THE RELATIONSHIP BETWEEN THE AMOUNT OF A SCHOOL’S INTERIOR SPACE AND STUDENT ACHIEVEMENT

by

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(Under the Direction of C. Kenneth Tanner)

ABSTRACT

The purpose of this study was to examine the relationship between a school’s interior space and student achievement. It sought to determine if a statistically significant relationship existed between the useable square footage per student and students’ achievement scores on the Georgia Criterion Reference Test for eighth grade reading and mathematics. Schools with a grade configuration of grades six through eight were sampled. Scores and demographics for the schools were collected from the Georgia K-12 Public School Report Card website. Square footage per student was determined using the interior square footage of the school, including areas of portable classrooms. Data were collected from the Facility Plans submitted to the Georgia Department of Education. This study found a statistically significant relationship between square footage per student and reading scores of eighth grade students and no statistically significant relationship between square footage per student and mathematics scores of eighth grade students. On average, students attending schools having more space per student scored higher in reading.

INDEX WORDS: Academic Achievement, Crowding, Educational Facilities, Middle Schools, Physical Environment
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DEDICATION

Without the support of my family this would have never been possible. I dedicate this dissertation to my husband and children. To my husband, Lynn, I am grateful for the support and encouragement. He never complained about the time and energy needed to complete the degree. To my daughters, Amy and Leigh Anne, you were always encouraging.
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CHAPTER I

INTRODUCTION

Concern for education in the middle level grades began early in the twentieth century. However, it was not until the 1960’s that a middle school with grades 5-8 or 6-8 was advocated by William Alexander as an alternative to junior highs with grades 7-9 (Lounsbury, 1996). The unique educational needs of these young students and the need for change were discussed in 1963 by William Alexander, considered the father of the middle school concept. In many cases, the transition from junior high to middle school and the stagnation of student progress during these years have left many professionals continuing to believe that the middle school years, grades five through eight, are education’s weak link (Cooney, 1998).

The release of the Carnegie Council’s report Turning Points: Preparing American Youth for the 21st Century (1989) focused attention on the need for middle grade reform and the decade after Turning Points has been a period of advocacy for middle school reform. These middle school years are critically important to the success of many students and have also been called the “last best chance to avoid a diminished future”. The Carnegie Corporation identified middle schools as the last best chance of reclaiming at-risk young people and issued recommendations for middle school reform. This report concluded “the middle school is a powerful institution in the life and promise of adolescence. Yet, all too often these schools exacerbate the problems of young adolescents. A volatile mismatch exists between the organization and curriculum of
middle grade schools and the intellectual and emotional needs of young adolescents” (Carnegie Council, 1989).

One of the recommendations of Turning Points 2000 was to divide large middle-grades schools into smaller communities for learning to foster relationships over time between students and teachers (Jackson and Davis, 2000). Ironically the concept of smaller communities of learners, also called teams, clusters, and pods has been a component of the middle school concept since the middle school movement emerged in the 1960’s. *This We Believe*, initially published by the National Middle School Association in 1982 listed ten essential components of middle schools with number ten being a positive school climate. In the 1995 revision of *This We Believe*, “the sixth condition, a positive school climate, recognizes that the school itself is a teacher. The nature of its environment, both in physical facilities and human relationships, is an important educational condition and establishes the context in which learning takes place” (Lounsbury, 1996 p. 3).

Creating smaller communities of learners addresses the class size, enrollment size of schools and the space assigned to the learning community. Class size is one of the most popular and costly reforms in education. There is a large body of research regarding benefits of reduced class size and student achievement (Glass & Smith, 1979, Finn & Achilles, 1999). Through their meta-analysis Glass and Smith (1978) found that as class size decreases achievement increases. The effect begins to emerge as class size falls below 20 students. The STAR project in Tennessee (Finn & Achilles, 1999) found that minority and inner-city children gained the most from smaller classes and the effects lasted longer after the student returned to regular sized classes. However, Hoxby (2000)
argues that there was no effect on student achievement when class sizes were lowered. Hanushek (1999) reviewing the evidence in Tennessee’s STAR Project found no support for class reductions in class sizes greater than 13-17 and for reductions in grades later than first grade.

As schools have grown in enrollment the space per student has also grown. In 1970, the median for middle schools was about 100 sq. ft. per student. By 1994, that median had grown to 128 sq. ft. per student and in 2003 the median was 145 sq. ft. per student (Abramson, 2004). However, 73% of the schools operating today were built during or before the 1970’s and in 1998, the average public school building in the United States was 42 years old (NCES, 2000). What are the implications for student achievement in classrooms built before 1970, built before computers and today’s technology, and crowded by students?

Although recent National Assessment of Educational Progress (NAEP) results indicate that scores for eighth graders have improved since 1996 when 16% of Georgia’s eighth graders were at the proficient or above level in mathematics and 49% were scoring below basic levels in mathematics. There continues to be concern when 23% of Georgia’s eighth graders scored at the proficient or above level in mathematics and 38% scored below basic levels in mathematics (NCES, 2006).

**Need for the Study**

Lee & Smith, 1997, Meier, 1995, and Bickel & Howley, 2000). However, much less research exists regarding the significance of the size for middle schools and more specifically the effects of facility size and crowding on student achievement. Lee, Ready, and Welner (2002) suggested that the quality of empirical research on school overcrowding (density) is, on average, not high.

