12-2016

Effect of Small Class Setting on the Algebra I Achievement of Ninth-Grade Students

Lisa Kissire
Harding University

EFFECT OF SMALL CLASS SETTING ON THE ALGEBRA I ACHIEVEMENT OF NINTH-GRADE STUDENTS

by

Lisa Kissire

Dissertation

Submitted to the Faculty of

Harding University

Cannon-Clary College of Education

in Partial Fulfillment of the Requirements for

the Degree of

Doctor of Education

in

Educational Leadership P-20

December 2016

EFFECT OF SMALL CLASS SETTING ON THE ALGEBRA I

ACHIEVEMENT OF NINTH-GRADE STUDENTS

by

Lisa Kissire

Dissertation

Dissertation Advisor	09/27/16 Date
Dissertation Reader	9/27/16 Date
Dissertation Reader	09.27.16 Date
Dean of the Cannon-Clary College of Education	9-27-16 Date
Provost	10/12/16 Date

ACKNOWLEDGMENTS

Many people contributed to the completion of this dissertation. Specifically, I thank God, and my support system of family, friends, co-workers, instructors, and team members, most of whom fell in more than one category. I also thank my three children who have been lifelong supporters throughout my work: my eldest son Severian, his wife Devin and their son Jax Kissire; my daughter Karissa Kissire, her fiancé' Jacob and their son Graysen Golden; and my youngest son, Serech Kissire were my most precious inspiration. I also could not have completed this dissertation without the support and help of my co-worker, supervisor, ex-husband, and friend Ronnie Kissire who worked on his doctorate at the same time. Of course, I could not have completed any of this work without my faith and my parents, Karen and Joe Duncan and Naaman Dean and Monique Freeman. Other significant supporters of my work were my best friend and boyfriend Ray Summit, and my brothers, Stephen, Justin, Jared, and Jacob Freeman.

Additionally, I could not have completed this work without the support of my friends Renee' Miller-O'Neal, Kristi Leach-Freeman, Nick Matthews, Dr. Michael Mullins, Michelle Graves-Troutman, Dana Holcomb-Short, Becky Steed-Carter, Lisa Whitworth, James William Clark, and Mike Schrader. Equally important were my many co-workers who, as friends and supporters also contributed to the success of my dissertation. I specifically mention Mrs. Amy Fulmer, Dr. David Thigpen, Mrs. Lyn McDade, Mrs. Helen Cook, Mrs. Chelley Fendley, Mrs. Terah Pricop, Dr. Larry

Hopkins, and with loving memory, Dr. Rebecca Morris. I must also thank my former professors from Henderson—Drs. Johnnie Roebuck, Patricia Weaver, and Penny Ferguson, and from Harding—Drs. David Bangs, Tony Finley, Keith Williams, and Donny Lee. There is an additional host of family members, friends, co-workers, instructors, administrators, teachers and students not mentioned by name, that were supportive in many ways suck as gathering data within their school districts. Lastly, but of significant importance to this work were those who put in the most effort besides myself, my dissertation committee members, Drs. Usenime Akpanudo, Michael Brooks, and Lynette Busceme, and Bruce Bryant. I am forever grateful to you all.

ABSTRACT

by
Lisa Kissire
Harding University
December 2016

Title: Effect of Small Class Setting on the Algebra I Achievement of Ninth-Grade Students (Under the direction of Dr. Usenime Akpanudo)

The effects of class size on student outcomes has been widely studied at the elementary level. Many such studies have found important relationships between class size and outcome in the areas of academic achievement, student discipline, and teacher retention. However, little attention has been given to the examination of how class size may affect student outcomes in the middle school and high school levels. The purpose of this nonexperimental study was to examine the effects of class size setting, gender, socioeconomic status, and school configuration on the Algebra I achievement of ninth-grade students. Participants were drawn from four rural schools in Arkansas using a two-staged sampling technique. In all, a total of 288 students were included in the study. Existing data from the Arkansas End of Course Exam for Algebra I was the primary instrument used in this study while data analysis involved three 2 x 2 factorial analyses of variance (ANOVAs) with a Bonferroni adjustment.

Results of the study revealed that class size setting had a minimal, but unimportant, effect on ninth-grade students' Algebra I achievement. A slightly more important effect of socioeconomic status on Algebra I achievement was also revealed.

However, neither gender nor school configuration were shown to significantly impact students' Algebra I outcomes. These findings suggest that the positive effects of class size widely documented at the elementary level may not necessarily carry over to the secondary grades. The findings also highlight the importance of socioeconomic status as a factor influencing student outcomes. Yet another important implication of this study is the introduction of the concept of class size setting as the more precise construction of class size at the secondary school level.

TABLE OF CONTENTS

LIST OF TABLES

CHAPTER 1

INTRODUCTION

Enacted in 2002, the No Child Left Behind Act intensified the demand for educators to become accountable for student performance outcomes (Klein, 2015; Peterson & Ackerman, 2015). In response to this increased pressure, the president of the National Education Association suggested that policy makers at state education departments should take a serious look at class size reduction as a means of improving students' academic performance (Roekel, 2008). However, even prior to the enactment of the No Child Left Behind Act, the effectiveness of class size reduction as a means of improving student performance had been an issue of ongoing debate among educational leaders. Many of the declared positions in this debate focused on the true benefit of implementing class size reduction in light of the seemingly high cost of the intervention. For instance, Miller-Whitehead (2003) acknowledged that the availability of funding, facilities, and faculty made class size reduction decisions potentially expensive options. Furthermore, as Roekel (2008) pointed out, for low-achieving schools serving students from relatively lower income backgrounds, resources including personnel were always stretched and additional faculty and facilities were usually out of the question. The argument from this position stands in sharp contrast to those of researchers who see nothing but good outcomes resulting from reduction in class size.

Achilles (2003b), for instance, suggested that smaller-class sizes not only improved students' academic achievement but also students' behavior, discipline, citizenship, participation, and engagement both in the classroom and outside of school. Additionally, he insisted that smaller-class size enhanced students' development toward becoming productive, humane, and responsible persons who could contribute to society. In light of these benefits, Sharp (2003) encouraged the reallocation of human and financial resources toward class size reduction. Achilles (2003b) however, argued that, in spite of the seemingly high costs of class size reduction, the legislative and administrative push for larger class sizes for the primary purpose of reducing fiscal deficits was counterproductive and negatively affected student performance.

Apart from short-term cost issues related to class size reduction, some consider long-term cost an even longer-term challenge. For example, Zahorik, Halbach, Ehrle, and Molnar (2003) suggested that projected future teacher shortages would only be magnified if administrators attempted to lower class sizes and that these deficits could only be avoided by larger class sizes. However, Huat, Gorard, and White (2004) noted that, in Wales and neighboring England, where class sizes had been reduced, reduction did not result in significant teacher shortages. They contended that the instances of teacher shortage observed were limited to certain regions as well as subject-specific disparities, but no serious shortages existed overall. Nonetheless, to counter the fears of teacher shortages, Achilles (2003c) suggested that smaller sized classes could actually serve as an incentive to attract and keep teachers in the field. Furthermore, Krueger (2002b) insisted that even such negative outcomes as teacher shortages could be avoided by initially reducing class sizes for student populations that stand to benefit the most from such an intervention. If this were the case, an exploration of class size reduction in specific settings is where administrators should begin the search for low-cost student performance benefits.

In the past, researchers have found several student populations and class settings to benefit the most from smaller-class sizes. Miller-Whitehead (2003) and Sharp (2003), for instance, advocated that students' academic achievement was most affected by class size in Grades K-3. Miller-Whitehead (2003) further proposed that diverse populations of students would benefit most from class size reduction. Similarly, Tomlinson (1990) suggested that minority students benefited the most from a reduction in class size. Choosing specific populations to attend reduced size classes might also avoid the dilemma of possibly widening the achievement gap disparity between student groups, which some suggest could happen if all students are given the advantage of smaller-class sizes.

In line with these findings, a major focus of the current study was to examine the effectiveness of class size reduction in a subject-specific setting among a population of ninth-grade students. Of particular interest in this study were the effects of class size reduction in the specific instructional settings for Algebra I students when considered in light of other student demographic characteristics such as gender, socioeconomic status, and school setting. This chapter provides a summary of the significance, as well as the background of the study. Additionally, definitions for specific terms needed to understand and conduct the study are also presented in this chapter.

Statement of the Problem

There were three purposes to this study. The first purpose of this study was to determine the impact of small versus regular-class size setting by gender on Algebra I achievement as measured by the Arkansas End of Course Exam for Algebra I students in four rural schools in Arkansas. Second, this study was used to determine the impact of small versus regular-class size by socioeconomic status on Algebra I achievement as measured by the Arkansas End of Course Exam for Algebra I students in four rural schools in Arkansas. Furthermore, this study was used to determine the impact of small versus regular-class size by school configuration on Algebra I achievement as measured by the Arkansas End of Course Exam for Algebra I students in four rural schools in Arkansas.

