroom. The returned questionnaire was an agreement to participate.

Of the 31 elementary schools in the school system, 8 agreed to participate. These schools' original construction dates range from 1938 to 1974. These dates help to explain the small in-building classrooms found in these schools. Classroom size regulations have increased over the years to the current 900 square feet recommended by Hawkins (1998).

Each of these schools has had renovations and classroom additions. Table 1 provides specific information about construction, renovations, and additions for each school.

Table 1

Construction and Renovation of Schools

| School | Year of original construction | Year of Renovation | Year of classroom additions |
|---|---|---|---|
| 1 | 1956 | 1993 Roof | 1964, 2000 |
| 2 | 1938 | 1979, 1999 | 1960, 1971, 1999 |
| 3 | 1972 | 1986 | 1980 |
| 4 | 1959 | 1972, 1999 | 1960 |
| 5 | 1959 | 1997, 2001 | 1999 |
| 6 | 1974 | 1985 | 1980, 1985, 1986 |
| 7 | 1954 | 1970, 1986 | 1955, 1959, 1966 1970 |
| 8 | 1963 | 1976, 1995, 1998, 1999 | 1967, 1976, 1995, 1999 |

In addition to construction and renovation dates, the free and reduced lunch percentages provide information about the socioeconomic make-up of each school. The average percentage of students eligible for free and reduced lunch in these eight schools is 69.99%. The median of the set is 75.27%.

Table 2

Free and Reduced Lunch Percentages

| School | Enrollment | Percentage of free and reduced lunch |
|---|---|---|
| 1 | 494 | 82.59 |
| 2 | 821 | 53.47 |
| 3 | 832 | 63.34 |
| 4 | 563 | 76.02 |
| 5 | 725 | 82.76 |
| 6 | 926 | 50.97 |
| 7 | 764 | 76.31 |
| 8 | 961 | 74.51 |

## Instrumentation

The instruments used for this study were the Criterion Reference Test and two teacher questionnaires. The Criterion Reference Competency Test (CRCT) is a standardized test given to fourth grade students each spring in Georgia. The reading and mathematics class averages were taken from summary sheets provided by the school administrator. The reading score includes students abilities to understand what they have read, recognize different types of text, answer questions about what they has been read, and locate and recall what has been read (Georgia Department of Education, 2001). The mathematics score represents students' abilities to use operations, place value of multi-digit numbers, geometric relationships, understand fractional portions, interpret data from circle graphs, complete number patterns, solve one-step word problems, and other related skills (Georgia Department of Education, 2001).

The Portable Classroom Questionnaire and In-Building Classroom Questionnaire were developed by the researcher to measure teachers' perceptions of instruction in these two environments and how these environments relate to student learning. Statements on the questionnaires were developed by the researcher based on conversations with teachers from each learning environment and teaching experiences in each environment. Statements were developed and from the list of statements, categories were developed which were then used for sections on the questionnaire. Statements were carefully developed so that language was common and questions were not persuasive (Berdie, Anderson, & Niebuhr, 1986). The first section of the questionnaires, Learning Environment, contained seven statements. The second section, Student Behavior, contained five questions. The third section, Resources, contained two questions. The final section, Written Response, consisted of six open-ended questions. The number of statements was limited to maintain a reasonable length and to develop a questionnaire that would require a minimal amount of time to complete.

A rating scale was used for the first three sections of the questionnaires. As Berdie, et al. recommended, the scale used was balanced on each side of the neutral position. A scale of one to five was used. A response of one indicated respondent strongly agreed, two indicated a disagreement, three indicated a neutral opinion, four indicated the respondent agreed with the statement, and five indicated a strong agreement. Each response on the scale will be assigned the value one to five for data analysis.

As Berdie, et al. (1986) suggested, a pilot test involving 20 teachers was conducted to refine the questions and format of the questionnaire. Changes were made based on teacher feedback. Through this pilot test, reliability could be established, thus the researcher could determine if the questionnaire had the same meaning to all people in the population (Berdie, et al., 1986). Question one under the Learning Environment section on both questionnaires was rephrased for clarity. Question one under the Student Behavior section on both questionnaires was reworded to relate behavior problems to crowded conditions. This question previously did not mention crowded conditions. One question was eliminated from each questionnaire. These questionnaires are presented as Appendix A and Appendix B.