Research indicates that schools that are very large or very small impair student achievement (Bickel and Howley, 2000; Fowler & Walberg, 1991; Lee & Smith; 1997). According to Lee (1994), high schools of 600 to 900 are ideal. Lee’s study tracked students over four years, 8th grade through 10th grades and found that socioeconomic status was not a factor while the school size was within the ideal size; however, as the schools became too large or too small achievement dropped off significantly. School size and organization become more significant as students become older (Lee & Smith, 1994). However, these studies focus primarily on the elementary child and high school student.

The relationship of the facility to student achievement needs consideration. Providing adequate space for children to learn is more than having square footage in a classroom. Spaces must be accessible to students and used appropriately (Tanner, 2000b). Weinstein stated that “there is considerable evidence that the classroom environment can affect non achievement behaviors and attitudes. High levels of density have resulted in dissatisfaction, decreased social interaction and increased aggression” (Weinstein, 1979, p.598). Maxwell (2003) found that square footage per child in the classroom is just as significant to children’s academic performance and interpersonal relationships as the number of students per class. Children may not benefit from the positive effects of smaller student population if classroom density is high.
In this era of test score awareness, maximizing the learning experience is essential for all children. There is a need to evaluate achievement test scores as they relate to student population density of the school. The research question becomes, does the amount of a school’s interior space have implications for the level student achievement?

Statement of the Problem

The literature is inconclusive regarding the relationship of student population density (square feet per student) to student achievement in middle schools. Given this gap in the literature, this study evaluated schools of different student population densities to determine, after controlling for socioeconomic status, how much of the variance in the reading and mathematics scores of eighth graders are accounted for on the Georgia Criterion-Referenced Test (CRCT). Factors such as the socio-economic status (SES) of the children have been proven to be contributing indicators to lower student’s achievement scores.

Purpose of the Study

The general purpose of this study was to determine the relationship between the amount of a school’s interior space and student achievement. Based on this investigation into the effect of school population density on student academic achievement, the following research question was generated as a guide:

Is there a correlation between school square footage per student and academic achievement in Georgia’s public middle schools?

Limitations of the Study

The study was limited to Georgia middle schools configured to grades six through eight. One of the constraints of this study is the use of a single measure of learning,
CRCT. The test data were reported by Riverside Publishing to the State of Georgia. All schools meeting the criteria were included. Assumptions that all students were tested by valid means and that all other data were reported accurately were made. A second restraint was the availability of facilities data for the school. Only schools with complete data were used. Data were collected from the facilities plans that school systems submit to the Georgia Department of Education. The determination of whether or not internal spaces were used for their original intent was not investigated. The age of buildings were not considered.

**Definition of Terms**

**Middle School:** For the purpose of this study a middle school was a school having grades six through eight.

**Grade Configuration:** The grade configuration was the range of grades served by the school.

**Percentage of Economically Disadvantaged Students:** This percentage is calculated by dividing the number of students eligible to receive free or reduced-priced meals (as reported to the Georgia Department of Education in October 2003 Nutrition Count) by the total school enrollment (as reported by the October 2003 FTE count). Previous years’ information is based on the October FTE collections from the corresponding years (Georgia Department of Education, 2004).

**Square Footage of School:** The square footage of the school was the interior square footage as found in the Facilities Plan submitted by each school system to the Georgia Department of Education. The areas of portable classrooms were included in the square footage.
Student Population Density: The ratio of school enrollment to square footage of the school defines student population density.

The Georgia Public Education Report Card: The Georgia Public Education Report Card is designed to assist systems and schools in educational improvement. The report includes a variety of data elements and is published annually in December.

Socio-Economic Status: Participation in the Federal Free/Reduced Price Lunch program was used to indicate SES for the school and system. On the report card this data is reported as Percent Economically Disadvantaged children.
CHAPTER II

REVIEW OF SELECTED LITERATURE

Schools have undergone significant changes from the period of the time when classrooms were multi-graded, were heated with a potbellied stove, and desks were bolted to the floor. Shifts in population distribution and a more mobile population also contributed to the changes in where children were educated. In the early part of the twentieth century children needed to be able to walk to school and every community took responsibility to educate their young ones. As the population became more mobile and the economy became more technical, communities began to consolidate secondary schools as a means of economy and need to provide a variety of curricula. Guthrie (1979) reported that the number of schools decreased from approximately 262,000 to 91,000 over the period from 1932 to 1972. Walberg (1994) reported a decline of 69% in the number of schools while the student population increased by 70% over the period from 1940 to 1990. Walberg (1994) also found that the total number of school districts declined dramatically during this period from 117,018 to 15,367, a decline of 87%. Guthrie (1979) described the trend towards larger schools as being the product of concerns for economic efficiency, fiscal equity, and the need to provide a wider variety of curricula offerings from specialized teachers.

Just as significant were the changes to facilities during the later part of the twentieth century. Schools were air-conditioned, carpeted, and equipped with a variety of electronic devices. Yet, Tanner (2000a) suggests that while schools have been held to
higher standards for students and teachers, “we do not hold to a higher standard is the way schools are planned, designed, and built.” “Many standards for the physical aspects of school design do not lend themselves well to educational reform measures.” The importance of the school building and physical environment in school reform has been underappreciated for its supportive role in student learning. The physical environment can be a major reform element (Moore & Lackney, 1993).

**Economy of Scale**

Economy of scale represents part of the reason the number of schools declined during the mid to end of the twentieth century. As transportation became more practical school districts began to look at cost efficient means of operating schools. Consolidating small schools into larger ones responded to two needs, cost efficient administration and better instruction. Between 1940 and 1990, the total number of elementary and secondary public schools has declined by 69%, from approximately 200,000 to 62,037, despite a 70% increase in the population of the United States. (Howley, 1994) The average size of a school has grown from 127 to 653. (Walberg, 1994) Schools of 2000 to 3000 have become expected in large urban and suburban areas. (Henderson & Raywid, 1994) School districts had also grown in size during this time. In 1940 there were 117,108 districts. Those districts had consolidated to 15,367 (Walberg, 1994).

