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ABSTRACT

The purpose of this study was to determine the relationship between school density and achievement test scores. The study utilized a bipolar sample in order to include schools whose achievement scores were at the top and bottom of the population spectrum when considering Iowa Tests of Basic Skills (ITBS) scores. Based on comparing test scores and student population density, it was concluded that elementary schools having an architectural square footage of less than 100 square feet per student tend to have significantly lower science, social studies, and composite ITBS scores than schools having more than 100 architectural square feet per student. Schools ranging from 100.27 to 134.1 architectural square feet per student had significantly higher ITBS science, social studies, and composite scores at the third-grade level. (Contains approximately 75 references.) (EV)

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EFFECTS OF STUDENT POPULATION DENSITY ON ACADEMIC ACHIEVEMENT IN GEORGIA ELEMENTARY SCHOOLS

by

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EFFECTS OF STUDENT POPULATION DENSITY
ON ACADEMIC ACHIEVEMENT IN GEORGIA
ELEMENTARY SCHOOLS

by

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In Memory of:

Richard N.Watts, Ph.D.
1957 - 1996

Thank you for brightening my life and the lives of so many others. I will miss you always!

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CHAPTER I

INTRODUCTION TO THE PROBLEM

Introduction

Educators have studied and debated the issue of class size over several decades. Variables such as socioeconomic status, race, and teaching methods all affect the outcome of the different studies (Summers & Wolfe, 1976; Wendling & Cohen, 1981; Shapson, Wright, Eason & Fitzgerald, 1978; Mosteller, 1995). Additional studies have focused on overcrowding and academic achievement (Burnett, 1995) or density and behavior (Loo & Smetana, 1978). Weinstein (1979) found that there has been considerable research on crowding, including the determinants of perceived crowding, the effects of crowding on task performance, and affective and social reactions to crowding. However, the density of individual schools and its relationship to academic performance has not been a factor in studies as the architectural areas of schools have not been measured.

Statement of the Problem

What do researchers say about space needs and the dynamics of small groups in traditional American classrooms? Abramson (1991) found higher achievement in schools with adequate space and further noted that if those larger spaces were used for instructional purposes the achievement was even greater. A high-density school influences achievement negatively. The effects of high density were summarized by Wohlwill and van Vliet (1985). "It appears as though the consequences of high density conditions that involve either too many children or too little space are: excess levels of stimulation; stress and arousal; a drain on resources available; considerable interference; reductions in desired privacy levels; and loss of control (pp. 108-109). High density or not enough space also

means more repairs and maintenance than normal (National Center for EducationalStatistics, 2000). The problem is that students need ample space because crowding (high density) causes problems in behavior and increases the cost of maintenance.

The issue of density must also be viewed through the psychological implications from the study of territoriality of place according to Banghart and Trull (1973). We know that the student is always dependent on the environment for psychological and sociological clues. The student is always interacting with the physical environment. Since the school is a social system within the cultural environment, we should consider social distance as it relates to crowding and density.

The lower middle range for social distance in man and woman is seven feet (Banghart & Trull, 1973, p. 233). Sommer (1969) completed several studies on small group ecology and found that when people are at 3.5 feet apart, they shift their seating positions in favor of "side by side" as opposed to "across" from each other (p. 66). Seven feet appears to be the maximum limit for social distance. Sommer's finding correlates with the seven feet (2 x 3.5 feet) needed for social distance in man and woman as recommended by Banghart and Trull (1973).

With these research findings from the above sources as a guideline, this study proposed the following question: What is the relationship of school density and the academic achievement of elementary school students? To answer this question the achievement of third grade students was compared to the school density baseline.

Achievement was measured through scores from the Iowa Test of Basic Skills (ITBS). The density factor of each school in the sample was determined by dividing the architectural area of each building by the student enrollment of the school.

Purpose of the Study

The purpose of this study was to determine the relationship between school density and achievement test scores. Third grade scores from the Iowa Test of Basic Skills as reported on the Georgia Public Education 1997-1998 Report Cards were used.

Research Hypothesis

The hypothesis that guided this study was:

There is no statistically significant difference between school density and the academic achievement of elementary school students as measured by the ITBS.

Definition of Terms

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

Academic Achievement - Knowledge attained or skills developed in school subjects designated by test scores. In this study, third grade scores from the ITBS as reported by the Georgia Public Education 1997-1998 Report Cards were used.

Architectural Area - The sum of the areas of the floors, measured horizontally in a plane to the exterior faces of perimeter walls or to the centerline of walls separating buildings.

Density - For the purpose of this study the density of each school was determined by dividing the architectural area of the school by the student enrollment of the school.

Low socioeconomic status - For the purpose of this study, students qualifying for free or reduced lunch were considered low socioeconomic status. This study looked at the percentage of low socioeconomic status students enrolled at each school.

Minority - Students whose race was anything other than White was considered minority. Included in this designation was Black, Hispanic, Asian, American Indian and Multiracial as reported on the Georgia Public Education 1997 - 1998 Report Cards. This study investigated the percentage of minority enrollment at each school.

School size - The student enrollment of a school is designated as the school size.

Significance of the Study

This study was designed to investigate the relationship between school density and the academic achievement of elementary school students. Although studies have looked at school size and achievement, density has not often been considered a factor, especially regarding academic achievement. Guthrie (1979) stated that if it is the case that small schools are "better", then studies should look at the actual scale of the physical plant, the size of its population, and the size of the organization in which the pupils and staff participate. Loewy (1977) examined the relationship between density, motivation, and different educational activities. He found that different levels of density did affect academic achievement when in discussion groups but that there was no difference in lecture groups. Burnett (1995) stated that overcrowding impacts the everyday logistics of running a school. Every available space is utilized for classrooms which lessens the use of alternative teaching strategies such as flexible grouping. Hallways are crowded between classes which can increase conflict and necessitates additional time to travel from class to class. In high density schools, administrators must allocate more time to maintaining order rather than to school improvement issues. Lee & Smith (1997) found that the optimal school size for high schools was similar in both low and high socio-economic schools. That is, high schools that have between 600 and 900 students have the highest achievement gains from both low socio-economic status students and high socio-economic status students. They also found that schools with larger enrollments had more discrepancies in achievement gains between low and high socio-economic status students.

When reviewing studies that dealt with school size, Cotton (1997) found that smaller schools benefit minority students and students of low economic status both academically and behaviorally. Summers and Wolfe (1976) examined 150 public schools in Philadelphia, Pennsylvania and found that increased academic achievement occurred in smaller schools. Their study also revealed that Black elementary students and low achievers

in senior high schools benefitted from small schools. Wendling and Cohen (1981) found that school size negatively related to third grade reading and mathematics achievement, when controlling for student socioeconomic status. The Citizen's Commission on Planning for Enrollment Growth for New York City found that students in overcrowded schools in New York City scored significantly lower in both reading and mathematics than students in schools not filled to capacity. In addition, both students and teachers reported that overcrowding negatively affected classroom activities and instructional techniques (Fernandez & Timpane, 1995).

Williams (1990) stated "On average, the research indicates that an effective size for an elementary school is in the range of 300-400 students and that 400-800 students is appropriate for a secondary school." Georgia is third highest in average number of students per school in public elementary and secondary schools in the United States. The average school size in the United States is just over 500 students while Georgia's average school size is approximately 700 students (U. S. Department of Education, 1996).

Limitations

The following were limitations for the study:

1. While all schools within the sample were mandated to follow the Quality Core Curriculum (QCC) as adopted by the State of Georgia, implementation of the curriculum was not consistent at the school level.
2. The quality of the teaching staff was not held constant.
3. Educational policy was interpreted and implemented differently at each school.
4. All data in the Georgia Public Education 1997 - 1998 Report Cards utilized for the purpose of this study were verified for accuracy at the school and state levels.
5. This study was concerned with the architectural area of schools and did not examine interior spaces. The determination of whether or not internal spaces were used for their original intent was not investigated.

6. The transfer rate of students at each school was not investigated.

7. District wealth was not considered.

8. Age of building was not considered.

9. Amount of parental involvement was not considered.

Organization of the Study

This study is organized into five chapters. Chapter I included the introduction to the study, the statement of the problem, the purpose of the study, the research hypothesis, the definition of terms, the significance of the study, and the limitations of the study.

Chapter II presents a review of related literature including the history of school facilities, the condition of today's schools, and the learning environment, along with research on school size, class size, and density. A table listing research regarding school size, class size, and density completes this chapter.

Chapter III describes in detail the methodology of the study. Included in this chapter is a description of the population, the procedures and criteria used to select the sample, the instrumentation, the hypothesis, a description of the data collection procedures, and the statistical techniques used to treat the data.

In Chapter IV, all findings related to the tested hypothesis are reported, and in Chapter V, a summary of the research is provided. Conclusions which can be supported by the findings are presented and recommendations are presented for further reseach.

CHAPTER II

REVIEW OF RELATED LITERATURE

History of School Facilities

The first schools in the American colonies began in homes, and churches. By the 1800's communities had grown such that the one-room schoolhouse was common. These schools were the responsibility of one teacher who supervised many students of various ages, and learning abilities (Lowe, 1991). Lancasterian schools brought about the organization of schools by age, and achievement. These schools consisted of large rooms filled with benches. Large numbers of students could be taught by stressing order, and a minimum of noise. This lowered the cost of education, and the public grew used to the idea of educating large groups of students rather than a select few (Lowe, 1991). Beginning in the 1850's, graded schools grew in popularity, however, instruction remained basically the same. The teacher lectured, and the student only participated when called on to stand and recite. One improvement was the development of individual desks for students rather than the Lancasterian benches, even though they were bolted to the floor in rigid rows and columns (Lowe, 1991).

As the concept of education as a life process came into being, class sizes became smaller, and memorization and recitation gave way to discussion, evaluation, investigation, and self-expression. The desks were unbolted and additional areas of study were added such as science, geography, music, and physical education (Graves, 1993). Comfort and safety became educational issues in the early 1900's. Concerns such as heating, lighting, toilet facilities, eating facilities, space per pupil, and fire safety all made tremendous advances although the architecture remained unchanged. Typical schools were boxy,

unrelieved interpretations of the one-room schoolhouse stacked on top of itself (Graves, 1993) . According to Lowe (1991), at around the same time, the concept of secondary schools became generally accepted. This paved the way for all children, regardless of socioeconomic status to earn a high school diploma. As programs were added to the secondary program, the size of the schools and the variety of spaces increased.