Background

The evidence regarding the relationship between class size and student academic achievement is mixed (Glass, 1980; Krieger, 2003). Although some authors found the greatest benefits to occur in the early grades between kindergarten and third grade (Miller-Whitehead, 2003; Sharp, 2003); others suggested that the greatest impact was among students from diverse ethnic backgrounds (Miller-Whitehead, 2003); or, even more specifically, economically disadvantaged minority students (Tomlinson, 1990). Ceci and Konstantopoulos (2009) further suggested that reducing class size not only increased current student achievement, but in addition, the longer students were in smaller classes, the greater their achievement gains became. The implication of this knowledge was that reductions in class size, like many other educational interventions, did not just increase the average achievement for all groups of students. In fact, reductions in class size might also increase the variability of student achievement, further exacerbating the achievement gap. Ceci and Konstantopoulos continued that these results lead to the possible conclusion that, because all students make gains in smaller classes, the highest scoring students would make bigger gains compared to students among low-income and minority populations, thus widening the achievement gap. The implications further suggested that educators should attempt to lower class sizes for the neediest student populations first.

Academic Performance and Gender

Chambers and Schreiber (2004) suggested there was not a significant difference in academic performance between the sexes. On the other hand, other researchers asserted that there was a difference in the academic performance of males and females. For example, Kimball (1989) suggested that, although attention might not be heightened toward the idea, a gender difference does exist in standardized test scores of mathematics achievement. Spencer, Steele, and Quinn (1999) agreed that there is a gender difference between the mathematics achievements of boys and girls. Kimball (1989) and Spencer et al. (1999) also agreed that males score higher in mathematics compared to females. Spencer et al. further suggested that women exhibit weaker mathematics skills because they are concerned about being negatively and stereotypically judged as having weaker mathematics ability. Kimball (1989) attributed the gender differences to several possibilities. Kimball maintained that one possibility for boys' greater success in mathematics achievement could be attributed to the magnitude of their mathematical experiences in relation to girls. Another possibility of boys' greater mathematics achievement could be due to boys' varied learning styles in mathematics. Boys' learning styles have been shown to be a greater benefit when dealing with mathematics than the learning styles exhibited by girls. Kimball's third and final suggestion for boys' greater success in mathematics achievement could be attributed to the authentic situational strengths of boys. This suggested that the situations students face in standardized test questions are types in which boys tend to excel. Royer, Tronsky, Chan, Jackson, and Marchant (1999) attributed higher mathematics scores on standardized testing to males' faster retrieval of basic mathematics facts. Furthermore, they suggested that mathematics-fact retrieval is a strong predictor of performance on standardized mathematics achievement tests for students in Grades 5-8 and in college. They continued that males and females in Grades 2–8 and in college did in fact differ greatly with mathematics-fact retrieval. Moreover, they additionally suggested that boys' greater mathematics performance was due to males' faster speeds at basic computations than that of comparable females. This basic mathematics computation speed was suggested to be mostly due to strong variations attributed to three main populations (Anglo-American, Chinese-American, Hong Kong Chinese). However, practice is shown to improve the speed of retrieval. This is good news for any student with lower mathematics achievement/performance.

Academic Performance and Socioeconomic Status

Hochschild (2003) suggested that socioeconomic status did affect student achievement. Jordan, Kaplan, Locuniak, and Ramineni (2007) tracked students' number sense development beginning in their kindergarten year and continuing through mid-year of Grade 1. At the end of first grade, students' general mathematics performance was then assessed. There was a strong correlation between beginning kindergarten values and the corresponding values at the end of first grade. The variance between these scores among students could mostly be attributed to performance and growth levels in first-grade mathematics achievement. A significant variance could not be attributed to students' background characteristics of income status, gender, age, and reading ability. However, the majority of children in the low/flat growth class were from low-income families. Hochschild (2003) reported that disadvantaged students, such as those from low-income families, did benefit from small-class sizes in elementary school. For example, Project Challenge was a policy that encouraged poor and low-scoring school districts in Tennessee to improve student achievement using the Tennessee Student Achievement Ratio Project (STAR) findings (Finn, & Bain, 1997; Mosteller, Light, & Sachs, 1996; Nye & Others, 1993). Those districts that reduced K-3 class sizes to a ratio of about 1:15 moved up in the Tennessee state rankings. Diaz (2008) agreed that the negative association between low socioeconomic status and student achievement could be overcome using small classes. In fact, reducing class sizes has been linked to increases in student achievement, especially for poor and African-American students (Bain, Achilles, Zaharias, & McKenna, 1992; Nye, Konstantopoulos, & Hedges 2004; Smith, Molnar, & Zahorik, 2003). For example, STAR data indicated that students from low-income homes increased their odds of graduating high school by approximately 67% for those who participated in three years of small classes (Achilles, 2012). For those students from low-income homes that participated in four years of small classes, their odds of graduating high school more than doubled (Achilles, 2012). Furthermore, graduation rates for students from low-income families, with three or more years of small-class participation, were at least as high compared to those of students from families with higher incomes.

This suggested that closing the income gap in graduation rates could also be accomplished through small class setting (Achilles, 2012).

Academic Performance and School Configuration

Gregg (2011) suggested that, in recent years, more evidence has been compiled to show a correlation between students' academic achievement, school configurations, and school size, regardless of student background. Gregg also suggested that this is not a popular theory because the majority of today's population was raised in a large school setting, believing in the Bell Curve and that some students were not as capable of learning. Gregg acknowledged that this is no longer a prevalent theory because it has been suggested that all students have the capacity to learn, no matter their background. In addition, Lee and Smith (1993) suggested that restructuring of schools has led consistently to a more equal distribution of achievement with young adolescents from all backgrounds. Brown (2004) suggested that school configuration is important because school-to-school transitions have been shown to have an adverse effect on students' academic achievement.

Schwerdt and West (2011) maintained that students entering middle school in sixth or seventh grade tended to experience a decline in academic achievement. This was especially prevalent in the areas of mathematics and English language arts when compared to students who did not enter middle school. They noted that, somewhat surprisingly, the academic decline was at a higher rate for students who enter middle school in seventh grade. In addition, academic achievement of students entering middle school in sixth or seventh grade tended to continually decline throughout students' middle school years. Furthermore, academic achievement of students entering middle school in sixth or seventh grade did not show recovery even as late as ninth and 10th grades.

Ramsey (2009) found no relationship between grade configuration and student achievement, except in the middle grades, and noted that this anomaly was definitely not isolated to only urban areas. Brown (2004) proposed that rural districts are particularly at risk and Schwerdt and West (2011) submit that the problem is not one that exists for urban areas alone. Brown (2004) recommended that administrators in rural school districts should be especially cognizant of creating schools with grade spans and student enrollment numbers most suitable for the characteristics of their rural students. Furthermore, Brown found that the academic decline appeared to be more pronounced for students in the bottom half of the achievement distribution. Brown warned that the academic decline was worse for ethnic minority students and for students in the subject area of mathematics. Moreover, Schwerdt and West (2011) indicated that students who entered high school in ninth grade experienced a smaller academic decline. In contrast to the decline in academic achievement among students transitioning to middle school, academic achievement for students transitioning to high school in ninth grade was typically a one-time event only and improved by 10th grade. The implication for United States educators was to recognize that a school's configuration affects student achievement, and middle school transitioning has the most adverse effects.

Schwerdt and West (2011) recommended that school districts configure schools into kindergarten through 8th-grade sites, and 9th through 12th-grade sites. The implication for policymakers is to heighten awareness in regard to creating appropriate school configurations that are in the best interest of all students. This awareness should also stretch to include the positive impact of attending schools with fewer student peers. Attending smaller schools with less student peers has been shown to increase students' academic achievement, as well as engagement. Lee and Smith (1993) advised schools to become more community organized and avoid the bureaucratic organization of today's United States schools. Lee and Smith defined the restructured school as more diverse in grouping, more team-oriented (especially among teachers), and less departmentalized. They submitted that this has been proven to have a positive impact on students' achievement and engagement, as well as lessening negative behaviors detrimental to learning.