Economy of scale is an economic theory developed in Britain during the last century to explain how increasing the size of industries could produce better returns on the investment. Simply stated, if there is an economy of scale then the increases in outputs will be greater in proportion than the increases in input. Increasing the size of the facility (school) can reduce production costs.
One the earliest references to school size come from the work of Cubberley (1922) originally published in 1915. Cubberley was a leading professor and former urban superintendent. The industry of the northeast was growing into other areas of the United States. People were moving from the farm into town as transportation became motorized. Cubberley championed consolidation of rural schools. Cubberley’s viewpoint was that consolidated schools could provide increased pupil-teacher ratios, longer terms, transportation, and rural appropriate curriculum that were consistent. He recommended that school systems be led and supervised by professional education administrators (Howley, 1996). At that time large schools consisted of high schools of 300-400 students. Cubberley was interested in how large schools could become.

Also writing during the early part of the century was Joseph Kennedy, dean of the school of education at North Dakota State University. In his book, Rural Life and the Rural School, written in 1914, he took a very different view. He wrote:

It might happen, as it frequently does, that a school is already sufficiently large, active and enthusiastic to make it inadvisable to give up its identity and become merged in the larger consolidated school. If there are twenty or thirty children and an efficient teacher we have the essential factors of a good school (Kennedy, 1914, p. 64).

Cubberley considered how large schools could be and Kennedy considered how small schools could be and still be considered viable. School boards use administrative and instructional viewpoints to justify consolidation of the schools or the continued existence of a small school. These two perspectives lead to very different perspectives about school size. And the argument continues today.

However, many small school districts and small schools continued to exist. Twenty-nine percent of school districts in the United States have fewer than 300 students.
Forty-two percent of schools have fewer than 300 students. During the 1970s and 1980s states had faced litigation over the issue of fiscal equity. The results were that states reduced the number of school districts and thereby attempted to resolve fiscal inequities (Lutz, 1990).

The trend towards consolidation was driven by the need to provide cost effective and a sufficiently varied curriculum. This is a concept borrowed from the business sector. Many researchers note that Conant’s 1959 book, *The American High School today*, greatly influenced the school consolidation movement. Others cite the 1957 launching of the Soviet Union’s Sputnik as an accelerating point. Compliance with school desegregation and special entitlement programs of the 1960’s brought more consolidations (Smith & DeYoung, 1988). Conant argued that a high school had to have at least 100 in its graduating class. Conant argued that the small high school was the number one problem in education, and that its elimination should be a top priority (Conant 1959).

Fanning (1995) examined the pressures to consolidate schools. Economies of scale and pursuit of national educational goals related to economic competitiveness. School districts usually look at the model of several elementary schools, one or two larger middle schools, and one large high school. There was evidence that consolidation may heighten some problems within schools. Common problems included personalization of climate, increased bureaucratic costs, and low levels of student participation.

Lee and Smith (1997) found that cost savings projected from having consolidated schools did not materialize. Instead of the projected economies of scale, they discovered
diseconomies, or penalties of scale. Large schools need more layers of support and administrative staff to handle the increased bureaucratic demands. Friedkin and Neccochea state that the relationship between school district size and availability of resources is inconsistent from community to community. Resources are determined by the socioeconomic status of the community (Friedkin & Neccochea, 1988).

**Middle Schools**

Since this is a middle school study, it was necessary to review the significance of the middle school movement to changes in school configuration and organization. Assigning students to teams within a grade level and creating a smaller learning community is a relatively new educational concept. During the early part of this century, education beyond the elementary school became normal. The search for the most effective kind of school for the student beyond sixth grade leads to the emergence of junior high schools. The junior high school with grades seven through nine experienced rapid growth during the 1920’s and 1930’s under the guidance of Koos and Briggs. During the 1940’s and 1950’s, concern for the development of junior high schools leads to a discussion of what schools ought to be. Gruhn and Douglass, in 1947, proposed and described six major functions of junior high: integration, exploration, guidance, differentiation, socialization, and articulation. These functions remain today as a foundational framework for defining an effective middle level school (Lounsbury, 1996). As dissatisfaction grew with the typical junior high school, educational leaders such as William Alexander and Donald Eichhorn began to push for a program to accommodate the needs of 10 to 14 years olds (Calwelti, 1988).
The middle school movement began to grow in the 1960’s. Today it is the predominant form of school organization for students aged 10 to 14. McEwin reported that 59% of the country’s middle schools were established after 1980 and that 75% of the junior high schools were established before 1980. Middle schools grew from 1970 to 1987. Schools with grades six through eight increased by 160%, schools with grades five through eight increased 47% and schools with grades seven and eight increased by 7%. Junior high schools decreased by 53%, from 4,711 schools to 2,191. By 1991, the number of junior high schools had decreased to 1,425 (McEwin, Dickinson, & Jenkins, 1996).

Becker, (1990) stated that schools with large enrollments are able to provide greater experiences for the middle school child. The study found that in schools of less than 600 students, only one-fourth of the students were receiving keyboarding and other technical related exploratory offerings. More than half of the schools with 600 students or more were able to offer these courses. Limited exploratory opportunities limit the experience middle school students need to envision themselves as successful adults and to explore areas of interest before reaching the high school. McEwin (1996) stated that exploration calls for opportunities to participate in activities that interest students either academically or recreationally. Neither of these enrichment experiences should be considered unimportant. Exploratory education is a sound preparation for success in high school.