## Data Collection

Data were collected through a variety of methods. Fourth grade teachers at those schools agreeing to participate were asked to complete a questionnaire that focused on delivery of instruction, student learning, distractibility, time-on-task, discipline, and acoustics in portable and in-building classrooms. Through this questionnaire teachers' perceptions of students' learning in the portable classroom and in-building classroom environment were compared.

In addition, standardized test scores of students instructed in a portable classroom and students instructed in in-building classrooms were collected for comparison. These scores were obtained through the schools' administrators. CRCT class averages in reading and mathematics from a group of 19 classes of students instructed in the portable classroom environment and 24 classes from the in-building environment during the 2000-2001 school year were collected.

The researcher visited each classroom and measured the usable square footage using a standard tape measure. Permanent objects such as cabinets and bookshelves were measured so these spaces that were not useable by students could be subtracted from the room square footage, thus giving the useable square footage of the classroom. The pupil density was calculated by dividing the useable square footage of the classrooms by the number of students in those classrooms. Pupil densities of the two environments were compared.

The acoustical quality of the classroom focused on only the background noise of each of the two environments. A Realistic Sound Level Meter was used to measure the decibels of the classroom with the air conditioning unit on. The instrument was placed in the most central location of the classroom and pointed in the direction of the chalkboard. The classroom door was closed, and only the researcher was present in the classroom. The researcher was careful not to stand between the meter and the air conditioning unit. This measurement provides information about the level of noise students are subjected to as they attempt to listen, work, discuss, and concentrate.

As data were collected, consistency was maintained as the researcher visited 43 classrooms. The meter was placed in the same location in each classroom as the noise level was measured.  As the classrooms were measured, those permanent objects subtracted from the total square footage were kept consistent. Only bookshelves, cabinets, air conditioning units, and walls were subtracted when the useable square footage was calculated.  These consistencies insure that the data were comparable.

# CHAPTER IV

# DATA ANALYSIS

## Introduction

The data collected for this study were used to determine if differences existed between Criterion Reference Competency Test scores, pupil density, useable classroom space, acoustics, and teachers' perceptions in portable classrooms when compared to in-building classrooms. A compilation of this data set is presented as Appendix C and Appendix D. In addition, variables were correlated to determine if relationships existed between the two environments. While the sample for this study was limited, the data collection methods were consistent (e.g., measurement and calculation of useable space).

## Descriptive Data

Data collected from each school included 2000 and 2001 school year Criterion Reference Competency Test mean scores in the areas of reading and mathematics for each fourth-grade class, the number of students in each of these fourth-grade classes, a decibel reading from each fourth-grade classroom, a measurement of square footage within those classrooms used for fourth grade during the 2000 and 2001 school year, measurements of permanent objects taking floor space in the classroom, and teacher questionnaires completed by the teachers of each of these classes.

From these data other calculations were made. The measurements of permanent objects were subtracted from the total square footage measurements. These calculations provided the useable space of each classroom. The pupil density for each class was calculated by dividing the useable space by the number of students in the class, thus the calculation provided space per child. The scaled response ranging from 1 to 5 that teachers provided on the questionnaires were average to calculate a mean score and standard deviation for each category on the questionnaires. Responses range from strong disagreement to strong agreement. A higher score indicates agreement. The number of teachers completing the questionnaires is provided as well. This raw data is summarized in the Table 3 and Table 4.

Table 3

Classroom Data Means

| | Mean | | Standard Deviation | | Sample size | |
|---|---|---|---|---|---|---|
| | Portable | Building | Portable | Building | Portable | Building |
| CRCT Reading | 320.16 | 321.88 | 9.53 | 18.56 | 19 | 24 |
| CRCT Mathematics | 304.05 | 307.29 | 6.97 | 14.63 | 19 | 24 |
| Useable Space | 902.88 | 624.35 | 1156.89 | 39.63 | 19 | 24 |
| Pupil Density | 29.42 | 31.47 | 6.36 | 8.04 | 19 | 24 |
| Decibel Reading | 61.42 | 58.50 | 1.57 | 3.22 | 19 | 24 |
| Teacher Experience | 9.89 | 16.75 | 9.02 | 8.93 | 18 | 20 |

Table 4

Teachers' Perceptions Questionnaire

| | Mean | | Standard deviation | | Sample size | |
|---|---|---|---|---|---|---|
| | Portable | Building | Portable | Building | Portable | Building |
| Learning Environment | 3.53 | 3.30 | 1.04 | .78 | 18 | 20 |
| Student Behavior | 3.06 | 3.43 | 1.14 | .82 | 18 | 20 |
| Resources | 3.97 | 2.97 | 1.23 | .83 | 18 | 20 |

A t-test for independent samples was computed to determine if a significant difference in standardized test scores existed between the portable classroom environment and the in-building classroom environment. Differences between Criterion Reference Competency Test scores from the two environments were not found to be significant with a p-value of .716 for reading and .380 for mathematics. Table 5 presents the data demonstrating that a significant difference does not exist in standardized scores between the two environments.