Although there are many variables that affect academic achievement, some are controllable through practices, policies, and legislation. Student variables that affect academic achievement and cannot be controlled are things such as diverse populations between gender, ethnicity, income, beginning academic levels, etc. However, research has shown that some of the variables affecting academic achievement can be controlled in order to best accommodate that which cannot be controlled. Variables that affect student achievement and can be controlled are things such as class size, school time spent in small classes, and school configuration. Research shows that these initiatives can improve students' academic achievement. This is especially true for the neediest populations such as students from low-income families, diverse backgrounds, content areas of struggle, and transitioning grade levels. For these reasons, it is believed that more research is appropriate and necessary to determine how student achievement is affected by small-class size, students' demographic differences, and school configurations.

Hypotheses

Although Achilles (2003c) and Krueger (2002b) have suggested that small-class size has a positive effect on student achievement, Chatterji (2005) specifically related the influence of small-class size on mathematics achievement. Many positive outcomes on other disciplines were also noted. Similarly, it is believed that the positive outcomes of small-class size may be established for secondary grade levels and for all students; therefore, the following null hypotheses were generated.

Ho_1: There will be no difference by gender in Algebra I achievement as measured by the Arkansas End of Course Examination for Algebra I for ninth-grade students in small-class size settings versus ninth-grade students in regular-class size settings at rural schools in Arkansas.

Ho_2: There will be no difference by socioeconomic status in Algebra I achievement as measured by the Arkansas End of Course Examination for Algebra I for ninth-grade students in small-class size settings versus ninth-grade students in regular-class size settings at rural schools in Arkansas.

Ho_3: There will be no difference by school configuration in Algebra I achievement as measured by the Arkansas End of Course Examination for Algebra I for ninth-grade students in small-class size settings versus ninth-grade students in regular-class size settings at rural schools in Arkansas.

Description of Terms

Mathematics achievement. Steinmayr, Meibner, Weidinger, and Wirthwein (2015) defined academic achievement as the measurement of one’s intellectual capacity through the assessment of many areas that encompasses a variety of learning domains.

Examples of ways to assess academic achievement are noted as grade point averages or by standardized assessments such as the Scholastic Assessment Test. Finn (2002) defined student achievement by measurement with the Stanford Achievement Test and the California Test of Basic Skills. For the purpose of this study, achievement is defined by raw score on the Arkansas End of Course Exam for Algebra I for first year, ninth-grade, non-advanced placement Algebra I students in a 1-year program only.

School configuration. According to the Commission for Arkansas Public School Academic Facilities and Transportation (2015), a school’s configuration is the methodical grouping of grades as determined by the school district at any school’s campus. For the purpose of this study, school configuration is defined as high school, or not high school, depending on whether the ninth-grade classes are scheduled to meet on the same campus as the 12th-grade classes. A high school configuration is defined as having 12th grade classes on the same campus as the ninth grade. A school classified as not having a high school configuration is defined as having ninth grade on a different campus as the 12th-grade classes.

Socioeconomic status. According to the American Psychological Association (2007), socioeconomic status is defined as the social standing of an individual, measured as a combination of salary, education, and occupation. For the purpose of this study, socioeconomic status is defined as a student’s lunch status in the school where the student attended Algebra I class. Students who were listed as participants in the free and reduced lunch program were considered to be of low socioeconomic status and vice versa.

Small-class size setting. Class size is defined as the number of students in a teacher’s classroom for whom that teacher is responsible on a regular basis (Finn, 2002;

Sharp, 2003). Class size is not to be confused with pupil-teacher ratio, which is defined as the number of students in an educational unit divided by the number of full-time professionals assigned to that unit (Finn, 2002; Sharp, 2003). In addition, Finn (2002) defined regular size classes as having at least 22, but less than 26 students. Finn defined small size classes as having a minimum of 13 students, and Krieger (2003) defined small size classes as having fewer than 18 students. Furthermore, according to Achilles (2003b), small-class size was defined as an entire day's schedule. In the current study, given that the small class environment was not maintained throughout the day but only for a specific class setting, the term *small-class size setting* was considered more appropriate than small-class size. For the purpose of this study, small-class size setting was defined as a small class of no more than 17 students set up within the course schedule period. Conversely, a *regular-class size setting* was defined as having at least 18 students in an Algebra I class period.

Significance

Since most citizens believe that the fundamental basis for success is developed through schooling (Parcel & Dufur, 2001), educators and students are constantly looking for the best ways to gain a high quality educational program at a reasonable cost (Toth & Montagna, 2002). This has led to current class size reduction initiatives by more than 20 states seeking to increase student achievement (Zahorik et al., 2003). Early elementary grades are generally the focus in the United States, with an attempt to lower the average class size to 15-18 students (Zahorik et al., 2003). This research leads to several ramifications for educational planning (Finn, 2002; Huat et al., 2004; Miller-Whitehead, 2003; Sharp, 2003). The differences between the two concepts of class size reduction and pupil-teacher ratios are also noted (Achilles, 2003c; Finn, 2002; Sharp, 2003). The overall significance of this study was to help secondary school administrators determine and transfer the academic implications of class size for their individual situations, especially in the area of mathematics.

Process to Accomplish

Design

A quantitative, causal-comparative strategy was used in this study. The independent variables for the three statements of the problem were class size and gender, class size and socioeconomic status, and class size and school configuration, respectively. The dependent variable for all three statements of the problem was student Algebra I achievement as measured by the Arkansas End of Course Exam for Algebra I for first year, ninth-grade students in a 1-year, non-advanced placement Algebra I program.

Sample

At least two intact Algebra I classrooms in each of four rural schools in Arkansas were identified to take part in the study. A total of 13 classrooms with 288 students were involved in the study. A 2-stage sampling technique was used. At the first stage of sampling, a convenience sample of 13 classrooms was drawn. Six of the 13 classrooms consisted of students in small-class size settings. At the second stage of sampling, a random sample of students from each of the four regular-class size settings was drawn to match the number of students drawn at the first stage of sampling. In both samples, the subjects drawn were limited to non-advanced placement, first year Algebra I students in the ninth grade. Students who were enrolled in Algebra I for any reason other than the first year of participation, or who were considered to be in an advanced placement were not included in the study. The actual class sizes for both samples ranged from 13 to 30 students per class.

This study used ninth-grade students in four rural schools in Arkansas. Both male and female students were included in the study. These students came from a range of socioeconomic and racial backgrounds, though all resided within reasonable daily traveling distances surrounding the geographical region of each of the four rural school district's boundaries. Furthermore, subjects ranged from 14 to 16 years of age.

Instrumentation

Subjects were given the Algebra I End of Course Exam in the state of Arkansas. The Arkansas Algebra I End of Course Exam contains 30 multiple-choice items, worth 50% of the test points, (Arkansas Department of Education, 2015). The other 50% of the test points are totaled from 3 open response items. Based on scores, students are identified as Below Basic, Basic, Proficient, or Advanced. Passing the Arkansas Algebra I End of Course Exam indicates that a student has been identified as Proficient or Advanced. Raw scores equivalent to these identifications are determined each year. Raw scores were used to calculate a class average/mean by gender, socioeconomic status, and school configuration for the class in which they were enrolled: small or regular size class setting (enrolled 2013-2014). Data were collected for each school in the same academic year (2013-2014). The Arkansas Algebra I End of Course Exam has been determined to be valid and reliable by the state of Arkansas, (Arkansas Department of Education, 2015).

Data Analysis

To test the three null hypotheses, three 2 x 2 ANOVAs were conducted. The three hypotheses used class size setting and gender, class size setting and socioeconomic status, and class size setting and school configuration as the independent variables, respectively. Mathematics achievement was measured by the raw score on the Arkansas End of Course Exam for Algebra I and served as the dependent variable for all three hypotheses. As is common in educational and sociological studies, an alpha level of 0.05 was set for the two-tailed test of each null hypothesis. A Bonferroni correction was also used.

CHAPTER II

REVIEW OF RELATED LITERATURE

For decades, within United States education systems, there have been many discussions relative to optimal class size as it relates to school funding and student success. According to Davis, Stillman, and Alas (2012), the relationship between class size and academic outcomes of K-12 students has been a topic of great interest over the past decades in the United States. Hanushek (1999a) suggested that “teachers’ unions have fought for smaller classes for decades” (p. 1). However, this interest has not only been limited to educators, educational researchers, and policy makers, but also to legislators and even economists. It is, therefore, not surprising that there have been many state-level class size policy initiatives in the country during this period. In fact, Hood (2003) noted that over the past two decades, more than 25 states have initiated class size reduction programs. Some have even used federal funds to reduce class sizes. Empirical outcomes have influenced some of these policies, but there is not a lack of research interest in the topic. Chingos and Whitehurst (2011) acknowledged that there has been an abundance of research on the effects of class size on student achievement. In 1979 alone, they identified at least 80 studies on class size reductions in the literature. Unfortunately, an overwhelming majority of these studies examined only the most basic elements of this relationship (Chingos & Whitehurst, 2011).