Tadlock and LoGuidice (1994) found that in many cases middle level instruction becomes a non-entity in small districts. Schools with grades K-8, 7-12 tends to have instructors in the middle levels that are either elementary trained or secondary teachers.
Students are less likely to receive specialized middle grade instruction. The instruction from the elementary teacher is likely to be less challenging and the instruction from the secondary teacher is a watered-down version of the secondary class rather than a unique course.

Kanthak (1996) describes how middle schools evolved as educators became concerned that junior high schools were too subject oriented and not enough student-centered. High achieving middle schools are built on the belief that all students can learn, achieve, and succeed at high levels. In these schools students pursue common, comprehensive, academically oriented core curriculum, but instructors believe that students learn differently and that students can learn at different rates. Middle schools are organized into small communities of learning, usually called teams, clusters, or pods. Teachers share these students within the team and become more responsible for the progress of the student. Methodology is an integral part of the middle school teacher’s training. This allows for differentiation of instruction for the variety of abilities and learning styles on the team. (Kanthak, 1996)

**School Size**

The discussion of small school versus large school seems to have settled into a pattern of discussing consolidation and the pros and cons of this debate. Much of the latest research is in the area of rural education and its value to the community (Howley, 1994). Urban areas have concluded that very large schools do no serve today’s child well. The research in this area is centered about reducing the impact of large schools by creating schools-within-schools (Raywid, 1996). Can a school be too small? Can a school be too large? There is little doubt that the answer to each is yes. The next question
becomes: When do schools begin to thrive because of their size and when does size become a detriment?

Monk (1987) found that large high school size does not guarantee advanced course offerings; rather, larger schools offered more introductory courses. When schools offered more advanced offerings, these seemed to favor the advantaged few. There was consensus with previous studies that high schools of more than 400 could be as effective as larger schools. Haller, Monk, Bear, Griffith and Moss (1990) found that small schools could offer a four-year complement of basic, advanced, and alternate courses. However, there was acknowledgement that comprehensiveness differed greatly. Comprehensiveness increased differentially both across and within subjects. (Haller, Monk, Bear, Griffith & Moss, 1990)

Lee and Smith (1997) found that smaller scaled schooling tended to be more beneficial to most students. The study drew four conclusions regarding school size and student achievement. (1) High schools should be smaller than they are. In this study, 600-900 for high schools was considered the optimal size. Learning is more equitable in smaller schools. (2) High schools can be too small. Students learn less in high schools of less than 600 students. The exceptions seem to be schools with high resources and a very homogeneous student population. (3) Ideal size does not vary by the types of students who attend. When using the optimal size school, size favored both high and low SES students. (4) Size does seem to matter more for some students than for others. Residential segregation was cited as increasing and those students were more likely to find themselves in school with more students like themselves. Specifically this was a student of the same or similar socioeconomic status and ethnicity. School size appeared to be a
much more significant issue in schools serving a sizable population of low socioeconomic students and/or traditional minority students. Schools should be especially anxious to reduce the size of the units for these students. There was also a recommendation that large schools adopt school-within-schools concepts to reduce the impact of large-scale schooling on these students.

Plecki (1996) examined the relationship between school size and student achievement in California elementary schools with varying student characteristics and urban/rural locations. For this study, third grade mean scores on the California Assessment program for 1986-1987, total enrollment; percentage of students whose families received Aid to Families with Dependent Children; percentage of students with limited English proficiency; and school location (urban, suburban, and rural). Results of stepwise linear regression, one-way analysis of variance, and trend analysis indicate that larger schools are not associated with improved student performance, even when comparing schools with similar student characteristics. Urban schools serving high percentages of students in poverty, school size, and student performance showed a negative linear relationship. Best results for poverty high schools were when enrollment was below 200. Schools of 200-800 seemed to serve students with low poverty rates best.

Much of the recent research on school size has centered about the consolidation of rural schools. West Virginia has closed nearly 20% of its schools since 1988. (Howley, 1995) Howley undertook to replicate a study conducted by Friedkin and Noccochea in 1988. The original study, with data from California, determined that the interaction between size and socioeconomic status, SES, benefited affluent students while small
schools benefited impoverished students. This study found that the SES systematically influences the effects of school and district size on aggregate student achievement. Friedkin and Noccochea (1988) found that small schools benefited impoverished students more than large schools benefited affluent students.

Howley (1996) investigated the schools and school districts of West Virginia. Data sets and variables were gathered from West Virginia and federal information. Dependent variables were derived from the West Virginia data. School sizes from the 1990 enrollment in the grade-level cohort that is the subject of analysis. This method controls for the effects of variation in the grade-level configurations of the schools. Achievement was defined by the regular administration of the Comprehensive Test of Basic Skills (CTBS) in grades three and six and the fall 1990 administration of the CTBS in grades nine and eleven, aggregated to the school level. Socioeconomic status is defined as the proportion of students at each school receiving free and reduced lunches in the school-lunch program during the fall of 1990. These data are reported to the West Virginia Department of Education to the National Center for Education Statistics (Howley, 1996).