Table 5

Portable and In-building CRCT Score Comparison

| | Portable classroom mean | In-building classroom mean | P-values |
|---|---|---|---|
| Reading | 320.16 | 321.88 | P=.716 |
| Mathematics | 304.05 | 307.29 | P=.380 |

A t-test for independent samples was used to examine the differences in pupil density between the two learning environments. The mean square feet per child was found to be 29.42 for the portable classroom, while the in-building classroom mean pupil density was 31.47. A p-value of .244 indicates that the difference was not statistically significant. While isolated cases were drastically different, overall the density within the portable classrooms of this study was found to be similar to that of the in-building classrooms. Table 6 presents these data.

Table 6

Portable and In-building Pupil Density

| | Mean sq. ft. per student | Standard deviation | P-value |
|---|---|---|---|
| Portable | 29.42 | 6.36 | .244 |
| In-building | 31.47 | 8.03 | |

The decibel readings recorded in these two learning environments were significantly different. The mean decibel reading of the portable classrooms was 61.42. The in-building classroom mean decibel reading was 58.50. An independent samples t-test determined a p-value of .001. This p-value indicates a significant difference in ambient noise between the two learning environments.

The repercussions of this difference in noise were examined by correlating this difference in decibel readings with the Criterion Reference Competency Test reading and mathematic scores. Correlating the portable classroom decibel readings yielded a -.231

correlation with reading scores and a -.235 correlation with mathematics scores. These correlations were found to be significant at the .05 level. Correlations for the in-building classrooms were -.047 for reading and -.048 for mathematics. Table 7 summarizes these findings.

Table 7

Decibel and CRCT Score Correlations

| | CRCT reading | CRCT mathematics | p-value |
|---|---|---|---|
| Portable decibels | -.231 | -.235 | .05 |
| In-building decibels | -.047 | -.048 | .01 |

Despite the lack of difference between the two environments in the area of pupil density, a significant correlation was found between the Criterion Reference Competency Test scores and pupil density. A composite score was calculated by averaging the reading and mathematics scores for each class. This composite score was correlated with the pupil density findings, and a negative correlation of -.616 was found to be significant at the .01 level. This negative correlation implies that as the pupil density increased, the standardized test scores decreased.

The perceptions of teachers from the portable classroom environment were compared to those from the in-building classroom environment through the use of the In-Building Classroom Teacher Questionnaire and the Portable Classroom Teacher Questionnaire. Teachers were asked to respond to statements on a scale ranging from one to five. A rating of one indicated that the teacher strongly disagreed with the statement, a two indicated the teacher disagreed, three was a neutral response, four indicated agreement, and five indicated that the teacher strongly agreed with the statement. Using this scale, values of one to five were assigned and mean scores were calculated for each section of the questionnaire.

The first section of the questionnaire focused on the learning environment. The 18 portable classroom teachers' perceptions of the learning environment as indicated by their responses on the questionnaire yielded a mean score of 3.53 with a standard deviation of 1.04. The 20 in-building classroom teachers' perceptions produced a mean score of 3.30 and a standard deviation of .78. An independent samples t-test found a p-value of .453, with no significant difference in the teachers' perceptions of the effectiveness of their corresponding learning environments.

The second section of the questionnaire related to teachers' perceptions of student behavior related to the learning environment. Portable classroom teachers responded with a mean score of 3.06 with a standard deviation of 1.15 for this section of the questionnaire. In-building classroom teachers' responses produced a mean score of 3.43 with a standard deviation of .82. The differences between these perceptions were not found to be significant with a p-value of .250. Considering the statements on the questionnaire and teachers' responses, this would indicate that in-building classroom teachers and portable classroom teachers are experiencing similar student behaviors.