After World War I, physical education became a major requirement due to the numbers of young Americans who were rejected by the armed services. This brought about a variety of spaces to facilitate the school program. As the additional school programs required a growth in the number and variety of spaces, community use of the school increased (Lowe, 1991). The era of Sputnik and the race to the moon brought about an interest in science. Science labs were added to the schools, and space to utilize and store equipment became a priority. School buildings were built using plastic, glass, and concrete which led to the trend of the single-story, flat-roofed structures of the 1950's (Lowe, 1991).

The open education (open spaces) movement of the 1960's is largely credited for the increase in awareness of the impact of the physical environment on student behavior and attitudes (Moore & Lackney, 1994). Carpeting, air conditioning, flexible walls, and teaching pods were innovations from this time period (Lowe, 1991). In the 1980's spaces for new or expanded programs such as special education, remedial classes, gifted classes, and career education were needed. Conservation of energy was imperative as was containing costs during a time when modernization was becoming a need (Lowe, 1991).

The design of schools have undergone many transformations since their inception. From one room buildings to campuses that included specialized spaces, schools continue to address the needs of rising enrollments and a diverse population. School size, class size, and density, along with technological needs and flexibility are all concerns for today's school designers.

Condition of Today's Schools

The National Center for Educational Statistics (2000) found that the average age of schools today was forty years old. Williams (1997) reported that 43 percent of the schools in operation were built in the 1950's and 1960's. Thirty-one percent were constructed more than fifty years ago, and only the remaining 26 percent were built within the past 25 years. Hansen (1992) broke down the percentage even more, reporting that only 14 percent of the schools in operation were built in the 1970's, and 11 percent were built in the 1980's. Schools constructed in the first part of the century were built for a life span of fifty to 100 years. Schools constructed after 1970 were designed to have a life span of twenty to thirty years. This means that over 60 percent of the nations schools are reaching the end of their predicted lifespan (Williams, 1997).

Schools built before World War 11 were not built with today's technology in mind. In fact, environmental concerns such as the use of asbestos and lead paint were not issues. Air conditioning was nonexistent, and electrical use was not as significant as it is today. The 1991 AASA survey of Administrators found that 12 percent of the nation's schools were not adequate places for learning. Administrators identified factors such as age, inadequate space, and inadequate maintenance (Hansen, 1992). The cost of maintenance has risen as school buildings age and adapting them for today's technology has become necessary. Maintenance budgets have progressively grown smaller as taxpayers complain about the amount of money they have to pay. This deferred maintenance causes costs to increase even more. Hansen (1992) reported that maintenance costs have quadrupled in just eight years from $25 billion to $100 billion.

A study conducted by the Education Writers Association (1989) found similar concerns.The EWA defined 25 percent of the nation's schools as inadequate. Of these:

- 61 percent needed maintenance or major repairs;
- 43 percent were obsolete;

- 42 percent had environmental hazards;
- 25 percent were overcrowded; and
- 13 percent were structurally unsound.

The General Accounting Office (1996) reported that while there are laws that require children to attend school, some school buildings are unsafe or harmful to children's health. While three-quarters of the schools had sufficient computers and televisions, they did not have the infrastructure to use them. They added that more than half of the schools needed to improve accessibility in order to comply with the Americans with Disabilities Act.

Edwards (1991) compared standardized achievement test scores of students in schools that were identified as in poor, fair, and excellent condition. After controlling for socioeconomic status and other variables, she found that students from schools in poor condition scored 5.5 percentage points lower than those students from schools in fair condition and 11 percentage points below those in buildings in excellent condition.

The National Center for Educational Statistics (2000) found that three-fourths of the nation's schools needed to spend money on repairs, renovations, and modernization at a cost of $127 billion. One in four schools, or eleven million of the nation's students, had at least one building on their campus that was in less than adequate condition. Schools with the highest enrollments of low socioeconomic status students were more likely to report that they had a building in less than adequate condition than schools with low enrollments of low socioeconomic status students. When nine building features such as roofs, floors, and electricity were considered, 50% of schools had at least one feature that was in less than adequate condition. Forty-three percent of schools had at least one of six environmental features such as lighting, heating, or acoustics that were less than adequate. The GAO (1996) recommended that schools for the 21st century should have flexible space, including space for small and large group instruction. Schools should have space to

store and display student assessment materials. Science laboratories set up for demonstrations and student experiments should be provided with adequate provisions for safety and storage. Each media center should have multiple computers networked to other information sources.

School and class size have become an issue as enrollments continue to rise. In 1993 - 1994 the national average class size was 25.2 in elementary schools. Many educators report that they have not ignored the research but with rising enrollments and declining budgets along with teacher shortages, reducing class size dramatically is not an option (McAdoo, 1994).

The U. S. Department of Education (1996) reported four key factors for rising enrollments. Baby boomers who waited to marry and have children are now beginning and expanding their families. This is the most significant reason for today's rising enrollment. Other factors include high birth rate among minorities, increased immigration, increased enrollment due to pre-kindergarten programs, and a reduced drop out rate.

Thirty-three states face rising enrollments while 17 states and the District of Columbia will decline in student enrollment. Between 1996 and 2006, elementary school enrollment is projected to grow by 2 percent from 37.3 million to 38.1 million. Georgia is fourth in rising enrollments and is fifteenth in percent of enrollment growth with an estimated growth of 8.5 percent (The United States Department of Education, 1996). Education Secretary Richard Riley projected an enrollment of 54.6 million students by the year 2006. This will necessitate the construction of 6,000 schools at a cost of $60 billion added to $112 billion needed to repair present facilities (Williams, 1997). Georgia is third highest in average number of students per school in public elementary and secondary schools in the United States surpassed only by Hawaii and Florida. The average school size in the United States is just over 500 students while Georgia's average school size is approximately 700 students (The U. S. Department of Education, 1996).

The Learning Environment

The importance of the school environment in the role of learning is becoming more apparent as research evolves in different areas such as brain-based education and multiple intelligences. Hawkins (1991) stated:

> The school environment affects attitudes and it affects behaviors. The character, appearance, and physical arrangement of the learning environment convey distinct messages to the users about the activities and responses that are expected and appropriate. The environment also operates in a practical way to enhance or interfere with the operation of the educational program. (p. G2)

Weinstein (1979, p.585) stated: "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."

The impact of the physical environment on student behavior and academic performance is an area that can be controlled in the education of our children (Moore and Lackney, 1994). The open classroom movement of the 1960's utilized school facilities as a learning tool. Today the use of technology and its constant improvement continues to effect schools to an unknown degree. Computers take up space and are generally added to the school and classroom without replacing the other space consuming materials and equipment that are already there. This affects student density and must be considered when designing schools and determining school and class size (Branch, 1994).

Design characteristics like school size, classroom size, location, and the provision of secluded study spaces all make substantial differences in learning outcomes. Black (1996) affirmed that small schools are better at solving problems, are more intellectually oriented, have more caring teachers, and have higher levels of parent/student satisfaction.

Sergiovanni (1996) stated that schools should be communities of learners where all individuals associated with a school, including teachers, students, administrators, parents,

and the community are bound together through a sense of belonging and shared responsibilities. He said that small schools encourage this sense of community. Teachers are more likely to counsel a student who is habitually late or forgetful rather than rely on rules to enforce discipline when there is a sense of community. He reiterates that teaching and learning should be the fundamental objectives in schools rather than control.

Historically the physical environment has been limited to the enforcement of minimum standards for classroom size, acoustics, lighting, and heating. Once these were in place, it was thought that a child's learning only depended on pedagogical, physiological and social variables. Moore and Lackney (1994) contend that the role of the physical environment should be a variable when learning outcomes are studied.

Moore and Lackney (1994) found that as early as 1979 there were studies showing that the classroom environment affected behaviors and attitudes. While this finding continues to have strong evidence, they also found that two architectural variables, school size and class size, impacted academic achievement as well. Moore and Lackney further identified behaviors influenced by school size including crime levels, student misconduct, and participation in extracurricular activities. They believed these behaviors are mediating variables that may in turn impact academic achievement. Moore and Lackney concluded that reductions from 30 to 20 students yield an achievement gain of six percentage points and a reduction from 20 to 10 yields another 13 percentage points. Moore and Lackney (1993) stated:

> There is considerable evidence reported in the last fifteen years that school size and classroom size directly lead to significant and substantial differences in learning achievement, and that location and the provision of secluded study areas within classrooms effect various beneficial mediating factors (like more student-teacher interaction, less interruptions, and greater student participation in learning) which

there is good reason to believe will in turn lead to higher educational achievement (p. 104).

Moore and Lackney (1994) created a model showing linkage between independent factors such as the physical environment and the social-organizational environment; mediational factors to include behavior, attitudinal, and physiological; and educational outcomes such as achievement scores and prosocial behavioral outcomes. They stated that as the physical setting of the school improves through decreased class sizes and smaller schools, teacher and student behavior and attitudes improve, and achievement and prosocial outcomes increase.

After reviewing the educational literature, Moore and Lackney (1994) analyzed architectural literature by studying the designs of 100 school buildings. Rather than focusing on the unique designs and user friendliness of the schools, Moore and Lackney found commonalities among the different designs that have passed the test of time. They then reviewed the educational reform literature to ascertain if educational reforms such as shared decision making, portfolio assessment or other educational reforms impacted school design. Lastly, they looked for findings that were reflected in more than one of the areas researched. Moore and Lackney stated that findings from educational research should be considered when designing a school and developed design patterns to be considered when building a school. Fiske (1995) reiterated the importance of architectural design. He stated that facilities must be designed to provide for students to work in small groups, that individual work stations aimed at encouraging higher-order thinking skills must be provided, and the diversity of student learning styles must be considered when designing schools.

With rising enrollments, aging buildings, increasing maintenance costs, and technological concerns, educators face many difficulties while providing the best possible education for students. The educational literature has shown that the physical environment

does effect educational outcomes. School designers must find ways to address these needs in order to provide environments that promote higher-order thinking skills and meet the diverse learning styles of students.

School Size

Cotton (1997) found in her review of 103 studies concerning school size, that schools continue to get larger and larger. Between 1940 and 1990 the number of schools declined by 69 percent while the United States population grew by 70 percent. She notes that the average school enrollment rose more than five times. While school enrollments increased, the number of schools decreased. The launching of the Soviet space satellite Sputnik brought about the belief that larger schools would produce more scientists. Other factors that increased school size included school desegregation and the growth of special entitlement programs. Cotton believed that the publication of Conant's book The American High School Today accelerated the growth of schools by proposing that larger schools were more cost efficient and could offer a wider curriculum for students. Today, however, Conant's definition of an adequately large high school, 300 to 400 students, would be considered a small school.