In order to realize the true potential behind increased student achievement in conjunction with class size reductions, and be able to replicate the results, more than just the basic elements within this relationship must be examined. Tienken and Achilles (2009) allude to this finding, citing 30 years of research indicating that student achievement increased when variables coined as *opportunity-to-learn variables* manifested themselves in the classroom. According to Tienken and Achilles, opportunity-to-learn variables are fostered through class size reductions and lead to behaviors associated with increased student achievement. A sense of community among the students and teacher is just one of those behaviors associated with increased student achievement via small-class size (Tienken & Achilles, 2009). This approach to examining the effects of class size at a deeper level allows researchers to see more than just the surface data. Something of this nature must become the focus for explaining the results of the study in order to fully understand the effects of class size at a deeper level. Studying the data at the basic level alone, without delving further into the reasons why results might occur, could convolute the interpretations of findings.

For example, Chingos and Whitehurst (2011) argued, since schools are so diverse in a variety of ways, findings might not be attributable solely to class size reduction. They elaborate with an example, explaining that due to the costs of class size reductions, the more impoverished schools tend to be the same ones that have the most difficulty providing smaller-class sizes; therefore, smaller-class sizes might could only be afforded by schools that are more affluent. They conclude that this could lead one to believe that small classes result in higher student achievement, when that might not be the actual reason for the achievement differences. Conversely, they continue, a school having discipline issues might reduce class sizes and not see as large of an improvement in student achievement as another school also reducing class sizes. This might possibly lead one to conclude that the result is ambiguous, when in fact there are other factors at play besides just class size reduction. Hanushek (1999a) also acquiesced that if all things are equal, though he submits that this is rarely the case, smaller classes are preferable to larger ones because each student is able to receive more individual attention. However, he further suggested that other factors, such as teacher quality, have a much larger impact on student achievement. Hanushek proposed that “class size reduction may be one of the least effective educational investments” (p. 1), and that some schools prefer to invest in other strategies. Progressing on this idea, Chingos and Whitehurst (2011) recommended that certain factors must be put in place as non-negotiables in order to incontestably study the effects of class size on student achievement. They contend that the most reliable class size reduction studies employed experiments using random assignments of subjects, research that involved natural situational variables, or investigations of longitudinal data through complex mathematical models.

Key Class Size Reduction Studies in the United States

In the United States, three main research strategies have been employed in robust studies of class size reduction (Chingos & Whitehurst, 2011). One strategy noted by Chingos and Whitehurst (2011) included using randomized experimentation on class size reduction by randomly assigning teachers and students to small-size or larger-size classes. In contrast, a second strategy noted by Chingos and Whitehurst involved natural experimentation on class size reduction by analyzing data regarding sudden changes in class size policy and comparing before and after effects. Finally, a third strategy on class size reduction noted by Chingos and Whitehurst used mathematical models by analyzing longitudinal data and estimating effects on individual students, teachers, and schools. All three of these approaches were used to some extent in the Tennessee class size experiment in the 1980s called Project STAR. The Tennessee Student Achievement Ratio Project; also known as the Tennessee STAR Project, became the best known study to stem from the interests in class size reduction.

The Tennessee STAR Project has the reputation of being the most significant, most cited, and most reliable study on the subject (Chingos & Whitehurst, 2011). Hood (2003) ascertained that, after the completion of the Tennessee STAR project interest in class size reduction programs increased. Chingos and Whitehurst (2011) acknowledged the STAR Project as "the most influential and credible study of class size reduction" (p. 1). Additionally, Mosteller (1995) conceded, "The Tennessee class size project [was] one of the most important educational investigations ever carried out" (p. 113). Adding to its widely renowned status was its uniqueness in its implementation as a state-level policy initiative by then Governor Lamar Alexander (Chingos & Whitehurst, 2011). The Tennessee STAR Project began as a statewide, randomized, longitudinal experiment of the effects of small-class size on the achievement of K-3 students. In addition, while the Tennessee legislature passed House Bill 544 launching the STAR Project to determine the effects of small classes, they also saw the need to offset the potential high costs of class size reductions by using full-time instructional aides. Instructional aides were assigned full time to classes with about 22-26 students in an attempt to gain the benefits of smaller classes more cheaply.

When the Tennessee STAR Project was initiated in 1985, students and teachers were randomly assigned to small or regular-size classes (Hood, 2003). Small-sized classes consisted of 13-17 students (Achilles, 2012; Hood, 2003) and averaged around 15 students (Chingos & Whitehurst, 2011). Regular-size classes consisted of 22-25 students, some of which were assigned a full-time teacher's aide (Achilles, 2012; Hood, 2003), and averaged around 22 students (Chingos & Whitehurst, 2011). This calculates to an average reduction of seven students, a 32% reduction of class sizes, overall. Each school participating in the study had at least one of each of the three different class types (Achilles, 2012). By its completion, the Tennessee STAR Project had involved over 11,000 students (Achilles, 2012; Hood, 2003).

Achilles (2012) and Hood (2003) concluded that positive impacts of small classes on student behavior and achievement were indicated by the STAR data analyses. These positive effects included higher test scores, greater school engagement, and less grade level retention. The data also indicated a greater benefit to poor, minority, and male students, helping to reduce the achievement gap. In addition, long-term benefits could be detected such as a greater likelihood for students to take Scholastic Assessment Test and American College Testing Exams, increased graduation rates, increased numbers students earning honor diplomas, and more participation in high school advanced placement classes (Achilles, 2012; Hood, 2003). STAR data revealed that each additional year of small-class participation translated into higher graduation rates in high school (Finn, Gerber, & Boyd-Zaharias, 2005). Overall, a student's odds of graduating high school increased by about 80% for those who participated in small classes for 4 years (Achilles, 2012). For all students similarly, STAR data indicated a significant positive impact on the number of foreign language classes taken in high school because of participating in small classes, even for students from low-income homes (Finn et al., 2005). In addition, STAR data indicated a positive impact on the likelihood of taking the higher levels of foreign languages and mathematics in high school for students participating in small classes. Furthermore, students who spent 3 or more years in Grades K-3 small classes netted the greatest benefits (Finn et al., 2005).

According to Chingos and Whitehurst (2011) and Hood (2003), this investigation concluded that students in the small-size classes outperformed students in the regular-size classes each year on both academic achievement and non-academic achievement, such as behavior and attendance, in both school and in college in future years. Krueger (1999) reported that students in small classes outperformed students in regular classes, on average, by about 0.22 standard deviations after 4 years. Krueger equated this difference to receiving about three months or 33% more schooling compared to those in regular-size classes. Additionally, Krueger (1999) and Hood (2003) indicated that greater achievement gains were seen among poor, minority, and male students as well as students who benefitted from small classes for a greater number of years. Krueger (1999) concluded that the benefits to class size reduction outweighed the costs by about 6%. These results became the foundation of many class size research projects to follow, including the expansion studies of the Tennessee STAR Project: the Lasting Benefits Study, Project Challenge, the Enduring Effects Study, and the STAR Follow-up Studies.

The Lasting Benefits Study, begun initially in 1989, used students' third-grade STAR scores at the end of their participation in regular-size fourth-grade classes (Nye & Others, 1991). Tests to measure achievement levels in reading, language, mathematics, science, social sciences, and study skills were given. The fourth-grade students who had participated in third-grade small classes during the STAR Project showed significant achievement gains in all areas compared to students who were in regular-size classes and regular-size classes with an aide (Nye & Others, 1991).

Project Challenge was initiated by the Tennessee Department of Education to reduce the student-to-teacher ratio for Grade K-3 at-risk students in rural schools (Nye & Others, 1992). Of the rural schools, 17 out of 138 Tennessee school systems participated in the study. The Tennessee Comprehensive Assessment Program achievement test was used as the evaluation tool for student achievement results. Project Challenge data from 1990-1991 indicated that out of 17 participating school systems, 9 improved their statewide rankings in reading, and 10 improved their statewide rankings in mathematics (Nye & Others, 1992).

The Enduring Effects Study addressed the graduation rates of STAR student participants from all three types of classes (Finn et al., 2005). The study included all of the participants in Tennessee's Project STAR. Analyses of the data indicated that graduation rates were related to K-3 student achievement. In fact, graduation rates and K-3 student achievement were both higher for students who participated in smaller-sized classes. Thus, Finn et al. (2005) concluded that student participants in smaller-sized classes in Grades K-3 had higher graduation rates. Furthermore, graduation rates were significantly increased for students who participated in smaller-sized classes for at least 3 years. This was especially true for students eligible for the free and reduced-cost lunch program.