Emerging from the school-level regression analyses the following statements could be made. (1) The indirect effect of school size on achievement is a better predictor of student achievement than either school size or socioeconomic status alone. (2) The nature of the prediction is that increases in school size imply increasingly more severe negative effects among impoverished children. (3) Impoverished children, as compared to more affluent children, generally attended smaller schools. (4) Smaller schools tend to disrupt the negative effects of socioeconomic status (Howley, 1996).
A study of the West Virginia school consolidation and review of financial reports for the years 1990-1995 revealed that student enrollment and the number of school personnel decrease each year. The number of counties reporting deficits increased each year. The most prevalent factors contributing to deficits were changes in the school aid formula, lack of excess levies to fund schools, scarcity of population, transportation expenditures, and other required program costs. (Margolin, 1996)

Cotton (1996) discusses school size, school climate, and school performance. Monk (1987) reporting that 100% increases in school size result in 17% increases in curriculum offerings. Increases in the size of very small schools are associated with greater curricular gain that increases in the size of larger schools. Cotton reports that about half of the student achievement research finds no difference between the achievement levels of student in large and small schools. None of the research finds large schools superior to small schools in their achievement effects. The assumption was made that small school achievement is at least equal and sometimes superior to large school achievement.

Tucker (1997) researched the effects of school size on selected dependent variables. Research was limited to middle schools of Virginia. The five largest and five smallest schools were restricted from the study to remove the effect of outliers on the study. A random selection of ten largest and ten of the smallest middle schools were included. Tucker found there was no statistically significant difference between large middle schools and small middle schools in Virginia the following curriculum indicators: the percent of eighth grade students taking a foreign language before ninth grade, percent of minority students taking a foreign language before ninth grade, percent eighth graders
taking Algebra I or Algebra I Part 1 prior to ninth grade. There was a statistically significant difference between large middle schools and small middle schools in the number of minority students taking Algebra I or Algebra I Part 1 prior to the ninth grade.

Tucker (1997) did not find a statistically significant difference in achievement between large middle schools and small middle schools. Tucker recommended several areas for possible future study. (1) Study the impact of wealth within the district, costs per student. (2) Examine class size as well as school size. (3) Consider differences between rural and urban middle schools and achievement.

“There is a natural predilection in American Education toward enormity,” said William J. Fowler (1992), “and it does not serve schools well”. Recent research seems to agree. Meier (1995) and Howley (1994) support the concept of schools housing 300-400 students. Lee and Smith (1997) conclude that high schools should have enrollments between 600 and 900. None of the reviewed literature recommended schools of less than 300 or more than 900 students. However, the reality is that schools routinely have enrollments greater than 1000. Raywid (1996) sees schools-within-schools as a means of reducing the impact of large-scale schooling. Middle schools have not been studied at the same level as other groups to bring consensus to the research.

Determining the best way to educate children means knowing what is best. Research generally supports the premise that rural, poor, and minority students learn more in smaller schools (Friedkin and Necochea, 1988). Georgia has a school population that is 49% minority. Forty-six percent of Georgia’s school children qualify for free or reduced price lunches as reported on the 2003-2004 Georgia Public Education Report Card (Georgia Department of Education, 2004). Thirty-two percent of Georgia’s
population lives in rural counties, 117 of 159 counties. Almost half of the rural residents of Georgia live in counties designated as persistent poverty counties by the USDA. In persistent poverty counties, 20% of the population has lived with an annual household income below the federal poverty level for more than 40 years (Ryan, 1996). Forty-three percent of the children in Georgia’s urban areas live in poverty. Eighty-three percent of Georgia’s urban children are African American (Olson & Jerald, 1998). Research indicates that children who are poor, live in rural or urban areas, and are minorities have less success academically (Cooney, 2000). Children who are in all three categories struggle to achieve academic success. Recent research revealed that school size may be a determining factor when turning low performing schools into high performing ones (Bickel & Howley, 2000).

Density of the School’s Physical Environment

Possibly one of the most popular school reform efforts in recent history is the reduction of class size. Class size at the early elementary levels has been shown to significantly affect academic achievement of students from low socioeconomic backgrounds (Finn & Achilles, 1999; Glass & Smith, 1979; Weinstein, 1979). Glass and Smith (1979) concluded that reduced class size as a reform would produce improvements in academic achievement. Class size of less than 20 had the most effect. Finn and Achilles found that minority and inner-city children gained more from smaller classes and that the effects of the smaller classes lasted longer after students returned to regular sized class rooms. Effects of reduced class size at grade levels above first were less conclusive (Finn & Achilles, 1999). The study suggested that these results might be the
result of less time spent managing the class. However, the research does not significantly address the effect of class size on middle or high school students (Noble, 1998).

Overcrowding is the relationship of the enrollment of a school to the capacity the school was designed to accommodate (NCES, 2000). Initially, the General Accounting Office (GAO) had attempted to collect data on overcrowding in the 1994 study by collecting data on space in original buildings, permanent additions, and temporary buildings. That attempt was not considered successful and was not reported. Data for the 1999 study includes a ratio of actual enrollment to building capacity to determine the percentage of capacity for the school. Temporary buildings were not considered as there was concern that they would obscure the overcrowding of the building. Results of this study found that approximately half of the schools were under enrolled, about one fourth of the schools were at or near capacity, and about a quarter were overcrowded based on the capacity of the original school. Middle schools as a sub group were not reported. Large schools were more likely to be overcrowded and schools with more than 50% minority enrollment were more likely to report being severely overcrowded 15% of the majority minority schools versus 6% of schools with 21% to 50% minority and 4% of schools with 5% or less. Overcrowded schools were more likely to suffer from a number of inadequate building features such as framing, floors and foundations, heating, ventilation, and air conditioning, and electrical power to be less than adequate. However, these reports were not statistically significant (NCES, 2000 pp. 45-50).