Cotton (1997) found sixteen documents of the 103 she reviewed on school size that dealt with attendance. She cited seven studies that found that students in smaller schools have higher attendance rates than those in large schools. Five reported improved attendance rates of students who changed from large to small schools. Cotton also reported that minority students and low socioeconomic status students are affected the most when they attend large schools.

Cotton (1997) found that about half of the studies focusing on student achievement concluded that the academic achievement of students in small schools was higher than those in larger schools. The other half concluded that the academic achievement of students in small schools was the same as the academic achievement of students in large schools. None

of the studies reviewed showed that the academic achievement of students in larger schools exceeded those of students in smaller schools. These results were found with other variables such as student attributes, staff characteristics, and time-on-task held constant.

Studies showed that smaller schools benefit ethnic minority students and students of low economic status both academically and attitudinally (Cotton, 1997). Summers and Wolfe (1976) examined school resources that possibly influence academic achievement using a sample of 627 elementary students, 533 junior high school students, and 716 high school students. They found the socioeconomic background of the student largely determined achievement. They also found that "in smaller schools increased learning at elementary and senior levels appears to take place. Black elementary school students seem particularly to benefit from being in smaller schools, and low achievers in smaller senior high schools." (p. 6). In a study of 1,021 elementary schools, Wendling and Cohen (1981) found that school size negatively related to third grade reading and mathematics achievement, when controlling for student socioeconomic status. Low achieving elementary schools had a mean size of 776, while high achieving schools had a mean size of 447. Kiesling (1967) showed a negative relationship between mathematics and verbal ability and elementary school size, even when controlling for socioeconomic differences.

Besides the relationship of school size to academic achievement, school size has also been found to influence behavior. Cotton (1997, p. 6) concluded after comparing the results of various studies of school size that "The research linking school size to social behavior has investigated everything from truancy and classroom discussion to vandalism, aggressive behavior, theft, substance abuse, and gang participation." Studies consistently find that students in small schools have more positive attitudes toward school. They have an attachment to their schools that is shown in higher attendance rates and lower dropout rates. Statistics also suggest that students attending small schools are more likely to participate in extracurricular programs (Black, 1996). Barker and Gump (1964) cited a

study of very big (over 2,000 students) and very small (100 - 150 students) high schools in Kansas. They concluded that small schools offered students greater opportunities to participate in extracurricular activities and to exercise leadership roles. Participation in school activities, student satisfaction, number of classes taken, employment in the community, and participation in social organizations were all superior in small schools as compared to large schools. It was found that as schools grew larger extracurricular participation did increase but not in proportion to the growth of the school. A twenty-fold increase in school population brought about only a five-fold increase in participation opportunities (Cotton, 1996).

Schneider (1985) studied four urban elementary schools and found that the more effective schools had active parent councils, parents actively participating as volunteer tutors in classrooms, and smaller total student enrollments. Academic achievement was affected by motivation, teacher expectations, parental support, time on task, total school enrollment, and pupil teacher ratio.

In 1992-1993, the average elementary school had 464 students. School districts in many high growth areas now have difficulty meeting this average. The National Association of Secondary School Principals (1996) suggested that schools have an enrollment of no more than 600 students in order for teachers and students to get to know one another better. Williams (1990, p. 7) stated "On average, the research indicates that an effective size for an elementary school is in the range of 300 - 400 students and that 400 - 800 students is appropriate for a secondary school." The University of Georgia School Design and Planning Laboratory (1999) asserted that larger spaces (90-100 square feet per student) and smaller schools (300-600 students per elementary school) may be as important to learning as special programs.

School size research has repeatedly shown that smaller schools benefit students both academically and behaviorally. Minority students and students of low economic status

particularly benefit from attending schools with smaller enrollments. School enrollment should be considered along with special programs when planning for the education of students.

Class Size

Research on school size and density had its beginning in class size research. Class size has been a focus of educational research for many years. Research conducted before 1920 dealt primarily with the effects of large classes on grade to grade promotion rates. As standardized achievement tests developed, research focused on individual student achievement. When baby boomers started entering school, the focus on class size research shifted again toward documenting the benefits of small group instruction and the impact on disadvantaged students (Mitchell & Beach, 1990).

Education Week along with the Pew Charitable Trust reported that class size was so important that the percent of K - 6 teachers with classes of fewer than 25 students and the percent of secondary school English teachers with fewer than 80 students accounted for 35% of the School Climate indicator in the 1997 report Quality Counts (Edwards, 1997). The 1998 report Quality Counts also used class size as 35% of it's school climate score by reporting the percentage of fourth grade students in classes of 25 or fewer and the percent of eighth graders in math classes of 25 or less. The 1998 report Quality Counts report also found that 83% of teachers, 60% percent of principals, and 44% of superintendents agreed that class size in elementary schools should not exceed 17 students (Edwards, 1998).

Glass and Smith (1978) identified 77 studies containing different comparisons of pupil achievement in classes of at least two different sizes. With the development of meta analysis, systematic interpretation of the research was possible (Mitchell and Beach, 1990). When Glass and Smith's meta-analysis was attacked for the inclusion of poorly designed studies, Glass redid the meta-analysis on 14 well-designed studies and concluded that the relationship of class size and achievement was even stronger. They concluded that the

major benefits of reducing class size occurred when there was less than 20 students in the class and that teacher morale, quality of the instructional environment, and student reactions were superior (Pritchard, 1999).

Robinson and Wittbols (1986) reviewed class size literature and clustered the literature according to grade levels, subjects, and student characteristics. Studies were categorized as significantly favoring small classes, no significant differences, or significantly favoring large classes. They then counted the number of studies in each category. Their results for Grades K-3 showed that in reading, of 22 studies, 11 showed better results for small classes, while nine showed no difference. Of fourteen studies in mathematics, five favored small classes while eight showed no difference. They concluded that the primary grades showed the clearest evidence in favor of reducing class size and that reducing class size for disadvantaged and minority students would be especially beneficial.

One problem with the study of class size is that there has been little consistency with the definition of large and small classes. A class size of 35 for example, which in one study is viewed as small, as compared to size fifty, turns out to be large in another study as compared to size 25 (Shapson, Wright, Eason and Fitzgerald, 1978). Another problem class size studies face is the issue of socioeconomic variables. When studies include influential socioeconomic variables, they tend to confirm a positive effect of small-scale schooling on the achievement of students. Studies that do not control very well for the influence of socioeconomic status, however, tend to find no difference in the achievement of students in large scale and small scale operations (Melnick, Shibles & Gable, 1987). The results suggest the importance of including influential socioeconomic variables in studies of the effects of small scale schooling on student achievement (Howley, 1989).

Many policy makers view small class size as only one factor that impacts learning. They theorize that teachers can apply effective practices to promote learning while retaining substantial savings of teacher salaries (Hallinan and Sorensen, 1985). Tomlinson (1990)

agreed and questioned the cost-effectiveness of lowering class size stating that a teacher shortage would occur and that teacher quality would decline if class size was reduced.

Finn (1998) suggested that costs and consequences must both be considered when determining cost effectiveness. Ingredients such as personnel, facilities, and equipment must be accounted for as well as the outcome of the intervention. Nye, Boyd-Zaharias, Fulton, and Wallenhorst (1992) suggested that two important factors are overlooked when discussing the cost effectiveness of small class size. They stated that economic costs and education costs stem from low teacher morale, job dissatisfaction, and increased teacher turnover. They believed each of these costs are incurred in overcrowded classes. Lane and Prickett (1990) reported that of the fifty states, only 24 have mandated maximum class size for grades K - 3. Only three of these states, Alabama, California and South Carolina, conducted needs assessments to determine the number of classrooms needed to meet the mandates. Each of these three states determined that over $300,000,000.00 would be required to meet the mandated maximum class size requirements.

Research is consistent in showing that smaller classes have a positive influence on teachers' classroom attitude and behavior (Odden, 1990). Burnett (1995) suggested that overcrowding and the struggle to maintain order increases the likelihood for teacher burnout. When class size was reduced, Johnson (1989) found that teachers felt more relaxed and able to meet the demands of teaching. Teachers reported that reducing class size improves students' attitudes toward learning, increases positive motivation, and higher academic achievement results. Hallinan and Sorensen (1985, p. 72) stated "Teachers favor small classes because they believe that they reduce their work load, decrease student disciplinary problems, permit more individualized instruction and provide more opportunities for personal involvement with the students." Several studies all report that teachers' attitudes and morale are better when class size is reduced (Finn, Achilles, Bain, Folger, Johnson, Lintz, & Word, 1990).

Finn, et al. (1990) found that teachers' morale and motivation were higher when there were fewer students. They felt that behavior management was easier and paperwork was lessened. The quality and nature of interactions between teachers and students were improved. More time was allocated to instruction and individuals received more attention. Lastly, it was found that social pressure to participate is strong when the group is small. Individual students do not have the option of becoming lost in the crowd. Johnson (1989) found that perception of time is a major factor for teachers with small class size. They felt that they had more time to monitor pupil performance, evaluate learning, provide feedback, and match instruction to ability . Hallinan and Sorensen (1985) argued that the larger the class, the less opportunity the teacher had to interact with any given student. By reducing class size, and increasing the amount of time a teacher could interact with each student, the quality of instruction would improve.

Johnson (1989) found that when class sizes are small, teachers were able to use more creative and supplemental activities when teaching the curriculum. They were better able to monitor students' progress and behavior during instruction and subsequently felt that they could avoid retaining students due to the attention they were able to provide. Teachers reported that lower class size enabled a faster instructional pace as well as being able to spend a larger percentage of time on instruction. Classroom management and supervision was easier. Teachers reported that they had a better sense of what was going on in the classroom and potential behavior problems were easier to address before they occurred. Students were able to be redirected without disrupting instruction. Transitions between activities took less time as well as distributing, collecting, and checking instructional materials. An added benefit of additional individual attention was increased communication with parents to inform them about positive as well as negative behavior. Elementary school teachers reported using fewer written tests with smaller class sizes because they had more detailed and immediately accessible knowledge of each child's

progress based on daily work and individual interactions with each child. Small class size brought about increased opportunities for immediate feedback and reteaching through this more efficient monitoring (Johnson, 1989).