The third section of the questionnaire found significant differences in teachers' perceptions of resources and technological opportunities available. The portable classroom teachers responded with a mean score of 3.97 with a standard deviation of

1.23, while the in-building teachers' mean score was 2.98 with a standard deviation of .83. An independent samples t-test yielded a p-value of .006 indicating a significant difference in the resources and technological opportunities teachers feel are available to them. A mean score of 3.97 from the portable classroom teachers indicated that these teachers agree that storage space and technological opportunities are limited. Due to the direction of the statements, the responses of the in-building teachers were inverted. The mean score of 2.98 indicates that this group of teachers' perceptions is neutral concerning storage space and technological opportunities. Teachers' perceptions of storage space and technological opportunities are significantly different between the portable classroom teacher and the in-building classroom teacher. Table 8 summarizes the results of these three sections of the In-Building Classroom Teacher Questionnaire and the Portable Classroom Teacher Questionnaire.

Table 8

Teacher Questionnaires Results Analysis

| | t | Significance |
|---|---|---|
| Learning Environment | .758 | .453 |
| Student Behavior | -1.168 | .250 |
| Resources | 2.950 | .006 |

The final section of the questionnaire consisted of open-ended questions. This section of the questionnaire contained questions concerning instructional practices and how the environment may have caused changes for teachers, benefits and drawbacks teachers associate with each environment, differences between the two environments, teachers' environment preferences, and the availability of technology for each learning environment. These questions provide space for teachers to elaborate on the opinions expressed in earlier sections of the questionnaires, and this section gave teachers the opportunity to express their perceptions of their teaching environment. . The questions were developed for the portable classroom teacher as well as the in-building classroom teacher. While the questions maintained the same focus, the environment was specific to the teacher. Many of the answers provided were similar in nature indicating common threads among teachers' perceptions. All answers were recorded, and responses were tallied based on common answers. The three most common responses for each question with percentages of teachers responding are presented in Tables 9 and 10. Teachers provided multiple answers to questions at times, and all responses will not be presented; therefore percentages will not equal 100.

Table 9

Portable Classroom Teachers' Perceptions

| Question | Responses | Percentages |
|---|---|---|
| Have your instructional practices changed as a result of teaching in the portable classroom? | No | 39% |
| | No space for group work | 12% |
| | Less space | .06% |
| What benefits are provided by the portable classroom? | Privacy | 33% |
| | Can do loud activities without disturbing others | 23% |
| | Control of heat and air | 23% |
| What drawbacks come from teaching in a portable classroom? | Weather conditions | 44% |
| | Lack of restroom access | 17% |
| | Isolated from others | 17% |
| How is your portable classroom different than in-building classrooms? | Less storage | 34% |
| | Less space | 22% |
| | Teacher feels isolated | 17% |
| Would you prefer to teach in a portable classroom or an in-building classroom? | In-building | 61% |
| | Portable | 39% |
| Please describe any discrepancies in technological opportunities as a result of the portable classroom? | No closed circuit television | 17% |
| | Less computers | 11% |
| | Older computers | 11% |

Table 10

<u>In-Building Classroom Teachers' Perceptions</u>

| Question | Responses | Percentages |
|---|---|---|
| Have your instructional practices changed as a result of teaching in the in-building classroom as opposed to a portable classroom? | No | 25% |
| | Space for group work | 22% |
| | Unknown | 20% |
| What benefits are provided by the in-building classroom? | Easy access to other places | 65% |
| | No weather problems | 60% |
| | Not isolated from others | 25% |
| What drawbacks come from teaching in an in-building classroom? | Hall traffic | 70% |
| | Noisy nearby classrooms | 15% |
| | Noise | 10% |
| How is your in-building classroom different than a portable classroom? | Larger | 55% |
| | More storage | 30% |
| | Less travel time | 10% |
| Would you prefer to teach in a portable classroom or in-building classroom? | In-building | 90% |
| | Portable | 10% |
| Please describe any discrepancies in technological opportunities as a result of the in-building classroom. | None | 25% |
| | Closed circuit television | 20% |
| | More available | 20% |

## Hypotheses Results

The results of this study yield mixed results concerning the null hypotheses.