School size and class size are measured in terms of the number of students. Also related to size is overcrowding of the school. Lee, Ready, & Welner (2002) suggest that this shifts the focus towards concerns about basic resources in the school. The issue of
overcrowding (density) has attracted attention because of concerns of equity of resources and facilities. Use of temporary buildings is considered a symptom of overcrowding. Solutions to overcrowding can also include increasing class size and alternative use of non-instructional space. Increasing class size seems economically feasible as it saves on teacher salaries and temporary buildings; however, student experiences are surely diminished (Lee, Ready, & Welner, 2002). Twenty percent of overcrowded schools hold classes in spaces not originally intended as classrooms (NCES, 2000).

Weinstein (1979) found “considerable evidence that the classroom environment can affect nonachievement behaviors and attitudes. High levels of density have resulted in dissatisfaction, decreased social interaction, and increased aggression.” (Weinstein, 1979, p.598). Researchers have suggested that space per student might be as important as the number of students in a class (Abramson, 1991; Maxwell, 2003; Swift, 2000; Tanner, 2000b). Maxwell’s study of elementary students found that girls’ academic achievement was negatively affected by increased numbers in classrooms and boys had more negative behavior (Maxwell, 2003). Swift (2000) found that elementary schools in Georgia had significantly lower science, social studies, and composite scores on the Iowa Test of Basic Skills for third grade when the architectural square footage was less than 100 square feet per student.

Lackney (1997) studied environmental implications for learning. The study found that 50% of the teachers reported concerns about classroom adaptability. These concerns included computer installation and other problems limit adaptability, need for more electrical outlets, need for storage space, and difficulties with inter class projects and cooperative learning activities.
The discussion of concerns about the age and condition of schools in the United States continues (Lackney, 1997; McGuffey, 1982; Tanner, 2000a). Over 50% of America’s schools were built during the 1960’s with a projected life of thirty-five years (Moore and Lackney, 1993). In 1999, the average age of the main instructional building(s) of public schools was 40 years, based on years since original construction (NCES, 2000). Key to these concerns is the need for classrooms to have technology not invented or available for use in the 1960’s. Tanner (2000b) has made recommendations for class size based on social distance needs of students. An average secondary classroom of 1024 square feet should house about 14 -15 students. A review of current facility minimum square footage guidelines in Georgia finds a recommendation of 660 square feet for a classroom for grades four through eight and recommendations for a science classroom with teacher demonstration table of 1000 – 1100 square feet (Georgia DOE, 2003). Maximum class size rules in Georgia allow 32 students per class in grades four through eight and plans for reducing maximum class size to 28 have been postponed until school year 2007-2008 (Georgia DOE, 2005).

The space needed for computers, projectors, and screens impact the space needs of children (Lackney, 1997). Wohlers (1995) found that averages for square feet per student do not reflect the type and scope of the educational programs those buildings house. The averages for middle schools were divided into three groups: Canada - 96.5 square feet per student, southern tier states – 81.25 square feet per student and the remaining 48 states – 154.45 square feet per student. Abramson (2006) reports that nationally middle schools under construction will have a median area of 146.2 square feet per student and serve a median enrollment of 793 students. Region 5, Georgia, Alabama,
Mississippi, and Florida, will have a median area of 149 square feet per student and a median enrollment of 885 students.

Burnett (1995) states that there is evidence that overcrowding has detrimental effects on students from poverty. Citing the Citizens’ Commission on Planning for Enrollment Growth report “Bursting at the Seams” to the New York City Board of Education, the commission’s study found that students scored significantly lower in mathematics and reading than did similar students in underutilized schools. Students and teachers in overcrowded schools reported negative effects on classroom activities and instructional strategies. Burnett (1995) also suggested that resources were negatively affected by overcrowding. Lunch times begin early and end late, shortages of lockers affect student personal space, shared classrooms make it difficult for teachers to plan and in some cases elective classes are lost to educational basics.

Salama and Adams argue that “the only way to address the needs of students is to understand their behavior in relation to the learning environment they occupy” (Salama & Adams, 2003, p.4). These needs include personal space, group behavior, crowding and density. Tanner states, “If we conclude that students need space and crowding is bad, it is our job as school planner and designers to provide an equation for architects and decision makers” (Tanner, 2000b, p. 3).
CHAPTER III
RESEARCH DESIGN

The purpose of this study was to examine the relationship between school population density and student achievement in the areas of reading and mathematics in Georgia’s Middle Schools. This quantitative study compared school population density of schools containing only grades six through eight in Georgia.

Subjects in the study were the Georgia middle schools housing grades six through eight. The most common configuration for middle schools is grades six through eight (McEwin, Dickinson, & Jenkins, 1996). Data were collected from the Georgia K-12 Public Education Report Card for the year 2003-2004. The report card reported the scores of schools in each of the measured categories. This report card is published annually.

Null Hypothesis

The following null hypothesis was examined for this study:

There is no significant correlation between the amount of square footage per student and the percentage of students that met or exceeded the Georgia reading and mathematics standards.

Statistical Analyses

Controlling for percent economically disadvantaged (PED), the percentage of students that met or exceeded the Georgia standards in reading or mathematics, on a per
school basis was correlated with the gross interior square feet per student. The confidence level $\alpha = .10$ was chosen for this study.

**Data Collection**

Data collected for each school in the study included: Interior Square Footage, School Enrollment, Percent Economically Disadvantaged (PED), CRCT eighth grade Reading scores, and CRCT eighth grade Mathematics scores. The information was collected from the Georgia Public Education Report Card for 2003-2004 and from the Facility Plan submitted by the school system to the Georgia Department of Education.

**Interior Square Footage**

The facility size was gathered using the Facility Plan submitted to the Georgia Department of Education. Schools with interior square footage included in the plan were used. The area of portable classrooms was added to determine the total square footage for the school complex. All areas internal to the school were included. Whether the areas were used as initially designed was not considered.