Teacher perception of classroom density combined with prior regular classroom teaching experience may limit a teacher's view of activities that are and are not possible in that space, and the level of behavior control required to maintain order in that space. If space is perceived as inadequate, instructional activities are limited. If teachers perceive space to be adequate, they are willing to provide a wider variety of learning activities as well as allowing students to use a greater variety of resources.Teachers with small classes talked about how the increased space was utilized for more activities and learning centers. There was more room for art projects, games, and pleasure reading. There were increased opportunities for students to work in pairs, in small groups and individually (Johnson, 1989).Tillitski, Gilman, Mohr,and Stone (1988) stated that to make lowering class size more effective, teachers need to be trained in small-class size teaching strategies to help them make better use of the additional time.

Teachers reported less discipline and management issues when there were fewer students and desks in the classroom, that students did not infringe on one another's space. It was also easier to physically isolate children with behavior problems. Teachers were more able to monitor student behavior and that students were aware of this and so were less likely to misbehave. Additionally, teachers had more time to work with individuals and so students did not have to misbehave to get the teacher's attention (Johnson, 1989).

The concept of workload has encouraged administrators to assign approximately the same number of students to each teacher for "regular" classes, despite student need or benefit. "Special" students are provided smaller class sizes as are students in advanced or vocational classes. In these situations, the conventional wisdom is that pupils in these special categories learn better in small classes. Achilles, Nye, Zaharias, and Fulton (1993)

reported that regardless of the benefits of small classes for all pupils, the changing demographics of youngsters coming to the schools today (poverty, drug/alcohol/tobacco abuse) suggest that all youngsters in early primary grades should be treated as "special" and be served by a variety of integrated services at school.

Administrative and organizational tasks take longer in larger class sizes. Record-keeping, transitions, and planning social events all demand more teacher time as the class size increases and instructional time suffers (Hallinan & Sorensen, 1985; Mitchell & Beach, 1990). Hallinan and Sorensen argue that class size is directly related to both length and quality of instruction.

Pritchard (1999) cautioned that teachers must change their instructional methods and classroom procedures to benefit from reduced class size. Robinson and Wittbols (1986) noted that smaller classes did not guarantee that teachers will take advantage of smaller class size and modify their teaching practices to include more desirable teacher practices such as more attention to individual children and more individualization of instruction. In the review of nine studies using direct classroom observation, six found no significant differences in teaching practices and three found teachers in smaller classes using more desirable practices.

Class size also affects the size of instructional groups. Teachers generally form about three groups despite the size of achievement distribution of classes. Therefore, as class size decreases, so does instructional group size (Hallinan & Sorensen, 1985). Finn, Fulton, Zaharias, and Nye (1989) agreed that it is not the number of students in the class that affects learning, but the processes that change when there are fewer students present in the class. Teachers tended to lecture more and explain more in larger classes while students in smaller classes tended to ask more follow-up questions. With smaller classes, teachers gave more homework, gave more oral tests, had more direct interaction with students, and had fewer procedural arrangements (Evertson & Randolph, 1989). Robinson and Wittbols

(1986) found similar results in their review of 22 studies of class size and teaching practices.

Those studies that have investigated the possible changes in small classes that would be responsible for increased student achievement identified the following factors: increased interaction between teacher and pupils, more individualization of instruction, better diagnosis of each child's learning needs, possibilities for more active involvement of students in learning tasks, and less time spent on classroom management (Slavin, 1990). Finn and Achilles (1990) suggested that three dimensions of school processes are affected by class size. First, teacher satisfaction is enhanced by reducing class size which may positively enhance student motivation to learn. Shapson et al. (1980) also reported this finding. Second, reduced class size optimizes individual attention by increasing teacher/student interaction. Third, smaller class size may increase a student's attention to and involvement with learning activities. Finn, Fulton et al.(1989) found that it is the processes of teaching that mediates achievement while Nye, Boyd-Zaharias et al. (1992) reported that small classes allow teachers to apply successful teaching strategies and increase parent involvement.

Pritchard (1999) cited the following three patterns of findings regarding class size:

1. A consensus of research indicates that class size reduction in the early grades leads to higher student achievement. Researchers are more cautious about the question of the positive effects of class size reduction in 4th through 12th grades. The significant effects of class size reduction on student achievement appear when class size is reduced to a point somewhere between 15 and 20 students, and continue to increase as class size approaches the situation of a 1-to-1 tutorial.
2. The research data indicate that if class size is reduced from substantially more than 20 students per class to below 20 students, the related increase in

student achievement moves the average student from the 50th percentile up to somewhere above the 60th percentile. For disadvantaged and minority students the effects are somewhat larger.

3. Students, teachers, and parents all report positive effects from the impact of class size reductions on the quality of classroom activity. (p. 6)

The Georgia Department of Education (1998) reported that Georgia would receive approximately $29,909,345.00 in class size reduction funds beginning July 1999. It was estimated that the state would hire 769 teachers to reduce class size. Stipulations for these funds included that they were distributed 80 percent based on child poverty and 20 percent based on school enrollment. Fifteen percent of these funds could be used for teacher testing and to provide staff development for teachers.

Ga. Regs. Sec. 160-5-1-0.8 Class Size (1999) enumerated maximum individual class sizes for the various grades and subject areas in elementary schools in Georgia. It also designated a maximum system average class size. In kindergarten, the maximum individual class size is 21 students without a paraprofessional and 28 students with a paraprofessional. In grades 1-3 the maximum individual class size is 25 students without a paraprofessional and 33 with one. In grades four and five the maximum individual class size is set at 33 with no paraprofessional. A paraprofessional is considered equivalent to one-third of a teacher. The maximum number of paraprofessionals that can be used to reduce the numbers in a regular class is two.

The maximum system average class size is determined by adding the number of segments in a funding category, such as grades 1-3, and dividing the sum by the total number of students assigned to those segments. This number may be different from the total number of students enrolled in a funding category due to participation in different special programs such as remedial classes or special education. School systems have ten working days to comply with maximum class size requirements when an individual class or

the system average exceeds the maximum or funding for these areas may be lost. The maximum system average for class size is lower than the maximum individual class size. Kindergarten's maximum system average with a paraprofessional is 24.2 and 18.2 without a paraprofessional. Grades 1-3 may have a maximum system average of 28.6 with a paraprofessional and 21.5 without one. Grades four and five have a limit of 28.6 for the maximum system average without a paraprofessional.

Class size research has shown that small class size is beneficial for students in the lower elementary grades, for minority students, and for students of low economic status. These results are shown both academically and behaviorally. Teacher perceptions also change when they teach small classes. They focus more on the needs of individual students. It has been found, however, that as class size is reduced, staff development is necessary to enable teachers to utilize desirable teaching practices. Individual class size studies are summarized below.

The Tennessee Class Size Project

Tennessee's large scale longitudinal study of class size, Project STAR, followed a cohort of pupils over a four-year period from kindergarten through the third grade. A large sample of schools that were representative of the different types of schools in the state (urban, rural, suburban and inner city) were selected. Schools were drawn from all parts of the state. Training was provided to teachers in how to take advantage of small class conditions. Seventy-nine schools were selected with 328 kindergarten classes, 128 small classes, 101 control classes, and 99 regular size classes with paraprofessionals. There were 76 schools and 345 classes in first grade, 75 schools and 340 classes in second grade, and 75 schools and 335 classes in third grade (Mosteller, 1995).

The Tennessee project on the effectiveness of small classes and of teachers' aides had three phases:

Phase 1: The educational system of Tennessee carried out a four-year experiment from 1985 to 1989 called Project STAR (for Student-Teacher Achievement Ratio) to assess the effectiveness of small classes compared with regular-sized classes and of teachers' aides in regular-sized classes on improving cognitive achievement in kindergarten and in the first, second, and third grades. It was found after the four years of the study that smaller classes scored around eight percentiles higher than the regular-sized classes without paraprofessionals for reading and mathematics. Regular-sized classes with paraprofessionals had only a slight gain in reading and mathematics over the regular-sized classes without paraprofessionals. The effect of small class size on minority students was double that of non-minority students, however this difference disappeared in later phases of the study (Mosteller, 1995).

Phase 2: The Lasting Benefits Study (LBS) was an observational study of the consequences of the experimental program on children when they returned to regular-sized classes in the fourth, fifth, and sixth grades and beyond. This research phase asked whether the children who started in the smaller classes performed better in later grades. Only students who had been in the experiment (Phase 1) could contribute data to this second phase. It was found that in the fourth and fifth grades, the students who had originally been in small classes scored higher than those who had been in regular-sized classes with a teacher and paraprofessional. In the fourth grade, the first year after students returned to regular sized classes; the effect size was about one-eighth of a standard deviation, averaged across six different cognitive subjects studied. In the fifth grade, it was nearly two-tenths of a standard deviation, again averaged across the subject areas (Mosteller, 1995).

Phase 3: Project Challenge implemented small classes in kindergarten, first, second, and third grades in the 17 economically poorest districts of Tennessee where children were the most at risk of dropping out early. These districts had the lowest average

incomes in the state. These districts improved their end-of-year standings in rank among the 139 districts from well below average to above average in reading and mathematics. Performance gains ranged from eleven to 34 percent. The results were consistent across rural, urban, suburban, and inner city schools. The evidence showed that smaller class size at the beginning of the school experience did improve the performance of children on cognitive tests. Observations from the Lasting Benefits Study confirmed that the effect continues into later grades when children are returned to regular-sized classes. In addition, the implementation of the program for the economically poorest districts seemed to improve the performance of children in these districts by noticeable amounts (Mosteller, 1995).

Data collected from the records of 3,000 participants of the STAR study have shown that more of the students who were enrolled in small classes graduated with honors and 72 percent of the students graduated on time as compared to 66 percent from regular classes and 65 percent from classes with a paraprofessional. These same students completed more advanced math and English classes than the other comparison groups. Less of these students dropped out of school, 19 percent versus 23 percent of the students from regular classes and 26 percent from classes that had a paraprofessional (National Educators Association, 1999).

Additional Studies

Prime Time: Prime Time investigated the effect of reduced class sizes in kindergarten, first, and second grades in Indiana. Classes were reduced from an average of 23 students to 14-18 students per teacher. Three findings were reported: 14 percent more of the students in smaller classes scored above average on standardized tests than those in larger classes; the smaller classes had fewer behavior problems, and teachers of smaller classes reported themselves as more productive and efficient than they were when they taught larger classes (Mosteller, 1995).