1. It was hypothesized that no significant difference in Criterion Reference Test class mean scores in reading and mathematics existed between students instructed in an in-building classroom setting and those instructed in the portable classroom environment. This null hypothesis was accepted.
2. It was hypothesized that no significant difference in pupil density existed between the two environments. This hypothesis was accepted.
3. It was hypothesized that no significant difference in acoustical quality existed between the portable classroom environment and the in-building classroom environment as measured by background noise with HVAC units in on position. A significant difference was found and therefore, this null hypothesis was rejected.
4. It was hypothesized that a significant correlation does not exist between standardized test score differences and acoustical measurements. This null hypothesis was rejected based on the negative correlations of -.235 and -.231 significant at the .05 level that was found between the standardized test scores and acoustical measurements.
5. It was hypothesized that a significant correlation does not exist between standardized test scores and pupil density. This null hypothesis was rejected based on the negative correlation of -.616 found between standardized test scores and pupil density data.
6. It was hypothesized that no significant difference in the perceptions of teachers' of the portable classroom and in-building classroom environments existed concerning pupil density and acoustical quality as demonstrated by instructional differences, student focus, student discipline, poor acoustics as a result of background noise, and

resources. This hypothesis was rejected based on the differences found in the Resources section of the questionnaires.

## Summary

This chapter provided an overview of descriptive data and statistical analyses conducted as a part of this study. Significant differences between the two learning environments were found in the areas of acoustics and teachers' perceptions of resources available. The decibel readings found in portable classrooms were significantly higher than those of in-building classrooms. Correlations were found between the decibel readings and standardized test scores as well as between pupil density and standardized test scores.

# CHAPTER V

# CONCLUSIONS AND RECOMMENDATIONS

## Introduction

The purpose of this study was to determine if relationships exist between portable classrooms and in-building classrooms in the areas of standardized test scores, pupil density, acoustics, and teachers' perceptions. Schools were selected from a suburban school system based on their agreement to participate in the study. From each school, fourth grade classes were used in data collection. From each class, mean CRCT reading and mathematics scores were collected, decibel readings were taken, and the useable square footage of classrooms was measured using a standard measuring tape. Teachers' perceptions were collected through the use of a Portable Classroom Questionnaire and the In-Building Classroom Questionnaire developed by the researcher. Standardized test scores consisted of CRCT class scores from fourth grade classes within those schools within the sample. All other data were collected through school visits by the researcher.

## Findings

The null hypotheses for this study stated that no relationship exists between portable classrooms and in-building classrooms when considering standardized test scores, pupil density, decibel reading, and teachers' perceptions. An independent variable t-test indicated in no significant differences between portable classrooms and in-building classrooms in the areas of standardized test scores and pupil density, thus these null hypotheses were accepted. A significant difference was found in acoustical quality as measured by decibel readings within the two environments. This null hypothesis was rejected. The portable classroom mean decibel reading was higher than that of in-building classrooms. This can be primarily attributed to the heating, ventilation and air conditioning (HVAC) units.

Additionally, it was hypothesized that no relationship existed between standardized test scores and pupil density, and standardized test scores and decibel readings. However, a significant relationship was found between standardized test scores and decibel readings and between standardized test scores and pupil density. The correlations between these variables were negative indicating that an increase in one variable yields a decrease in the other. Therefore, an increase in decibel readings correlates significantly with a decrease in standardized test scores, and an increase in pupil density correlates with a decrease in standardized test scores. These results were true without regard to a specific environment. Portable classrooms had a significantly higher decibel reading of background noise; therefore according to the results of this study, students in the portable classroom environment should score lower on standardized tests than those in a school building.

## Implications

The results of this study have many implications for elementary schools. While this study compared portable classrooms and in-building classrooms, the results did not show significant differences between the two environments. However, this study found that the pupil density of a classroom has an impact on student performance. The more students put in a space, the lower will perform on standardized tests. A determination of how many students must be added to cause this decrease in performance is worth consideration. Certainly, the addition of one student would not create such an impact.

This is crucial for school systems, especially those dealing with overcrowding problems. While state guidelines regulate the student-teacher ratio, the square footage of portable classrooms is not regulated. Therefore, the need for state guidelines on student density in classroom environments is needed. In addition, many classrooms in older schools fall greatly below the minimum square footage requirements. Therefore, despite the teachers' efforts, if the classroom is too small for the number of students, standardized test scores will be lower. This finding is supported throughout the research.

In addition to pupil density, acoustical quality is of concern. A significant difference in background noise, measured in decibels, was found between the portable classroom and in-building classroom. This is further complicated by the correlation indicating that as the background noise increased, standardized test scores decreased. The use of portable classrooms, shown to have higher levels of background noise, is rampant in many school systems; therefore standardized test scores in many school systems may be greatly affected by noise. Acoustical quality is another factor over which the teacher has no control. With teacher accountability on the rise, factors such as pupil density and acoustical quality must be addressed. Teachers should not be held accountable when the variables influencing student performance vary from classroom to classroom and school to school.