The STAR Follow-up Studies during the 1996-1997 school year explored data from 10th-grade students who had participated in the STAR Project's smaller-sized classes (Pate-Bain, Boyd-Zaharias, Cain, Word, & Brinkley, 1997). Data analyses were performed on all three types of classes: smaller-sized classes, regular-size classes, and regular-size classes with a full-time teacher's aide. Data from the state-mandated Tennessee Competency Exam, required for high school graduation, was used for the study. Although no significant statistical differences were found by class type in test scores for 10th-grade students, a significant difference existed for small-class size students in their eighth-grade test data. In fact, the eighth-grade test data showed a significant difference between students who attended small-size classes and students who attended the other two class types. The data indicated a large portion of students who attended small-class size had already passed the 10th-grade state testing requirements at the eighth-grade level. Throughout the years following students' STAR participation, further data analyses indicated that students who participated in smaller-sized classes in Grades K-3 had continued to maintain higher academic achievement levels. This translated into better high school grades for small-class size students long after their participation in small classes, when compared to their peers who participated in the other two class types. In addition, students who participated in smaller-sized classes in Grades K-3 enrolled in more advanced courses over their peers from the other two class types. Moreover, students from smaller-sized classes were less likely to fail a grade level or be suspended compared to their peers in the other two class types. However, the STAR Project was not the first research done on class size, nor was it the last.

Before the STAR Project, Indiana had initiated a statewide study in 1981 called Prime Time (Achilles, 2003a). Initially, Prime Time reduced class sizes in first and second grades; later, it was expanded to include reductions in class sizes for kindergarten and third grade. These class size reductions involved teacher aides and used a pupil-teacher ratio intervention; yet, this study was still called an initiative and not a mandate for reduction in class size. In addition, Texas passed their own bill to initiate class size reductions in 1984, also before the STAR Project. This bill limited class sizes to 22 students in Grades K-2. Following the STAR Project, an amendment was added to the Texas bill in 1986, which limited class sizes to 20 students in kindergarten through fourth grades. Many reasons were indicated for implementing these initiatives to reduce class sizes, and the majority of educators and other school stakeholders considered all of them worthwhile (Achilles, 2003a). These reasons included increasing a school's ability to provide better instruction, more individual student attention, and additional accommodations for the growing diverse student populations in public schooling.

Other studies were also conducted after the STAR Project was concluded, several of which attempted to duplicate the process and results. For example, in the mid-1990s, Rivkin, Hanushek, and Kain (2005) investigated the effects of class size in Texas using a natural experiment and statistical modeling. They studied longitudinal data from more than 500,000 students in over 3,000 schools. Because they used state assessment results, their data were limited to students in fourth grade and above. From these data, results revealed positive effects for the smaller-class size fourth-grade group in reading and mathematics. Positive effects were also indicated for fifth-grade reading and mathematics, but no significant effects existed for the later grades. Rivkin et al. estimated effects for the fourth and fifth-grade class size reduction in this Texas study amounted to about half of what was shown in the Grades K-3 Tennessee STAR Project results.

California authorities began conducting a large-scale, voluntary class size reduction initiative in 1996 that included participation incentives for teachers in Grades 1-3 (Achilles, 2003a). Because of the participation incentives, unanticipated consequences occurred including a large-scale movement of certified teachers from poor and urban districts. This movement of teachers resulted many times in replacement teachers who were either not certified or who were merely certified under emergency criteria and circumstances. Achilles (2003a) reported that the initiative produced only modest overall student gains and did not indicate higher gains for minority students, as was found in other class size studies. He also questioned how much effect was due to the influence of teacher mobility.

Like California, Wisconsin also began its initiative in 1996, after the STAR Project was concluded. The class size reduction initiative in Wisconsin was called Student Achievement Guarantee in Education (SAGE). Graue and Rauscher (2009) reported that, initially, SAGE primarily included urban areas of Wisconsin but was later expanded to include any district meeting the criteria for eligibility. Just as other research had shown, SAGE data indicated both academic and non-academic gains for students in smaller-sized classes. Graue and Rauscher noted that these gains included higher test scores, better behavior, and decreased disciplinary events. They cited non-academic gains from both STAR and SAGE data as resulting in fewer discipline problems in smaller-sized classes. STAR researchers described students as interacting in class more often, and SAGE researchers characterized students as spending more time on instruction (Rivkin et al., 2005; Graue & Rauscher, 2009). Teachers felt they were more effective and able to provide more individual student attention in the smaller classes. Wenglinksy (1997) described the fourth-grade students in smaller-sized classes as exhibiting academic achievement levels at about a half a year ahead of peers in regular-size classes and indicated that "the largest effects seem to be for poor students in high-cost areas" (p. 25). In addition, minority and at-risk students showed higher gains and appeared to exhibit greater benefits compared to other students (Graue & Rauscher, 2009).

Achilles (2003a) argued that the longer students remained in smaller classes throughout their educational career, the higher their gains. He also noted that these gains continued beyond the time that students attended the smaller-sized classes. The data indicated a long-term benefit for students' achievement, showing continued gains for these students throughout and beyond high school. The benefits noted were almost identical to those indicated by the original STAR Project. These benefits included additional growth of about a year in all subjects for students in smaller-sized Grades K-3 classes when compared to students in regular-size classes. Students in small-size classes also displayed significantly lower retention rates, higher graduation rates, and higher honor diploma percentages. Additionally, students who attended small-size classes in early grades demonstrated a significant reduction in the gap shown on college admissions tests between White and minority students. In contrast, regular-size classes with aides, which reduced pupil-teacher ratios but not class size, did not show an increase in students' achievement levels. The data showed a particular ineffectiveness for minority male students, which might explain some of the inconsistencies in the Prime Time outcomes after aides were allowed as a small class alternative.

More recently, data from tax records from the Internal Revenue Service was used to investigate long-term effects of small-size classes for subjects who participated in the STAR Project. At age 20, subjects assigned to small classes in the beginning of their elementary school years were about two percentage points more likely to be enrolled in college than their peers who were assigned to regular-size classes (Chingos & Whitehurst, 2011). No significant difference was found in STAR participants' income levels at age 27, but the effects were measured with too large an imprecision to conclude evidence one way or the other. More positive evidences were observed when studying international effects of class size reduction.

Angrist and Lavy (1999) used data to conduct a natural experiment from Israel, where class sizes were limited to 40 students. When a grade level reached 41 students, a second teacher and classroom was added, causing class sizes to sometimes be dramatically different from school to school and/or grade level to grade level. For example, if the fourth grade class had 40 students enrolled, there was one teacher with 40 students, but if the fourth grade class had 41 students, they had two teachers with 20 and 21 students in their classes, by law. Angrist and Lavy's research indicated positive effects on achievement for those students in fourth and fifth grade who attended smaller-sized classes compared to their peers in regular-size classes. Although results were positive, they were on the low end of those found in the STAR study. Some of this difference, however, could be attributed to the natural result of the difference in regular-class size numbers. In the United States, typically classes are limited to 30 students, after which an additional teacher is hired. This enrollment cap, however, depends on the subject taught and the grade level discussed.

Definitions of Class Size

As can be expected, the definition of what constitutes a small class versus a regular-class size varies widely. Achilles (2003a) defined a small-class size as having 15-17 students, and Finn (2002) characterized a small-class size as having a minimum of 13 students. Similarly, Krieger (2003) defined small-size classes as having fewer than 18 students. In addition, Hood (2003) categorized class size in most class size reduction programs between 13 and 20 students, with the typical range as lying between 15 and 18 students. It is also worth noting that, in the original Tennessee STAR Project, a small-class size was defined as ranging between 13 to 17 students, which seemed to align with the parameters established in the literature. Correspondingly, Achilles (2003a) defined regular-class size as having 22-25 students, and Finn (2002) characterized regular-size classes as having at least 22 but less than 26 students. Krieger (2003) defined regular-size classes as having 25 or more students. Again, the original Tennessee STAR Project defined regular-class size as a range of 22-26 students.

Furthermore, Achilles et al. (1998) defined class size as the number of students in a class for whom a teacher is responsible on a daily basis. They alternatively defined pupil-teacher ratio as the number of students at a site divided by the number of professional educators at that site. Achilles (2012) argued that class size and pupil-teacher ratio are not the same, and thus, pupil-teacher ratio data could not be used to compare actual class size data. On average, Achilles calculated the difference between these two to be about 10 students for an elementary school in the United States. According to Achilles, research between 1980 and 2012 indicated that the terms class size and pupil-teacher ratio have been used interchangeably yet are two distinctly different concepts that can potentially produce different empirical outcomes. Hanushek (1999a) reasoned that reduced class sizes have not produced a significant gain in student achievement; however, he then refers to a reduction in pupil-teacher ratios in the United States. He reports a lack of improvement in our international achievement results as proof; however, his argument contends that over the past 45 years (from 1950 to 1995), the United States reduced pupil-teacher ratios by 35% (from 27:1 to 17:1), yet student performance did not show a significant gain. Achilles (2012) and Hood (2003) both specifically agreed that analyses of pupil-teacher ratio data revealed little effect on student achievement; whereas they contend, analyses of class size data indicated considerable positive effects on both short and long-term student outcomes.