Burke County, North Carolina: In 1995, over 2,000 first and second graders in Burke County participated in a reduced class size initiative that reduced the class size to fifteen students per class. At the same time, teachers participated in staff development activities covering instruction and evaluation. Compared to a matched group of students that were not in small classes, the students in the study outperformed the comparison group on both reading and mathematics achievement tests. The percentage of instructional time was also higher than that of the larger classes and the amount of non-instructional time was lower (Pritchard, 1999).

SAGE: During the 1996-1997 school year, Wisconsin implemented the Student Achievement Guarantee Education Program. The objective was to provide reduced class size for students in kindergarten though the third grade in districts serving low-income families. They found that first grade students performed consistently better than the comparison group in reading and language arts. The achievement gap between White and Black students lessened and second grade students' academic achievement continued to be higher than that of the comparison group (Pritchard, 1999).

Toronto: Grades Four and Five: Shapson et al. (1978) conducted a large scale study of fourth and fifth grades in Toronto, Ontario. The difference between smaller and larger classes was negligible for reading, but large for mathematics. The largest advantage in mathematics was realized by the smallest classes, with sixteen students, as compared to classes with 22, 30 and 37 students. They concluded that grade four is beyond the age at which reduced class size can have its greatest impact (Finn et al. 1990).

Lee and Smith : Lee and Smith (1997) utilized data gathered from the National Educational Longitudinal Study of 1988 to measure academic achievement in high school in the areas of mathematics and reading. They studied achievement growth as a function of the characteristics of students and the effects of school demographics on learning and equitable distribution. They found that learning gains were largest in small and moderate-sized

schools but not in the smallest ones. In addition, high schools in the 600 - 900 enrollment range had the highest achievement for both higher socio-economic status schools and lower socio-economic status schools. Schools with larger enrollments had more discrepancies in achievement gains between low and high socio-economic status students. Schools with over 1,800 students showed almost no achievement growth, regardless of minority concentration.

Density

Weinstein (1979) defined density as a mathematical measure of the number of people in a given space and crowding as the perceived judgment of excessive density. Saegart (1978) stated that physical density involves two separate components, the number of people in a given space and the amount of space per person. Studies regarding density become complicated due to the differences between social and spatial density. Social density studies vary the number of subjects while the size of the environment remains the same. Spatial density studies vary the size of the environment while the number of subjects remains the same (Ginsburg, Pollman, Wauson & Hope, 1977). Saegart (1978) illustrated the complications of studying density by stating that the density in two studies might have both equaled 12 square feet per person, but in one case there were 200 people in an assembly hall and in the other there were four people in half of a small laboratory room.

Hutt and Vaizey (1966) were some of the first researchers to study the effects of density on children. They investigated the behavior of normal and intellectually disabled children in varying social densities. They hypothesized that in accordance with the findings from animal studies, that increasing group density would change the nature and frequency of social encounters. They also theorized that the effects would differ according to the personality of the subject. They studied children with autism, traumatic brain injury, and typical children while at play. It was found that aggressive and destructive behavior increased for both typical and traumatic brain injured children under high density

conditions. The data collected also showed that typical children participated in less social interaction while in the high density setting.

Loo (1978) completed several studies regarding density. In one study, Loo examined the behavior of preschool children identified as having behavior problems. She found that high anxiety students reacted to high density with emotional helplessness while low anxiety students responded by reducing mobility and increasing facing out positions. High hyperactive and distractible students became more active in high density conditions while low hyperactive and distractible students showed no significant difference in their activity level. Students who were labeled as hostile-aggressive did not react differently to density than typical children.

Ginsburg, et al. (1977) maintained that the one-way mirror used to observe the subjects altered the results of the Loo study, stating that mirror-image stimulation has been proven to affect behavior. The study they designed measured differences in the aggressive behavior of third through fifth grade male students videotaped from a distance when the spatial density of a play area was changed. They found that there was a functional relationship between the amount of space and the aggressive behavior in children. The observational records from this study showed an increased frequency of aggression when the students were in the smaller playground. They also found a shift from the behavior pattern of flight from an aggressor in the large playground to fight as the dominant behavior when confronted by an aggressor in the smaller playground. Fights in the larger playground usually involved two participants while fights in the smaller playground involved more than two participants. Shapiro (1975) compared the behavior of children in classrooms that allowed less than 30 square feet per child to the behavior of children in classrooms with more than 50 square feet per child. More disruptive and aggressive behavior occurred in the high density classrooms. Smith and Connelly (1972) found that density did not effect aggression but that the amount of play equipment did. Loo (1978)

stated that while the results of Smith and Connelly's study are suggestive, they are not definitive due to the inconsistency of comparing indoor and outdoor behavior.

In a second study, Loo (1978) looked at the effects of spatial density on social behavior, motor levels, and types of activity. Personal space differences due to density and sex differences regarding density were also investigated. The students were more aggressive, engaged in more rough play, and made fewer social overtures and more negative interactions in the high density condition. It was found that the boys reacted to the high density condition with more activity and aggressiveness than girls and that the girls showed more avoidance behaviors than the boys. Students identified as having high personal space needs showed more negative and nonsocial interactions and less involved play than the low personal space needs students while in the high density condition. Rohe and Patterson (1974) found results similar to Loo's regarding gender differences. They found that males exhibited more aggressive and destructive behavior than females while in high density conditions and females showed more unoccupied behaviors.

When high density and physical interaction was investigated, Heller, Groff and Soloman (1977) found that each condition produced perceptions of crowding, but poorer task performance resulted only when high density and physical interaction were together. Stokols, Ohlig, and Resnick (1979) stated that the experience of crowding is heightened by excessive social stimulation. The perception of crowding is linked to restraints on behavior freedom and infringements on privacy imposed by the proximity of others. Increased demand for space may result from a scarcity of social and/or physical resources in the setting.

McGrew (1970) looked at spatial and social density when observing the free-play behavior of preschool students. Spatial density was changed by allowing the students to play in all or only part of the room. Social density was changed by varying the number of participants. Four conditions were observed: low social and low spatial conditions, low

social and high spatial conditions, high social and low spatial conditions and high social and high spatial conditions. It was found that increased solitary play and close peer proximity occurred under the high spatial density conditions. Rohe and Patterson (1974) studied the behavior of students in high and low density conditions with both high and low amounts of resources. They found that both density and the amount of equipment affected aggression. There was a significant increase in aggressive, destructive, and unoccupied behavior due to increased density. While there were decreases in positive behavior such as relevant participation and constructiveness, when resources were increased, the positive behaviors increased and irrelevant participation decreased. The data also suggested that while there was more interaction in the high resource conditions, they tended to be more negative. Rohe and Patterson suggested that when high density conditions cannot be avoided, that increasing resources will lessen the impact of crowding. Loo (1978) in a third study, examined the differences between social density versus spatial density. Participants in low social density (32.7 square feet per student) had fewer aggressive acts than participants in the high social density condition. Participants in the low spatial density condition (44.2 square feet per student) had more aggressive acts than participants in the high spatial density condition.

Aiello, Nocosia, and Thompson (1979) found age to be a moderating factor of density. They studied children who were 9, 13, and 16 years of age. They found that although the older children experienced comparable stress related arousal, they used more socially acceptable techniques to avoid each other in high density conditions. They also showed no increase in aggression. They suggested that crowding has more detrimental effects for young children and that coping mechanisms develop with age.

Murray (1975) hypothesized that children who lived in crowded conditions were more aggressive and insecure. The family size and house size of 250 children were studied in relationship to the children's behavior. Murray found that crowded children were more

aggressive, impulsive, and extroverted. Boys in crowded conditions were more neurotic than boys in conditions that were not crowded while girls in crowded conditions were less neurotic than girls from uncrowded conditions. Loo and Smetana (1978) found that the perception of overcrowding is mediated by whether those involved knew the people they were with. They cited studies that found that people felt more crowded if they were with unfamiliar people and that strangers are more likely to express negative reactions. However, when boredom or stress is involved, acquaintances are more likely to express dissatisfaction. Freedman (1975) stated that high density does not have generally negative effects on humans. Additionally, high density does effect people, but these effects depend on other factors in the situation. He suggested that as density increases, the intensity of our moods and behavior increases. Freedman stated that the more friendly two people are, the closer they tend to stand. Given plenty of room, friends, spouses, parents, and children tend to stand much closer than strangers and acquaintances. In addition, a person usually stands closer to someone he likes than to someone he dislikes, even if he knows both equally well.

Wohlwill (1985) stated that most studies focused on the crowding of children do not look at the impact on child development. He believed that the influence of density on the development of a child is mediated by other variables. He postulated that density and the rate of social interaction should be studied rather than the effects of crowding. Wohlwill believed that variations in the environment are necessary for a child's development and that the availability of a room for the child to "escape to" free of noise, congestion, and general activity is related to early cognitive growth. He stated that crowding is perceived differently in interior and exterior space. Wohlwill identified four correlates of density: Activity level and intensity of environmental stimulation; competition for limited resources, diversity in choice of peers, and diversity of settings and facilities.

One reason overcrowding has not received much attention is that there have not been many studies tracking the effects of overcrowding on academic progress over time. A school is considered overcrowded when it is operating with an enrollment exceeding its capacity. How the school reacts to overcrowding determines the consequences of overcrowding on student achievement (Burnett, 1995). Overcrowding impacts the everyday logistics of running a school. Lunch periods must start earlier to accommodate more and more students. Every available space is utilized for classrooms which lessens use of electives and teaching strategies such as flexible grouping. Hallways are crowded between classes which can bring out increased conflict between students and necessitates additional time to travel from class to class. Lastly, administrators must concern themselves with maintaining order which lessens the amount of time and focus on school improvement issues (Burnett, 1995).

A person's perception of whether or not a space is crowded is dependent on variables such as past experiences, personal space preferences, familiarity with other individuals present, and the type of activity occurring (Weinstein, 1979). Krantz and Risley (1972) found that when kindergartners were crowded around a teacher who was reading a story or conducting a demonstration, they were less attentive to the teacher or to the educational materials than when they were spread out in a semicircle. McCall (1997) stated that students in overcrowded schools scored significantly lower in both reading and mathematics than students in schools not filled to capacity. In addition, both students and teachers reported that overcrowding negatively affected classroom activities and instructional techniques.