## Recommendations for Future Research

Further research on the portable classroom environment is necessary. These environments are different acoustically, aesthetically, and geographically. Each of these areas has profound implications for teachers as well as students. While many factors are involved in students' abilities to learn, as the research has shown in Chapter III, environmental factors such as the aforementioned are influential.

The acoustical differences found within this study are of significant interest. As stated repeatedly in research, a signal-to-noise ratio is a difference between the intensity of a signal and the intensity of the background noise (Berg, 1993; Crandell & Smaldino, 2000; Erdreich, 1999). The significantly higher background noise decibel readings found in portable classrooms will create a lower ratio between the signal, the teachers' voice, and the background noise. Further research is necessary to determine the ratios in each of these environments. A ratio of 3:1 dB or less between the signal and background noise produces an environment that is unacceptable for intelligibility (Anderson, 2001; Crandell & Smaldino, 2000). The differences in acoustical quality between the portable classroom and in-building classroom warrant further research in the area of signal-to-noise ratio.

In addition to signal-to-noise ratio, reverberation is another area for further research. Reverberation is calculated as the time required for a sound to drop 60 dB. Reverberation times are most influenced by the components of the environment. In the classroom, ceiling tiles, carpeting, and wall surfaces are influential. Further research is necessary to determine if reverberation times are significantly different between the two environments. Research in this area is significant because as sound reflects in the room and is not absorbed for an extended period of time, speech intelligibility becomes more difficult.

Aesthetically, there are differences between the portable classroom and in-building classroom. The outside appearance of the portable classroom building is very different than that of the in-building classroom. Future research in the area of students' perceptions of their classroom environment would be of particular interest when comparing these two learning environments. A student questionnaire allowing students from each environment to provide their perceptions might be another area of difference between the two environments.

Finally, the location of portable classrooms is often a great distance from key places within the building. Responses on the Portable Classroom Questionnaire administered in conjunction with this study, included problems with location. Access to restrooms, travel time as students move from place to place, and inclement weather were all given as areas of concern from portable classroom teachers. Further research in the area of instructional time for classes in the portable classroom as compared to in-building classrooms might yield significant differences. In addition to differences in instructional time, discipline referral occurrences would be another area of special concern. Lengthy travel time may contribute to a difference in discipline referrals between portable classroom environment students and in-building classroom environments.

## Conclusion

While significant differences were found within this study, altering the design for future replication might provide a more comprehensive study of the topic. A larger sample, selected randomly and incorporating many school systems, would insure that the results were an accurate representation and therefore would be applicable throughout. The sound meter used to measure background noise in the classrooms was a basic instrument with limited features. A more complex and sophisticated sound meter would give more accurate readings for comparison. Finally, analyzing standardized test scores of individual students over a 3-year period, tracking scores and classroom environments would provide a method of comparing achievement of students in various environments.

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APPENDIX A

# Portable Classroom Teacher Questionnaire

School ___________________________ Name (optional)____________________________

Highest Degree Completed _____________________________________________________

Years of teaching experience ___________ ___________ ___________

Total Traditional Classroom Modular Classroom

Number of students in your class _____ Classroom design: (circle) square rectangular

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**Directions: Please answer the following questions as thoroughly and as completely as possible. Please share your knowledge and experience with detailed answers when possible.**

5=Strongly Agree 4=Agree 3=Neutral 2=Disagree 1=Strongly Disagree

## I. Learning Environment

1. Methods of delivering instruction are altered due to the portable classroom design.

5 4 3 2 1

2. Instructional strategies such as cooperative grouping are difficult to implement in my classroom.

5 4 3 2 1

3. As students move around my classroom, they are crowded and inadvertently touch other students or other students' belongings.

5 4 3 2 1

4. The design of my classroom limits arrangement possibilities.

5 4 3 2 1

5. The noise experienced by students and teachers inside the portable classroom interferes with instruction and classroom activities.