Funding Class Size Reduction

Achilles (1999) faulted critics who claimed that, although effective, the implementation of reducing class sizes would be far too costly to school systems nationwide. He vied that research had not concluded small classes to be harmful or large classes to be better; therefore, educators and policy makers should be influenced to move toward the implementation of smaller-class sizes. In responding to the funding debate, Achilles (2012) presented his analysis of the cost of reducing class sizes.

> [F]rom a societal perspective (incorporating earnings and health outcomes,) class size reductions would generate a net cost savings of approximately $168,000 and a net gain of 1.7 quality-adjusted life years for each high school graduate produced by small classes; [and] when targeted to low-income students, the estimated savings would increase to $196,000 per additional graduate. (p. 3)

From his analysis, Achilles proposed that class size reduction would actually provide savings over time for school districts.

Over the past 20 years, state expenditures in American Public K-12 education rapidly increased as initiatives on class size reduction succeeded. Chingos and Whitehurst (2011) indicated that the cost of educating a student increased 58% during that time. This also resulted in lowering the average pupil-teacher ratio in American public schools to 15.3 students in 2011, a 21% decrease over the past 20 years. Because the average teacher salary was about $55,000 in 2011 in the United States, the cost of educating each student at that time calculated to about $3,600 in teacher salary alone. With about 49.3 million public school students in the United States in 2011, Chingos and Whitehurst argued that changing the average class size by one student would have resulted in about a $12 billion a year increase. Of course, teacher salaries are just one cost of class size reductions; there would be structural costs, as well. For example, reducing the average class size by one student in the United States would translate into a need of more than 225,000 classroom additions across America.

In an attempt to summarize the research, Achilles (1999) stated that most researchers agree that “appropriate-sized classes in K-3 offer quality (higher achievement), equality (all participants get the same), and equity (minority and hard-to-teach youngsters benefit more)” (p. 7). Because research demonstrated its effectiveness, Achilles challenged school districts to focus on *how* to reduce class sizes in grades K-3 not become fixed on *if* they should reduce class sizes.

Legislative Decisions Regarding Class Size

In K-12 American public education, class size is subject to legislative action. Chingos and Whitehurst (2011) noted the somewhat sensitive nature of this fact, given that class size is thought by many to have a significant impact on student achievement. Undeniably, legislators and education advocates generally rely on evidence from research to support their legislative beliefs (Chingos & Whitehurst, 2011). The concern then stems from the necessity for the research to be of high quality and relevant to the prospective action, as well as challenged by opposing viewpoints from other research so that conflicting ideas are also studied and considered. Low quality or weak evidence provides little, if any, support for conclusions. Nevertheless, even high quality research can have little or no relevance to the action being sought, and opposing viewpoints must still be considered.

Unfortunately, advocates for legislative positions might choose to ignore opposing research that raises questions regarding the position they favor. At other times, advocates might emphasize the flaws in contradictory research to raise validity concerns of the opposing viewpoint. According to Chingos and Whitehurst (2011), class size reduction advocates, on both sides of the argument, accuse the other side of either ignoring the opposing views or emphasizing only the flaws in the contradictory research when policymakers begin looking at prospective legislation on the topic. In an ideal world, all those involved should consider the best use of public funding for education before legislating educational variables. Therefore, Chingos and Whitehurst contended that the responsible perspective for stakeholders, especially because current funds are not only limited but also shrinking, should be on extensive research of potential legislation before expenditures are given support.

Although the majority of legislative mandates on class size deal with maximum levels, at least 24 states have taken legislative actions to reduce class sizes in recent years (Chingos & Whitehurst, 2011). This has proven to be costly to many state and district budgets. According to Chingos and Whitehurst (2011), changing the pupil-teacher ratio by one student changes the budget by $12 billion in annual teacher salaries alone. This amount would fund the total expense for the federal Title I program (the largest in education) for Grades K-12 across the United States. This cost is justified by those who believe that small classes positively influence student learning and achievement. With limited school finances, Johnson (2002) suggested that class size reduction is too expensive and there may be more cost-efficient ways to improve student achievement. Hanushek (1999a) advocated spending monies on things like tutoring, raising teacher salaries to recruit more qualified applicants, implementing salary incentives for increasing student performances, and other such individualized reforms might prove more effective in increasing student achievment. Hanushek (2002) ultimately contends that teacher quality is more important than class size in increasing student achievement. Chingos and Whitehurst (2011) further advised that the focus of funding any educational policy should become not only whether it has any positive effects at all, but whether or not it is the “most productive use of educational dollars” (p. 1). They continued by suggesting that alternate educational mandates could be funded by tax dollars but need to be studied and compared to class size reduction benefits. They noted that, even though there is no specific research that compares class size reduction directly to alternate investments in the United States, one analysis of a variety of educational interventions provided evidence to support Hanushek’s (1999a) conclusion that class size reduction was the least cost effective of all of the potential investments compared.

No matter what is discovered by specific comparisons of educational interventions, Chingos and Whitehurst (2011) acknowledged that it might be difficult to increase class sizes due to mandates regarding maximum class sizes, as well as the public’s favorable perception regarding class size reductions. They recognized that this might even hold true if decreased budgets lead to a necessary reduction of select educational interventions in order to sustain certain other educational investments that are believed by some to have outcomes that are more positive on student achievement. For this reason, Chingos and Whitehurst concluded that it is necessary for state policymakers to begin considering targeting certain populations of students who are shown to benefit most from class size reductions; these populations include disadvantaged students in elementary school. Another conclusion was to allow school leaders to determine how to distribute a finite dollar amount earmarked for class size reduction funding for targeted school districts.

When determining if an increase in class size is a credible way to reduce educational expenses, policy makers would first want and need to understand the impacts of passing such legislation. In fact, Huss (2010) warned that “legislators must not adopt policies blindly or implement initiatives half-heartedly” (p 118), if they expect to obtain the same outcomes indicated by the research studied. Therefore, while legislation increasing class sizes might be a potential way to lower educational expenses in states where maximum class size mandates are not as strict, legislators would want to research the full implications of such policies. Some research suggests there is a true possibility of causing negative effects on student achievement by simply increasing class sizes and that it could be more detrimental to student achievement depending on how implementation of class size increases are performed (Chingos & Whitehurst, 2011). These statements must be dealt with accordingly. For example, the United States would realize about a 7% reduction in the teaching workforce simply by increasing the pupil-teacher ratio by one student (Chingos & Whitehurst, 2011). If the teaching workforce were reduced by 7% through a method based on criteria not related to a teacher's effectiveness in the classroom, such as seniority-based reductions in force, class size increases might lead to a more detrimental effect on student achievement. If a reduction in force were chosen by using a method directly related to teachers' effectiveness in the classroom, class size increases might not be as detrimental on student achievement due to increased teacher quality of those remaining in the classroom.

Educational resources should be allocated in the most efficient way possible due to the scarcity of today's resources. Critics against class size reductions contend that reducing class sizes might not be the best use of educational funds because of the mixed results of some of the research (Hanushek, 1999a; Johnson, 2002). Chingos and Whitehurst (2011) reported that reductions in class sizes "are expensive [and have] been shown to work for some students in some grades in some states and countries, but its impact has been found to be mixed or not discernable in other settings and circumstances that seem similar" (p. 2). Therefore, they suggested that the alternatives to class size reduction mandates be carefully studied against each other to determine which mandates should be chosen as the most cost effective and beneficial to students. At the local level, citizens in the state of Arkansas became especially cognizant of class size reduction research from the findings of a 2002 adequacy study conducted by court order.

Class Size and Arkansas' School Funding Formula

On November 21, 2002, the Arkansas Supreme Court echoed an earlier ruling of the Chancery Court (*Lake View v. Huckabee*) by affirming the state funding system for education to be unconstitutional (Odden, Picus, & Fermanich, 2003). The Supreme Court upheld the lower court's finding that the Arkansas school finance system was inequitable; inadequate; and failed to "maintain a general, suitable and efficient system of free public schools" (Odden et al., 2003, p. 1). In order to determine a solution to this problem, the court ordered the state of Arkansas to conduct a school finance study on adequacy, noting previous court rulings of this nature in 1994 and in 2001. The Arkansas state Legislature's Joint Committee on Educational Adequacy contracted with Picus and Associates to help conduct the adequacy study. After four months of work with the Arkansas state Legislature, the final report on adequacy, presented by Picus and Associates, contained the definition of an adequate education, as well as its cost for the state of Arkansas.