Although many researchers have looked at the class size and achievement issue, room size has not been considered. This factor complicates the study of the effects of density on achievement (Weinstein, 1979). Guthrie (1979) believed the actual scale of the physical plant, the size of its population, and the size of the organization in which the

pupils and staff participate should be studied. Weinstein (1979) stated that while the impact on achievement is unclear, there is evidence that high density results in dissatisfaction, nervousness, less social interaction, and increased aggression.

The Georgia Department of Education has not stated the maximum elementary school size, however, schools are mandated to serve a minimum of 200 students with three or more grade levels. Square footage requirements of elementary schools and their classrooms are determined by instructional unit. Instructional unit is defined as classroom or learning area. Included within this total are the following requirements: Classes designed for students in kindergarten through third grade must be at least 750 square feet, grades four and five must have classrooms of at least 660 square feet. Additional requirements specify that corridors must be eight feet wide when serving two or more instructional units. One foot of additional width is required if ten or more instructional units are served. Square footage requirements increase if media centers, cafeteria, art, music, and physical education suites are included (Georgia Department of Education, 1996).

Studies regarding the effects of high and low density on children found that high density had significant impact on the behavior of children. The age of the subjects and the sex of the subjects along with the amount of resources available all altered responses to high density. The impact of density on achievement has not been researched thoroughly and additional data is needed.

Summary

The review of related literature in Chapter II followed a progression of findings regarding the history of school facilities, the condition of today's schools, and the physical learning environment. Research regarding school size, class size, and density was then reviewed. A listing of studies and their findings in the areas of school size, class size, and density follow in Table 1.

Table 1

Findings Regarding School Size, Class Size, and Density

Source	Findings
School Size	
Keisling (1967)	• There was a negative relationship between mathematics and verbal ability and elementary school size, when controlling for socioeconomic status.
Summers and Wolfe (1976)	• Increased learning took place in smaller schools. • Black elementary students particularly benefitted from being in smaller schools. • Low achievers particularly benefitted from being in smaller senior high schools.
Wendling and Cohen (1981)	• School size was significantly negatively related to third grade reading and mathematics achievement, when controlling for socioeconomic status.
Burnett (1995)	• Students in overcrowded schools scored significantly lower in reading and math than students in schools not filled to capacity.
Black (1996)	• Students attending small schools were more likely to participate in extracurricular programs.
Cotton (1996)	• A twenty fold increase in school population brought about only a five fold increase in participation opportunities.

Table 1 (Continued)

Lee and Smith (1997)	• Optimal school size for high schools was found to be 600 - 900 students where both low and high socio-economic students had the highest achievement gains. • Schools with larger enrollments had more discrepancies in achievement gains between low and high socio-economic status students.
Class Size	
Hallinan and Sorensen (1985)	• Teachers felt that reducing class size reduced their work load, decreased student disciplinary problems, permitted more individualized instruction and provided more opportunities for personal involvement with students. • Instructional time suffered as class size increased. • Class size effected the size of instructional groups as teachers generally form three groups.
Schneider (1985)	• More effective schools had active parent councils, active parent volunteers, and smaller total student enrollments. • Academic achievement was effected by motivation, teacher expectations, parental support, time on task, total school enrollment, and pupil teacher ratio.
Robinson and Wittbols (1986)	• Primary grades showed the clearest evidence in favor of reducing class size.
Johnson (1989)	• Teachers felt that reducing class size enabled them to better monitor students' progress and behavior during instruction and avoid retaining students. • Reduced class size increased opportunities for immediate feedback and reteaching.

Table 1 (Continued)

	• If teachers perceived space to be adequate, they were willing to provide a greater variety of resources.
Finn, Achilles, Bain, Folger, Johnson, Lintz and Word (1990)	• Teacher morale and motivation were higher when there were fewer students.
Mitchell and Beach (1990)	• Instructional time suffered as class size increased.
Nye, Achilles,Boyd-Zaharias, Fulton, and Wallenhorst (1992)	• Students from small classes outperformed all other students regardless of location.
Mosteller (1995)	• Project STAR: Smaller classes scored around eight percentiles higher than regular-sized classes on achievement tests. • The Lasting Benefits Study: Students who were in small classes during their primary grades continued scoring higher than those students who were not, even after returning to regular sized classes. • Project Challenge: Implementation of reduced class size in economically poorer districts improved the performance of children in these districts by noticeable amounts. • Retention of students was reduced when class size was reduced.
Density	
Hutt and Vaizey (1966)	• Greater density caused increased aggression.
McGrew (1970)	• Increased solitary play and close peer proximity occurred under high spatial density conditions.
Krantz and Risley (1972)	• When kindergartners were crowded around a teacher who was reading a story or conducting a demonstration, they were less attentive than when they were spread out in a semicircle.

Table 1 (Continued)

Murray (1975)	• Crowded children were more aggressive, impulsive, and extroverted. • Boys in crowded conditions were more neurotic than boys in conditions that were not crowded. The opposite effect was found for girls.
Smith and Connelly (1972)	• There was no increase in aggressive behavior when resources were held constant.
Rohe and Patterson (1974)	• There was no increase in aggressive behavior in high density conditions when resources were high. • There was an increase of aggressive behavior in high density conditions when resources were low.
Shapiro (1975)	• More disruptive and aggressive behavior occurred in high density classrooms.
Gingsburg, Pollman, Wauson and Hope (1977)	• There was a functional relationship between amount of space and aggressive behavior.
Heller, Groff and Soloman (1977)	• High density and physical interaction produced perceptions of crowding but only the combination of the two lead to poorer task performance.
Loo (1978)	• High anxiety students reacted to high density with emotional helplessness. • Hyperactive students became more active in high density situations. • Boys reacted to high density situations with more activity and aggression than girls.
Loo and Smetana (1978)	• The perception of overcrowding was motivated by whether those involved knew the people they were with.
Aiello, Nocosia, and Thompson (1979)	• Age was a moderating factor of density.

Table 1 (Continued)

Weinstein (1979)	• A person's perception of whether a space is crowded was dependent on variables such as past experiences, personal space preferences, familiarity with other individuals present, and the type of activity occurring.

CHAPTER III

METHODS AND PROCEDURES

Population

The population for this study included 48 elementary schools in seven counties in Georgia, all members of the Middle Georgia RESA (Regional Educational Services Agencies) area. The seven counties included: Bibb, Crawford, Houston, Jones, Monroe, Peach, and Twiggs. Elementary schools that did not serve kindergarten through the fifth grade and magnet schools were excluded from the population.

Sample Selection

A bipolar sample (30 schools - 15 with high ITBS scores and 15 with low ITBS scores) was chosen for this study in order to include schools whose ITBS scores were at the top and bottom of the population's spectrum of scores. A multiple regression analysis (including analysis of covariance) was employed to eliminate bias in the ITBS scores resulting from minority enrollment percentages, low socioeconomic status percentages, teacher experience, and teacher education. These served as the independent variables. The schools within the population were then ranked according to the third grade composite ITBS scores. The top fifteen schools and the bottom fifteen schools were selected to be included in the bipolar sample for this study.

Instrumentation

The instrument used for this study was the Iowa Test of Basic Skills (ITBS). The ITBS is a group administered, norm-referenced test given every spring to third grade students in Georgia. The 1998 ITBS scores as reported on the Georgia Public Education 1997-1998 Report Cards were utilized for the purpose of this study. The scores for third

grade include reading comprehension, mathematics total, language arts, social studies, science, and the composite score. The composite score is obtained by determining the mathematical mean of the developmental standard scores from the ITBS. The scores used for computing the composite score as reported in the Georgia Public Education 1997-1998 Report Cards include: the Reading total, which is the mathematical mean of the Vocabulary and Reading test scores; the Language total, which is the mathematical mean of the Spelling, Capitalization, Punctuation, and Usage and Expression test scores; the Mathematics total, which is the mathematical mean of the Mathematics Concepts and Estimation section and the Mathematics Problem Solving and Data Collection section; Social Studies; Science and the Sources of Information total, which is the mathematical mean of the Maps and Diagram section, and the Reference Materials section (Hoover, Hieronymus, Frisbie, & Dunbar, 1996).

Hypotheses

The following null hypothesis was examined for this study:

Null Hypothesis: There is no statistically significant relationship between school density and the academic achievement of elementary school students as measured by the ITBS.

Data Collection

Initial data for this study were collected from the Georgia Public Education 1997 - 1998 Report Cards. This report contained information from each school regarding total enrollment, minority enrollment percentages, low socioeconomic status percentage enrollment, teacher experience, teacher education, and ITBS results. Personal communication with county administrators produced information regarding architectural area. Permission was obtained from county and school officials to visit schools after school hours in order to measure the architectural area of the school. A surveyor's wheel was used to determine linear footage that was then converted into the architectural area of each

school. This measurement along with the total enrollment of each school was used to determine the density of each school.

Data Analysis

The statistical software program SPSS 6.1 Graduate Pack for the Macintosh was utilized to provide the statistical analysis for this study. Initially a multiple regression analysis and correlation were used to determine the sample for the study. This eliminated sampling bias due to the influences of variables such as minority enrollment, low socioeconomic enrollment, teacher experience, and teacher education. Schools were then classified as having high, medium, or low density. Homogeneity of variance tests were computed on each of the achievement test scores reported for the study to ensure homogeneity. Achievement test scores were classified as high or low according to their school's ranking in the bipolar sample. An analysis of variance for each set of the achievement test scores was computed to test the null hypothesis with a level of .05 confidence level.

Summary

Chapter III included a description of the methods and procedures used for this study. The population, sample selection, instrumentation, and hypothesis, along with the procedures for data collection and data analysis were discussed. Chapter IV follows with the presentation and analysis of the data.

CHAPTER IV

PRESENTATION AND ANALYSIS OF DATA

Introduction

The purpose of this study was to determine the relationship between school density and achievement test scores. Data collected for the study came from a bipolar sample of thirty schools from the Middle Georgia RESA (Regional Education Services Agencies) area. The information from one school was ineligible for use in this study after it was determined that the school was utilized for purposes other than serving students in kindergarten through the fifth grade. Therefore, it did not meet the requirements set for the population of the study.

Descriptive Data

Data collected from each school included the architectural area, the student enrollment, the percent of minority enrollment, the percent of low socioeconomic status enrollment, the average teacher experience, and ITBS (Iowa Test of Basic Skills) scores.This data are presented in the Appendix. The density of each school was determined by dividing the architectural area of the school by the student enrollment of the school.