5 4 3 2 1

6. The acoustics within my classroom cause my classroom to be too noisy.

5 4 3 2 1

7. The location of our classroom requires extra travel time, thus reducing instructional time.

5 4 3 2 1

## II. Student Behavior

1. Problems with student behavior occur frequently in my classroom as a result of crowded conditions.

5 4 3 2 1

2. Students frequently have disagreements over personal space and belongings.

5 4 3 2 1

3. Students' focuses are often diverted by distractions that would not occur in the building.

5 4 3 2 1

4. Students often ask for me to repeat directions.

5 4 3 2 1

5. When arriving in the morning, my students often have difficulty settling in to start work.

5 4 3 2 1

## III. Resources

1. Storage space in my portable classroom is limited.

5 4 3 2 1

2. The technological opportunities in my portable classroom are limited.

5 4 3 2 1

## IV. Written Response

1. In your opinion, have your instructional practices changed as a result of teaching in the portable classroom instead of an in-building classroom? If so, please describe in detail.

2. What benefits are provided by the portable classroom?

3. What drawbacks come from teaching in a portable classroom?

4. How is your portable classroom different than an in-building classroom?

5. If give a choice, would you prefer to teach in a portable classroom or an in-building classroom? Explain.

6. Please describe any discrepancies in technological opportunities for you or your students as a result of teaching in a portable classroom as opposed to an in-building classroom.

**Please return this questionnaire by March 22, 2002. Thank you!**

APPENDIX B

# In-Building Classroom Teacher Questionnaire

School ____________________________ Name (optional)_________________________

Highest Degree Completed ___________________________________________________

Years of teaching experience ___________ ___________ ___________

Total Traditional Classroom Modular Classroom

Number of students in your class __________ Room # ___________

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**Directions: Please answer the following questions as thoroughly and as completely as possible. Please share your knowledge and experience with detailed answers when possible.**

5=Strongly Agree 4=Agree 3=Neutral 2=Disagree 1=Strongly Disagree

## I. Learning Environment – Circle your response.

1. Methods of delivering instruction are altered due to my classroom design.

5 4 3 2 1

2. Instructional strategies such as cooperative grouping are difficult to implement as a result of my classroom design.

5 4 3 2 1

3. As students move around my classroom, they are crowded and inadvertently touch other students or other students' belongings in my classroom.

5 4 3 2 1

4. The design of my classroom limits arrangement possibilities.

5 4 3 2 1

5. The noise experienced by students and teachers inside my classroom interferes with instruction and class activities.

5 4 3 2 1

6. The acoustics within my classroom cause it to be too noisy.

5 4 3 2 1

7. The location of our classroom requires extra travel time, thus reducing instructional time.

5 4 3 2 1

## II. Student Behavior – Circle your response.

1. Problems with student behavior occur frequently in my classroom as a result of crowded conditions.

5 4 3 2 1

2. Students frequently have disagreements over personal space and belongings in my classroom.

5 4 3 2 1

3. Students' focuses are often diverted by distractions that should not occur in the building.

5 4 3 2 1

4. Students often ask me to repeat directions.

5 4 3 2 1

5. When arriving in the morning, my students often have difficulty settling in to start work.

5 4 3 2 1

## III. Resources – Circle your response.

1. Storage space in my classroom is abundant.

5 4 3 2 1

2. The technological opportunities in my classroom are advanced.

5 4 3 2 1

## IV. Written Response

1. In your opinion, are your instructional practices different as a result of teaching in an in-building classroom rather than a portable classroom? If so, please describe in detail.

2. What benefits are provided by the in-building classroom?

3. What drawbacks come from teaching in an in-building classroom?

4. How is your in-building classroom different than a portable classroom?

5. If given a choice, would you prefer to teach in a portable classroom or an in-building classroom? Explain.

6. Please describe any discrepancies in technological opportunities for you or your students as a result of teaching in an in-building classroom as opposed to a portable classroom.