The final report on adequacy established many inquiry conclusions derived by Picus and Associates and included their detailed recommendation for the state of Arkansas (Odden et al., 2003). Within this detailed recommendation, endorsements for smaller-class sizes were acknowledged. Picus and Associates noted that small classes in Grades K-3, consisting of 15 students in each class, have significant, positive impacts on student achievement in the areas of mathematics and reading (Odden et al., 2003). Particular to their investigation, they referred to a study by Glass and Smith (1979) establishing that, in order to realize an impact on student achievement through class size reduction, it was imperative that class sizes be reduced to 15 students or less. In addition to an overall increase in student achievement, research had shown that small-class size in Grades K-3 resulted in an increasingly positive impact on achievement for students from low-income and minority backgrounds (Finn & Achilles, 1999; Krueger & Whitmore, 2001). Therefore, Picus and Associates concluded that class sizes for Grades K-3 should be limited to 15 students (Odden et al., 2003). They agreed that it could be argued that implementation of this policy could be limited only to schools that primarily served lower income and minority students, but they contended that recent research suggested that all students benefit substantially from small-class sizes and cited studies such as Nye, Hedges, and Konstantopoulous (2002).

Although limiting small-class sizes to only a select group of students might seem illogical, Picus and Associates also recognized that different results have been shown regarding class size, and that not all research has concluded that students benefit from small-class size. For example, Odden (1990) reworked the data provided by the 1979 study of Glass and Smith and concluded that the increase in student achievement was non-existent in class sizes of 14-17 students until individual tutoring was provided. Chingos and Whitehurst (2011) suggested that the large percentage of class size reduction (about 32%) in the STAR Project only increased students' achievement for about three additional months of school in 4 years. Chingos and Whitehurst also noted, "[O]ther rigorous studies [had] found mixed effects in California and in other countries, and no effects in Florida and Connecticut" (p. 1). Additionally, Hanushek (2002) questioned the benefits of small-class size, denied the existence of class size reduction gains, and dismissed the studies conducted throughout the late 1980s and early 1990s when new evidence of the positive effects of class size on student achievement was provided. The new qualification of research was on randomized experiments, which determined the impact of a certain treatment based on scientific evidence (Mosteller, 1995). The Tennessee STAR Project came out of this era and is still the primary evidence of the impact of small classes.

Even though the Tennessee STAR data indicated no significant positive impact on student achievement for a regular class of 24-25 students with an aide, it was understood that this was a reduction in pupil-teacher ratio and not in class size. Based on these findings, many justified their proposals to eliminate instructional aides in elementary classrooms (Gerber, Finn, Achilles, & Boyd-Zaharias, 2001). However, it did not necessarily eliminate the foundational idea that small-class size improved student achievement. Although Hanushek (2002) suggested that the positive impact of class size on student achievement was only produced in the Kindergarten year. Yet, further investigations on the data from the Tennessee STAR Project revealed that the positive impacts of small classes carried on into middle and high school and beyond (Finn, Gerber, Achilles, & Zaharias, 2001; Krueger, 2002a; Lawrence & Rothstein, 2002; Nye, Hedges, & Konstantopulos, 2001a, 2001b; Hood, 2003). Consequently, although Picus and Associates recognized the debate over the impact of class size, they accepted the conclusion that class size does indeed have a positive impact on student achievement (Odden et al., 2003). Furthermore, based on the implications of the data, they argued that the benefits of smaller-class sizes are attributed only to class sizes of 15 students or less for Grades K-3, which agreed with the research of Achilles (1999), Finn (2002), Grissmer

(1999), and Krueger (2002a). Similarly, data from Project Prime Time in Indiana indicated benefits from class sizes of 15 students in Grades K-3 (Chase, Mueller, & Walden, 1986). Picus and Associates further noted that class sizes in other grades should be no larger than the national average of about 25 students (Odden et al., 2003). They concluded that the majority of comprehensive school reform models base their findings on this class size and referenced Odden (1997), Odden and Picus (2000), and Stringfield, Ross, and Smith (1996).

The committee for the adequacy study completed by Picus and Associates recommended staffing resources to maintain 1 teacher for every 15 students in Grades K-3; 1 teacher for every 25 students in Grades 4-8; and 1 teacher for every 25 students in Grades 9-12, with no teacher exceeding a workload of 150 students each semester (Odden et al., 2003). This would mean that an elementary school housing 500 students for Grades K-5 should employ about 22 teachers for Grades K-3, and 6-7 teachers for Grades 4-5. A middle or high school housing 500 students should employ about 20 content area teachers. Current Arkansas standards resulted from the Picus and Associates report (Odden et al., 2003). Current Arkansas standards in 2003 required Kindergarten classes to include no more than 20 students (Arkansas Department of Education, 2003). In addition, the average number of students allowed in first through third-grade classes was set at 25 students, and districts were required to maintain an average pupil-teacher ratio of no more than 23:1. Grades 4-6 were allowed no more than 28 students in any actual class, and districts were required to maintain the average pupil-teacher ratio of no more than 25:1. For grades 7-12, current Arkansas standards for 2003 limited individual classes to no more than 30 students in any single class, and districts were required to maintain a teacher's complete workload to no more than 150 students per semester.

Clarifying Definition

Some research has been criticized for confusing pupil-teacher ratio with class size (Biddle & Berliner, 2002). Achilles (2003b) noted that class size and pupil-teacher ratios have been used imprecisely but are different and should not be confused. He continued by suggesting that, although these terms have been used as synonyms, research done in this manner has been extensively criticized. Similarly, Achilles noted that most class size research in the United States was done at the elementary level; therefore, by nature, the definition of small-class size indicated that students would attend a small class for the majority of the school day, if not all. In fact, Achilles (2012) clarified that the STAR experiment was maintained over the course of the "entire school day every day of the school year, for up to four consecutive years" (p. 1). He continued that the learning setting was directly affected, "influencing all student-teacher interactions taking place in that setting" (p. 1). It is important again to note that Chingos and Whitehurst (2011) described the STAR Project as "the most influential and credible study of class size reduction" (p. 1). In contrast, in secondary schools, this would not necessarily be the case. Robinson (1990) stated that only a few studies have been done for secondary Grades 9-12 and that those studies are "seriously limited in quality" (p. 80). Therefore, Robinson concluded that, although studies in secondary Grades 9-12 have not been able to show that small classes have a positive effect on student achievement, they have been severely limited and flawed. Again, Chingos and Whitehurst (2011) indicated that there were only a few credible studies regarding class size reduction, and that those studies differ greatly by “setting, method, grade [levels], and magnitude of class size variation” (p. 1), leading to ambiguous conclusions.

In an attempt to avoid “crude classifications of class sizes,” termed by Glass and Smith (1979, p. 2), a definition of class size setting was established. The term *class size setting* was chosen to operationalize the unique situation in this study where the small and regular class configurations were not maintained throughout the school day. Although this distinction might appear minor, it was important in light of earlier misuses of class size when really pupil-teacher ratio was implied. Small-class sizes that result from reductions limited to a particular setting (class size setting) should therefore not be confused with small-class sizes that are maintained throughout the school day.

CHAPTER III

METHODOLOGY

Potential benefits of small-class size have been researched extensively. Some of these investigations have suggested positive effects of class size reduction. The Tennessee STAR data analyses conducted by Hood (2003) and Achilles (2012) both concluded that small classes led to positive effects on student behavior and achievement. Data from several studies have also indicated the potential of small classes in helping to reduce the achievement gap because a greater benefit has been seen for poor, minority, and male students. For example, Krueger (1999) and Hood (2003) both indicated greater achievement gains among poor, minority, and male students. Additionally, data from the SAGE project, (a Wisconsin class size reduction initiative begun in 1996), found higher gains and greater benefits to poor, minority, and at-risk students when compared to other students (Graue & Rauscher, 2009). Wenglinksy (1997) described fourth-grade SAGE participants from smaller-sized classes as exhibiting academic achievement levels at about a half a year ahead of peers in regular-size classes and indicated the greatest benefit was to poor students in high-cost areas.

However, a large-scale, voluntary class size reduction initiative in 1996 conducted in California was reported by Achilles (2003a) as having produced only modest overall student gains that did not indicate higher gains for minority students, as was found in other class size studies. Nevertheless, Achilles (2003b) also noted this study included participation incentives for teachers in Grades 1-3, which inevitably caused unanticipated consequences such as a large-scale movement of certified teachers from poor and urban districts. Many times this movement of teachers resulted in replacement teachers who were either not certified or who were merely certified under emergency criteria and circumstances. This caused Achilles (2003a) to question the effect of teacher mobility on this study.