The density of the remaining twenty-nine schools was classified as high, medium, or low. These classifications are presented in Table 2. Ten schools were classified as high density schools and ranged from 56.17 square feet per student to 84.29 square feet per student. Seven schools were classified as medium density schools and had from 87.13 square feet per student to 97.64 square feet per student. Twelve schools were classified as low density schools and ranged from 100.27 square feet per student to 134.01 square feet per student. These divisions were made on the basis of accumulative percentages to

approximate a third in each classification. Because the square footage of some schools were close (e.g. 100.27, 100.42, and 100.93) the middle class was reduced to seven entries. The high density class contained ten schools and the low density class contained twelve schools.

Table 2

Classification of Density as Low, Medium, or High

Density of School	Classification	Code
56.17	High	1
57.76	High	1
63.74	High	1
69.27	High	1
75.70	High	1
76.52	High	1
81.47	High	1
82.83	High	1
83.42	High	1
84.29	High	1
87.13	Medium	2
87.90	Medium	2
92.60	Medium	2
93.03	Medium	2
93.27	Medium	2
94.04	Medium	2
97.64	Medium	2
100.27	Low	3
103.42	Low	3
103.93	Low	3
109.17	Low	3
110.48	Low	3
111.99	Low	3

Table 2 (Continued)

115.20	Low	3
117.41	Low	3
124.95	Low	3
128.75	Low	3
131.39	Low	3
134.01	Low	3

Cochran's and Bartlett-Box tests for homogeneity of variance were computed on the covariates of density class, percentages of Black enrollment, and percentage of free and reduced lunch percentages for each of the ITBS scores reported in this study. This included third grade ITBS reading comprehension, mathematics, language arts, social studies, science, and composite scores. In all but two cases the alpha for the Bartlett-Box test were higher than .05. Ferguson (1981) states that "Moderate departures from homogeneity should not seriously affect the inferences drawn from the data (p 245)." In each of the two cases for the Bartlett-Box test and one case for the Cochran's test, a probability between .01 and .05 were found. Only one variable (third grade Social Studies) actually had an alpha of less that .05 for each test of homogeneity of variance. These results are presented in Table 3.

Table 3

Univariate Homogeneity of Variance Tests

Variable	Cochran's	p	Bartlett-Box	p
3rd grade Reading Comprehension	.37936	.244	1.37775	.231
3rd grade Math	.28209	.834	.54633	.741
3rd grade Language Arts	.35037	.362	1.80374	.110
3rd grade Social Studies	.51310	.028	2.89184	.014
3rd grade Science	.45465	.077	1.40867	.219

Table 3 (Continued)

3rd grade Composite	.36519	.297	2.35190	.040

ITBS scores were classified as low (1) or high (2) according to their school's ranking in the bipolar sample. This was done to differentiate the ITBS scores of low ranking and high ranking schools. Fourteen schools were classified as low (1) and fifteen were classified as high (2). The combined unweighted adjusted means for the density classifications and the ITBS classifications for each of the ITBS scores reported in this study are presented in Table 4. The means for all third grade achievement test scores of high density schools were lower than the third grade achievement test score means of medium density and low density schools.

Table 4

Combined Unweighted Adjusted Means

Source of Variation	Density			ITBS	
	high 1	medium 2	low 3	low 1	high 2
3rd grade Read. Comp.	44.020	50.278	49.601	40.528	55.405
3rd grade Mathematics	54.284	61.606	61.342	47.406	70.749
3rd grade Language Arts	52.048	61.133	63.190	45.880	71.700
*3rd grade Social Studies	48.632	57.406	56.844	42.836	65.752
*3rd grade Science	48.000	56.065	56.302	41.190	65.721
*3rd grade Composite	48.028	56.699	57.153	41.266	66.654

* Significantly different at the .05 level.

Findings Related to the Hypothesis

The null hypothesis for the study stated that there is no statistically significant relationship between school density and the academic achievement of elementary school students. General factorial analysis of variances with covariates of percentage of students receiving free and reduced lunch services, and percentage of Black students were computed for each of the achievement test areas. These areas included third grade reading comprehension, mathematics, language arts, social studies, science, and composite ITBS scores. The results for these analyses are found in Table 5. The data in Table 5 reveals that in three of the six areas statistically significant differences were not found. These include third grade reading comprehension ($F = 1.92$, $p = .172$), third grade math ($F = 1.71$, $p = .206$), and third grade language arts ($F = 2.27$, $p = .129$). Statistically significant differences in three of the six areas measured, third grade social studies ($F = 8.01$, $p = .003$), third grade science ($F = 10.39$, $p = .001$), and third grade composite ($F = 4.90$, $p = .019$) were found and are also presented in Table 5. Given the above analysis, the null hypothesis was rejected and a statistically significant relationship between school density and the academic achievement of elementary school students was found.

Table 5

Analysis of Variances

Sources of Variation	SS	DF	MS	F	p
3rd grade Reading Comprehension					
Within Cells	960.49	20	48.02		
Regression	516.73	3	172.24	3.59	.032
Density Class	184.62	2	92.31	1.92	.172
ITBS Class	295.70	1	295.70	6.16	.022

Table 5 (Continued)

3rd grade Mathematics					
Within Cells	1569.74	20	78.49		
Regression	53.95	3	17.98	.23	.875
Density Class	268.58	2	134.29	1.71	.206
ITBS Class	727.95	1	727.95	9.27	.006
3rd grade Language Arts					
Within Cells	2358.40	20	117.92		
Regression	48.53	3	16.18	.14	.937
Density Class	536.20	2	268.10	2.27	.129
ITBS Class	890.66	1	890.66	7.55	.01
3rd grade Social Studies					
Within Cells	469.97	20	23.50		
Regression	284.83	3	94.94	4.04	.021
*Density Class	376.33	2	188.16	8.01	.003
ITBS Class	701.58	1	701.58	29.86	.000
3rd grade Science					
Within Cells	333.01	20	16.65		
Regression	720.26	3	240.09	14.42	.000
*Density Class	346.03	2	173.01	10.39	.001
ITBS Class	803.90	1	803.90	48.28	.000
3rd grade Composite					
Within Cells	834.76	20	41.74		
*Regression	241.60	3	80.53	1.93	.157
Density Class	408.94	2	204.47	4.90	.019
ITBS Class	861.09	1	861.09	20.63	.000

Summary

Chapter IV presented the descriptive data utilized for this study and the results of the statistical analyses. A statistically significant relationship between school density and the academic achievement of third grade elementary school students was found for social studies, science, and the composite ITBS score; therefore, the null hypothesis was rejected. Chapter V follows with the conclusions of the study and recommendations for further research.

CHAPTER V

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Introduction

The purpose of this study was to determine the relationship between school density and achievement test scores. The study utilized a bipolar sample in order to include schools whose achievement scores were at the top and bottom of the population spectrum when considering ITBS scores. Achievement was measured through scores from the Iowa Test of Basic Skills (ITBS).Third grade scores in the areas of reading comprehension, mathematics, language arts, social studies, science, and composite were utilized. The density of each school was determined by dividing the architectural area of the school by the student enrollment of the school.

Summary of the Findings

The null hypothesis for this study stated that there is no statistically significant relationship between school density and the academic achievement of elementary school students. A general factorial analysis of variance, with covariates of percentage of students receiving free and reduced lunch services, and percentage of students that were Black was computed for each of the six academic areas studied. Statistically significant differences were found in three of the six areas, third grade social studies, third grade science, and third grade composite test scores. Because of these results, the null hypothesis was rejected. A statistically significance relationship between school density and the academic achievement of elementary school students was found.

Conclusions

Based on these findings, it was concluded that elementary schools having an architectural square footage of less than 100 square feet per student tend to have significantly lower science, social studies, and composite ITBS scores that schools having more than 100 architectural square feet per student. Schools ranging from 100.27 to 134.1 architectural square feet per student had significantly higher ITBS science, social studies, and composite scores at the third grade level.

Recommendations for Further Study

Based on the results of this study, the following recommendations for further study are made:

1. The impact of classroom density on academic achievement should be studied.
2. A study focusing on the impact of space consuming materials and equipment on density and academic achievement could supplement the finding regarding the space needs of students.
3. The impact of the density of usable space by students and academic achievement should be considered.
4. Further research is necessary on the effect of classroom density on lower elementary grade students versus its effect on upper grade students.
5. The impact of school and classroom density on the academic performance of secondary students (middle and high school students) would augment the findings regarding density.

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APPENDIX A

Data Utilized for Study Regarding Density

Appendix A

Data Utilized for Study Regarding Density

School	Enrollment	Black	White	Hispanic	Asian	Am. Indian	Multiracial	FreeLunch	3rd grade Reading Comprehension
3	528	90.00	9.50	.20	.00	.00	.40	95.80	24
4	549	90.89	8.74	.36	.00	.00	.00	93.60	31
6	509	74.90	24.20	1.00	.00	.00	.00	90.40	37
7	419	100.00	.00	.00	.00	.00	.00	97.60	50
8	945	27.20	69.00	.60	1.30	1.60	.30	23.60	62
9	424	98.82	1.18	.00	.00	.00	.00	96.70	37
10	419	99.76	.24	.00	.00	.00	.00	96.20	31
12	485	99.80	.20	.00	.00	.00	.00	97.70	31
14	364	47.53	48.90	1.10	1.65	.27	.55	47.50	70
15	495	67.27	28.28	2.83	.61	.00	1.01	80.80	33
16	535	7.10	92.00	.40	.60	.00	.00	27.30	62
17	459	24.40	74.90	.20	.00	.00	.40	26.80	61
20	891	26.50	68.60	.80	4.20	.00	.00	16.80	69

Appendix A (Continued)

21	547	39.30	58.00	.40	1.80	.00	.50	34.60	63
23	622	53.90	43.70	.20	.60	.50	1.10	47.60	54
24	554	63.00	35.70	.00	.00	.70	.50	91.20	41
25	476	97.69	1.89	.21	.00	.00	.21	98.10	28
26	695	12.95	84.60	.72	1.58	.00	.14	27.30	59
27	761	11.43	86.73	1.05	.66	.13	.00	32.10	55
28	498	27.31	72.09	.60	.00	.00	.00	46.00	54
29	456	83.33	14.69	1.32	.44	.00	.22	88.80	19
31	399	32.33	64.91	.75	.75	1.00	.25	52.60	74
34	1072	16.98	79.01	2.05	1.59	.09	.28	15.40	64
36	719	13.63	81.64	.97	2.64	2.78	.83	19.70	69
37	714	27.45	69.00	1.40	1.40	.28	.42	28.90	62
39	540	70.00	27.22	.74	.56	.19	1.30	86.30	25
40	556	46.58	51.08	1.26	.36	.00	.72	61.90	60
46	262	59.54	39.69	.00	.00	.00	.76	81.30	43
47	481	23.28	75.68	.42	.00	.00	.62	75.90	30