**Student Population Density**

Student Population Density (Square Feet per Student) was determined by dividing the square feet of the school by the number of students enrolled.

**Percent Economically Disadvantaged**

Economically disadvantaged is the term used in the Georgia Report Card to report the percentage of students who are eligible for free/reduced price lunches, also known as the socio-economic status for a school. The percentage of students eligible for free/reduced price school lunches is considered a valid proxy for socioeconomic status of the school and therefore the community. This variable was chosen because of its
continued use as an indicator of school need for federal assistance through Title I programs and its high correlation with performance on mathematics and reading subtests of standardized tests. This variable was used as a covariant to control for the variability due to socioeconomic differences. The use of a covariant is intended to account for the variance caused by economic differences in the communities of the schools included in the study.

Instrumentation

Scores in reading and mathematics from the spring 2003-2004 administration of the Georgia Criterion Referenced Competency Test, CRCT, was used. The CRCT is a group administered criterion-referenced test given to eighth grade students in Georgia. The 2004 CRCT scores, reported on the Georgia K-12 Public Education 2003-2004 Report Card (Georgia Department of Education, 2004), were utilized for the purpose of this study.

Data Analysis

The statistical software package program SAS 9.1.3 was utilized to provide the statistical analysis for this study. To study the relationship of school population density on the selected dependent variables, analysis of covariance (ANCOVA) was used. This method uses the concepts of analysis of variance and regression analysis simultaneously. ANCOVA is used to increase power by adding a covariate. A covariate is a source of variation that is not controlled for in the design of the experiment, but which does affect the dependent variable.
CHAPTER IV
PRESENTATION AND ANALYSIS OF DATA

The purpose of this study was to determine the relationship between school population density and achievement test scores. Data for the study were collected from the Georgia K-12 Public Education Report Card for the year 2003-2004 and from the Facility Plan submitted to the Georgia Department of Education for each school system. The 2004 scores on the Georgia Criterion-Referenced Test were used to measure academic achievement. Only schools housing grades six through eight exclusively were used in the study. Schools without interior square footage included in the facility plan were not included in the study. Grade eight scores were selected since they represented three years of effect by the school. A total of 389 schools met the criteria.

Descriptive Data

Data collected from each school included the interior square footage, the student enrollment, the percentage of students who were economically disadvantaged, the percentage of students who met or exceeded standards on the CRCT in reading and mathematics. The data are presented in Appendix A.

The density of each school was determined by dividing the interior square footage by the number of students enrolled in the school. Interior square footage was hand calculated from the facility plans for each school. The interior square footage was calculated by adding areas of the square footage of the original building, additions to the building, and portable classrooms. Student enrollment was collected from the Georgia
report card. The interior area of the schools in the study ranged from 21,997 to 275,904 interior square feet. The number of students enrolled in the schools ranged from 183 to 3,156 students. The student population density ranged from 55.4 to 219.4 square feet per student.

In order to assess the extent of differences in student characteristics and student achievement among the data subsets, the percentage of students classified as economically disadvantaged, eligible for free and reduced price lunches (SES), was collected. These data were chosen since students from low income families have lower achievement scores (Cooney, 2000 and Howley & Howley, 2004).

Reading and mathematics scores from the 2004 administration of the Georgia Criterion-Referenced Test for eighth graders were chosen because all schools have scores and eighth grade students have been administered the CRCT for a longer period of time. Eighth grade students were initially given the CRCT in 2000.

Data were analyzed using a pre-determined alpha of .10 and SAS 9.1.3. The findings indicated by the statistical analyses of data are included in this chapter.

**Findings**

Statistical Analysis was completed using the SAS 9.1.3 version from SAS Institute, Inc. Georgia had a total of 389 schools housing grades 6-8. Schools with incomplete data or schools sharing space or facilities with another school were excluded from the sample. A total of 326 schools were included in the sample.

The mean enrollment for the schools was 1027, the mean square footage for the schools was 110,666 and the mean square feet per student was 112.97. The median student enrollment was 958, the median square footage for the schools was 103,553 and
the median square feet per student was 108. Abramson (2006) reported the median square footage per student of newly built middle schools to be 146.2 square feet per student. Consideration for the impact of school building and physical environment on learning has led to increased recommendations for gross square footage per student. Hawkins and Lilley (1998) define gross square footage as the total amount of space within exterior walls. It is their recommendation that 120 gross square feet per student be used when determining building capacity for middle schools. This is an increase from 90 square feet per student traditionally used to determine building capacity, and clearly implies that many of Georgia middle school students are housed in schools well below current construction norms. Links to Georgia guidelines are found in Appendices B and C, and these policy documents unquestionably influence the 108 median square feet per student in Georgia’s middle schools.

The partial correlation of square feet per student and reading scores, with the scores adjusted for the percentage of economically disadvantaged, was \( r = .015 \). This indicated a small positive linear correlation between increased square footage per student and increased reading scores. The partial correlation of square feet per student and mathematics scores, with the scores adjusted for the percentage of economically disadvantaged, was \( r = .010 \). This also indicated a small linear correlation between increased square footage per student and increased mathematics scores.

An analysis of variance, with the covariant for percentage of economically disadvantaged (PED) students, was computed for each of the two sets of achievement tests. These areas included scores of students that met or exceeded the standards for reading and mathematics.
When controlling for PED, $R^2 = 0.64$ for reading scores. The data in Table 1 reveal that the $R^2$ was statistically significant different from “0” ($F = 2.69; p = .10$). Therefore, factoring out the effects of PED, 64 % of the variance in reading scores was accounted for in the number of square feet per student. The null hypothesis was rejected.