**Please return this questionnaire by March 22, 2002. Thank you!**

APPENDIX C

In-building Classrooms Data

| Class | Useable sq. ft. | Reading CRCT | Reading N | Pupil density reading | Math CRCT | Math N | Pupil density math | Decibel reading |
|---|---|---|---|---|---|---|---|---|
| 1 | 613.09 | 321 | 18 | 34.06 | 311 | 18 | 34.06 | 58 |
| 2 | 644.80 | 326 | 22 | 29.31 | 299 | 22 | 29.31 | 56 |
| 3 | 642.19 | 331 | 21 | 30.58 | 314 | 20 | 32.11 | 64 |
| 4 | 618.30 | 331 | 20 | 30.92 | 313 | 20 | 30.92 | 56 |
| 5 | 647.68 | 322 | 21 | 30.84 | 305 | 21 | 30.84 | 59 |
| 6 | 540.45 | 324 | 21 | 25.74 | 307 | 21 | 25.74 | 58 |
| 7 | 544.87 | 321 | 21 | 25.95 | 314 | 21 | 25.95 | 58 |
| 8 | 539.25 | 344 | 20 | 26.96 | 318 | 20 | 26.96 | 58 |
| 9 | 659.51 | 317 | 22 | 29.98 | 307 | 22 | 29.98 | 58 |
| 10 | 651.43 | 304 | 22 | 29.61 | 302 | 22 | 29.61 | 58 |
| 11 | 673.32 | 319 | 22 | 30.61 | 313 | 22 | 30.61 | 58 |
| 12 | 658.76 | 327 | 21 | 31.37 | 321 | 20 | 32.94 | 62 |
| 13 | 645.84 | 323 | 18 | 35.88 | 310 | 18 | 35.88 | 68 |
| 14 | 647.51 | 324 | 20 | 32.38 | 297 | 19 | 34.08 | 64 |
| 15 | 617.34 | 343 | 19 | 32.49 | 327 | 19 | 32.49 | 56 |
| 16 | 613.71 | 352 | 23 | 26.68 | 326 | 23 | 26.68 | 56 |
| 17 | 591.07 | 318 | 20 | 29.55 | 297 | 20 | 29.55 | 57 |
| 18 | 594.28 | 329 | 21 | 28.30 | 316 | 21 | 28.30 | 55 |
| 19 | 614.52 | 334 | 22 | 27.93 | 316 | 22 | 27.93 | 61 |
| 20 | 676.10 | 326 | 22 | 30.73 | 312 | 22 | 30.73 | 54 |
| 21 | 674.92 | 254 | 10 | 67.49 | 253 | 10 | 67.49 | 59 |
| 22 | 620.62 | 303 | 21 | 29.55 | 294 | 21 | 29.55 | 57 |
| 23 | 626.79 | 305 | 21 | 29.85 | 298 | 21 | 29.85 | 57 |
| 24 | 628.14 | 327 | 22 | 28.55 | 305 | 22 | 28.55 | 57 |

APPENDIX D

Portable Classrooms Data

| Mod. Class | Useable sq. ft. | Reading CRCT | Reading N | Pupil density reading | Math CRCT | Math N | Pupil density math | Decibel reading |
|---|---|---|---|---|---|---|---|---|
| 1 | 791.54 | 327 | 22 | 35.98 | 303 | 22 | 35.98 | 61 |
| 2 | 823.36 | 309 | 19 | 43.33 | 296 | 19 | 43.33 | 61 |
| 3 | 706.46 | 316 | 22 | 32.11 | 308 | 22 | 32.11 | 63 |
| 4 | 702.83 | 314 | 19 | 37.20 | 294 | 19 | 37.20 | 62 |
| 5 | 708.35 | 331 | 23 | 30.80 | 305 | 21 | 30.80 | 62 |
| 6 | 707.57 | 328 | 20 | 35.38 | 316 | 20 | 35.38 | 62 |
| 7 | 707.32 | 303 | 20 | 35.37 | 303 | 19 | 37.22 | 60 |
| 8 | 559.9 | 328 | 19 | 29.47 | 303 | 19 | 29.47 | 60 |
| 9 | 708.28 | 320 | 20 | 35.41 | 297 | 19 | 37.28 | 62 |
| 10 | 566.24 | 338 | 20 | 28.31 | 319 | 20 | 28.31 | 61 |
| 11 | 571.42 | 321 | 21 | 27.21 | 314 | 21 | 27.21 | 58 |
| 12 | 570 | 326 | 24 | 23.75 | 299 | 24 | 23.75 | 60 |
| 13 | 567.5 | 326 | 24 | 23.65 | 306 | 24 | 23.65 | 61 |
| 14 | 566.08 | 326 | 24 | 23.59 | 309 | 24 | 23.59 | 61 |
| 15 | 567 | 316 | 22 | 25.77 | 298 | 23 | 24.65 | 61 |
| 16 | 570 | 317 | 24 | 23.75 | 304 | 24 | 23.75 | 60 |
| 17 | 565.24 | 306 | 21 | 26.92 | 307 | 21 | 26.92 | 64 |
| 18 | 539.35 | 325 | 22 | 24.52 | 297 | 22 | 24.52 | 64 |
| 19 | 556.35 | 306 | 21 | 26.49 | 299 | 21 | 26.49 | 64 |