Appendix A (Continued)

3rd grade Math	3rd grade Lang. Arts	3rd grade Social Studies	3rd grade Science	3rd grade Composite	Architectural Area	Percent Non-white	ITBS High/Low	Density Classification	Density
42	38	31	27	30	40403	90.50	1	1	76.52
41	50	30	35	35	59936	91.26	1	3	109.17
44	32	30	27	30	42462	75.80	1	1	83.42
86	82	63	54	69	53946	100.00	1	3	128.75
70	74	67	68	68	71533	31.00	2	1	75.70
67	64	48	33	48	41398	98.82	1	2	97.64
49	50	37	33	37	39082	99.76	1	2	93.27
45	48	35	35	36	63725	99.80	1	3	131.39
58	76	71	70	69	34230	51.10	2	2	94.04
32	36	35	32	32	31550	71.72	1	1	63.74
66	75	74	74	71	47024	8.00	2	2	87.90
70	65	71	66	67	39994	25.10	2	2	87.13
73	77	68	73	72	73803	31.40	2	1	82.83
66	61	68	66	65	31593	42.00	2	1	57.76

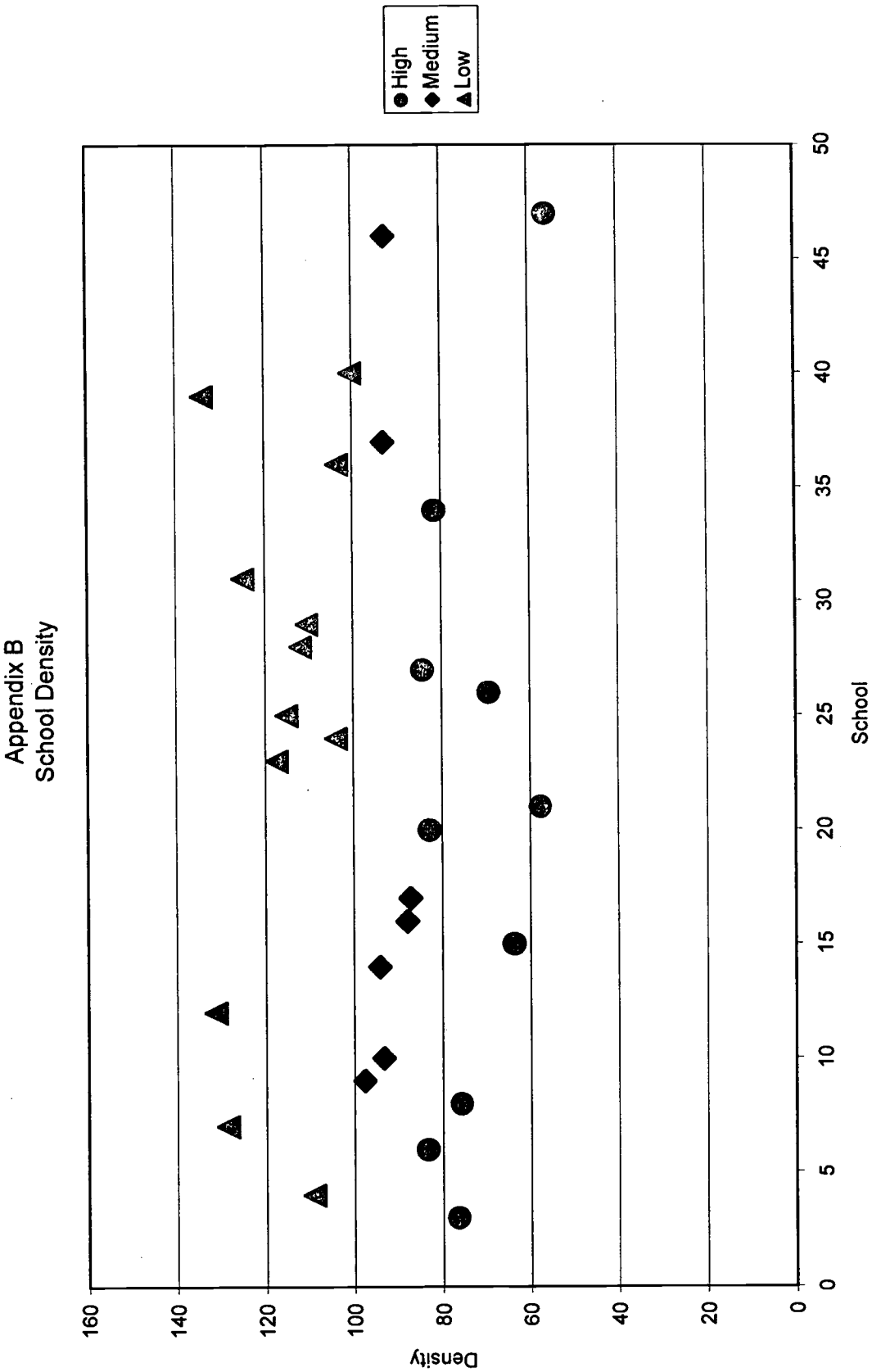
Appendix A (Continued)

72	63	64	60	61	73031	56.30	2	3	117.41
55	60	43	45	46	57579	64.30	1	3	103.93
54	45	42	35	38	54834	98.11	1	3	115.20
68	63	65	70	64	48144	15.40	2	1	69.27
60	68	69	73	66	64141	13.27	2	1	84.29
51	66	55	52	55	55771	27.91	2	3	111.99
25	22	31	33	24	50377	85.31	1	3	110.48
83	83	76	80	82	49856	35.09	2	3	124.95
78	76	71	74	75	87331	20.99	2	1	81.47
81	82	77	80	80	74356	18.36	2	3	103.42
80	77	70	81	78	66426	31.00	2	2	93.03
38	36	49	49	38	72364	72.78	1	3	134.01
75	82	68	62	71	55748	48.92	2	3	100.27
55	35	43	41	39	24260	60.31	1	2	92.60
38	32	33	35	31	27018	24.32	1	1	56.17

APPENDIX B

School Density

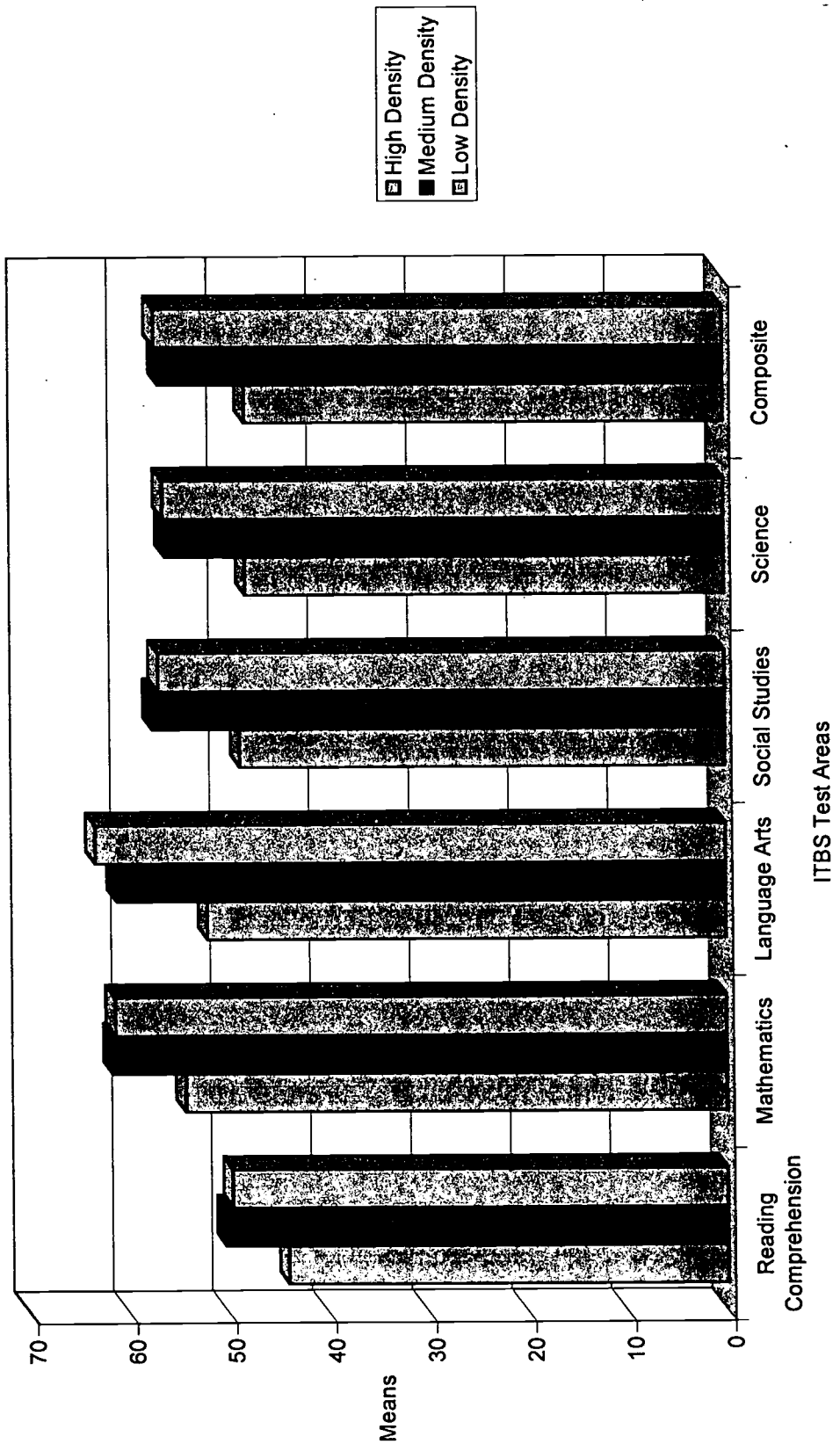
Appendix B
School Density



APPENDIX C

Combined Unweighted Adjusted Means

Appendix C
Combined Unweighted Adjusted Means



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