### Table 1

**Analysis of Covariance Results Percentage of All Students Meeting Reading CRCT Standards**

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>df</th>
<th>Sum of Squares</th>
<th>Mean Square</th>
<th>F</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percent Economically Disadvantaged</td>
<td>1</td>
<td>313.202</td>
<td>313.202</td>
<td>14.65</td>
<td>0.00</td>
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<tr>
<td>Sq. Ft. per Student</td>
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<td>57.612</td>
<td>57.612</td>
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<tr>
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<td>66.301</td>
<td>66.301</td>
<td>3.10</td>
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<tr>
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<td>21.385</td>
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<tr>
<td>Corrected Total</td>
<td>325</td>
<td>19287.083</td>
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</table>
When controlling for PED, \( R^2 = 0.59 \) for mathematics scores. The data in Table 2 reveal that the \( R^2 \) was not statistically significant different from “0” \( (F = 2.22; p = .13) \). Given the analysis below, the null hypothesis was not rejected.

Table 2

Analysis of Covariance Results Percentage of All Students Meeting Mathematics CRCT Standards

<table>
<thead>
<tr>
<th>Source of Variation</th>
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<th>Sum of Squares</th>
<th>Mean Square</th>
<th>F</th>
<th>p-value</th>
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</thead>
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<td>1235.801</td>
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<td>Sq. Ft. per Student</td>
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Summary

Chapter IV presented the descriptive data utilized for the student and the results of the statistical analyses. A statistically significant amount of the variance for reading scores was accounted for by square feet per student \( (\alpha = .10) \), while no statistically significant amount of the variance for mathematics scores was accounted for by square feet per student \( (\alpha = .10) \).
CHAPTER V

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

The purpose of this study was to determine the relationship of school population density to student academic achievement. The study utilized the interior square footage of schools to determine the student population density for each school. The density of each school was determined by dividing the interior square footage of the school by the number students enrolled. Achievement was measured though scores from the Georgia CRCT for eighth grade students.

Summary of the Findings

The null hypothesis for this study stated that there is no significant correlation between the amount of square footage per student and the percentage of students that met or exceeded the Georgia reading and mathematics standards. The analysis of variance, with the covariate for the percentage of economically disadvantaged students was computed for reading and mathematics. Statistical significance was found in the area of reading. Because of these results, the null hypothesis was rejected. A statistically significant correlation was found between the amount of square footage per student and the percentage of students that met or exceeded the Georgia reading standards. However, no statistical significant correlation was found between the amount of square footage per student and the percentage of students that met or exceeded the Georgia mathematics standards.
Conclusions

The finding of a significant relationship between reading scores and square footage per student has implications for the number of students housed in buildings with space allocations less than current space recommendations by Abramson (2004) and Hawkins and Lilley (1998). This study found that the median of 108 square feet per student in Georgia middle schools was closer to 1970 allotments of 100 square feet per student (Abramson, 2004). Abramson (2006) reported that newly constructed middle schools average 146 square feet per student. Hawkins and Lilley (1998) recommended 120 gross square feet per student. The median enrollment for schools in this study was 958 and the mean was 1027. Lee and Smith (1997) indicated that schools of 600-900 are considered the upper limit for middle schools. Other researchers indicate that students from lower socioeconomic backgrounds achieve at higher levels in smaller schools (Cooney, 2000; Bickel & Howley, 2000; Lee & Smith, 1997; Meier, 1995). Georgia’s middle schools are larger than those recommendations, yet Georgia has 46% of students qualifying for free or reduced lunch.

Recommendations for Further Study

There were areas of interest emerging from the data and the review of literature that encourage further study:

1. A study that specifically looks at the schools using portable classrooms for some students compared to schools with permanent classrooms for all students is needed.
2. A study is needed to measure the exact interior square footage of classrooms and the number of students assigned to the classroom. These data should be used to generate a density factor for comparison with academic achievement.

3. Parallel to the two issues above, a study is needed in Georgia that specifically investigates the age and condition of the buildings housing students as compared to the current national recommendations.
REFERENCES


Calwetti, G. (1988, November) Middle schools a better match with early adolescent needs, ASCD survey finds. ASCD Curriculum Update 1-12.


Georgia Department of Education (2003). Square Footage Requirements for Developing the Local Facilities Plans and State Capital Outlay Applications for Funding. {Electronic version}. Georgia Department of Education, Facilities Unit, Atlanta, GA


## APPENDIX A

Data Utilized for the Study of School Population Density

<table>
<thead>
<tr>
<th>Number of Students</th>
<th>Interior Area of School (sq.ft.)</th>
<th>School Population Density (sq.ft./stud)</th>
<th>Percent Economically Disadvantaged (PED)</th>
<th>Percent of Students Meeting or Exceeding Standards in Mathematics</th>
<th>Percent of Students Meeting or Exceeding Standards in Reading</th>
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APPENDIX B

Square Footage Requirements for Use in Developing the Local Facilities Plans and State Capital Outlay Applications for Funding

The Georgia Department of Education Facilities division establishes square footage requirements for schools. Facilities resources are found on the Department website. Below is a link to information used in this study.

APPENDIX C

Data Utilized for the Study of School Population Density

160-5-1-.08 Class Size   Code: IEC

The Georgia Department of Education maintains a database with all current rules. Below is the link to class size information used in this study.

http://public.doe.k12.ga.us/_documents/doe/legalservices/160-5-1-.08.pdf