In Texas in the mid-1990s, Rivkin et al. (2005) used a natural experiment and statistical modeling to investigate the effects of class size. They studied longitudinal data from more than 500,000 students in over 3,000 schools. From state assessment data, which only existed for Grades 4 and up, results revealed positive effects in reading and mathematics for the smaller-class size fourth-grade group. The smaller-class size fifth-grade group also indicated positive effects for reading and mathematics, but no significant effects existed for the later grades. Rivkin et al. estimated effects from this study amounted to about half of what was shown in the Tennessee STAR Project results.

The purpose of the current study was to determine the impact of small versus regular-class size setting by gender on Algebra I achievement as measured by the Arkansas End of Course Exam for Algebra I students. It was also the purpose of this study to determine the impact of small versus regular-class size by socioeconomic status on Algebra I achievement as measured by the Arkansas End of Course Exam for Algebra I students in five rural schools in Arkansas. Finally, this study aimed at determining the impact of small versus regular-class size by school configuration on Algebra I achievement as measured by the Arkansas End of Course Exam for Algebra I students in five rural schools in Arkansas. To address these purposes, the following null hypotheses were generated.

H_{o1}**:** There will be no difference by gender in Algebra I achievement as measured by the Arkansas End of Course Examination for Algebra 1 for ninth-grade students in small class settings versus ninth-grade students in regular class settings at rural schools in Arkansas.

H_{o2}: There will be no difference by socioeconomic status in Algebra I achievement as measured by the Arkansas End of Course Examination for Algebra 1 for ninth-grade students in small class settings versus ninth-grade students in regular class settings at rural schools in Arkansas.

H_{o3}: There will be no difference by school type in Algebra I achievement as measured by the Arkansas End of Course Examination for Algebra 1 for ninth-grade students in small class settings versus ninth-grade students in regular class settings at rural schools in Arkansas.

Achilles (2003a) defined a small-class size as having 15-17 students, and Krieger (2003) defined small-size classes as having fewer than 18 students. Finn (2002) characterized a small-class size as having a minimum of 13 students, and Hood (2003) categorized class size in most class size reduction programs between 13 and 20 students, with the typical range being 15-18 students. For the original Tennessee STAR Project, a small-class size was defined as 13-17 students, which aligned with the literature.

Correspondingly, Achilles (2003a) defined regular-class size as having 22-25 students, and Krieger (2003) defined regular-size classes as having at least 25 students. Finn (2002) characterized regular-size classes as having 22-26 students. Again, the original Tennessee STAR Project defined regular-class size as including 22-26 students. Furthermore, Achilles et al. (1998) defined class size as the number of students in a class for whom a teacher is responsible on a daily basis, not to be confused with pupil-teacher ratio. Additionally, in an attempt to avoid less than adequate class size classifications, a definition of *class size setting* was established. Class size setting was the term chosen to address the upper grade level situation in this study where the small and regular-class sizes are not maintained throughout the school day. This distinction was determined to be important in light of earlier confusion between class size and pupil-teacher ratio. Therefore, small-size classes that result from a reduction in a particular setting (class size setting) should not be confused with small-class sizes that are maintained throughout the school day.

Research Design

A quantitative, causal-comparative strategy was used in this study. According to Johnson and Christensen (2008), because this study uses "hard quantitative data; [i.e.] standardized test scores" (p. 19), it is quantitative research. Indeed, data used for this study was collected using existing data from students' standardized test scores on the 2013-2014 Arkansas Algebra I End of Course Exam. Furthermore, according to Mills (1872), a causal-comparative approach was considered the most appropriate method because this study used a small number of cases to infer an alleged cause for the calculated effect. Three 2 x 2 factorial ANOVAs were conducted to test the three null hypotheses. The independent variables for the three statements of the problem were class size and gender, class size and socioeconomic status, and class size and school type, respectively. The dependent variable for all three hypotheses was student Algebra I achievement as measured by the Arkansas Algebra I End of Course Exam for first-year, ninth-grade students in a 1-year, non-advanced placement Algebra I program.

Sample

At least two intact Algebra I classrooms in each of four rural schools in Arkansas were identified to take part in the study. A total of 13 classrooms with a total of 288 students were involved in the study. A 2-stage sampling strategy was used. At the first stage of sampling, a convenience sample of 13 classrooms was drawn. Six of the 13 classrooms consisted of students in small class settings. At the second stage of sampling, a random sample of students from each of the seven regular class settings was drawn to match the number of students drawn at the first stage of sampling. The random sampling from regular-class size setting was proportional to the first stage of sampling by stratifying for gender and school type.

In both samples, the subjects drawn were limited to non-advanced placement, first-year Algebra I students in the ninth grade. Students who were enrolled in Algebra I for any reason other than the first year of participation or who were considered to be in an advanced placement were not included in the study. The actual class sizes for samples ranged from 13 to 17 students per class in the small-class size setting and 18 to 30 students per class in the regular-class size setting.

This study used ninth-grade students in four rural schools in Arkansas. Both male and female students were included in the study. Though all students resided within reasonable daily traveling distances surrounding the geographical region of each of the four rural school district’s boundaries, they came from a range of socioeconomic and racial backgrounds. Furthermore, subjects ranged from 14 to 16 years of age. Table 1 detailed the demographic characteristics of the ninth-grade students sampled in this study.

Table 1

Demographics of Characteristics of Ninth-Grade Students

Ethnicity	Male	% Low SES	G&T	IEP	Female	G&T	IEP	% Low SES	Total Low SES
Black	18	22.2	0	4	22	1	5	22.7	22.5
White	64	56.3	9	5	41	9	6	46.3	52.4
Total	102	94.1	11	9	86	11	11	47.7	72.9

*G&T = Gifted & Talented

Instrumentation

Subjects were given the Algebra I End of Course Exam in the state of Arkansas. The Algebra I End of Course Exam has been determined to be valid and reliable by the state of Arkansas for several reasons (Arkansas Department of Education, 2003; 2015). First, the Arkansas Content Standards for Algebra I are used to construct the End of Course Exam. Moreover, proven test construction practices are used by independent contractors in assessment design, scoring, scaling, and reporting. Furthermore, the technical advisory committee who observes and advises the overseeing of test construction practices is comprised of a group of independent experts who have been trained in assessment and psychometrics.

The Arkansas Algebra I End of Course Exam contains 30 multiple-choice items, worth 50% of the test points (Arkansas Department of Education, 2015). The other 50%

of the test points are determined from three open-response items. Based on scores, students are identified as Below Basic, Basic, Proficient, or Advanced. Passing the Arkansas Algebra I End of Course Exam indicates that a student has been identified as Proficient or Advanced. Raw and scale scores equivalent to these identifications are determined each year. According to the Arkansas State Department (2014), scale scores are calculated using raw scores. Each year, raw scores are used to calculate equivalent scale scores, although a scale score may be the same for more than one raw score depending on the distribution of the results. Scale scores are used in the American College Testing and Scholastic Assessment Test examinations, as well as many other national testing programs. Scale scores are used to provide "the basis for long-term, meaningful comparisons of student results across different test administrations" (Arkansas Department of Education, 2014, p 1).

A class average/mean by gender, socioeconomic status, and school configuration was calculated using scale scores for the class in which students were enrolled: small or regular size class setting (enrolled 2013-2014). Data were collected for each school in the same academic year (i.e., 2013-2014).

Data Collection Procedures

Permission to collect and use the data in this study was given by the Institutional Review Board on March 21, 2016. After this permission was granted, the superintendents of the school districts participating in the study gave permission for their schools' data to be collected and submitted. A certified faculty member from each school was designated by each superintendent to collect and return the data after redacting student names and identification numbers. Data were submitted using a variety of methods, such as facsimile, electronic mail, stamped mail, and telephone for follow up questions.

Using a 2-stage sampling technique, samples were taken in two phases. At the first stage of sampling, a convenience sample of 13 classrooms was drawn. Six of the 13 classrooms consisted of students in small-class size settings. At the second stage of sampling, all students in a small class setting were included in the study, and a random sample of students from each of the seven regular class settings was drawn to match the number of students drawn at the first stage of sampling. The random sampling from regular-class size setting was proportional to the first stage of sampling by stratifying for gender and school type. At the second stage of sampling, in order to keep the percentages of males to females and school type statistics the same as those in the small class setting, the students were divided and drawn at random. The students were divided into four groups of male and female participants from both types of school configuration, high school and junior high school types. An equal number of high school females and junior high school females were drawn to match the small-class size setting sample for each school. The same was done for males.

This means that the same number of females enrolled in high school and females enrolled in junior high were randomly chosen from the regular-class size setting to match the first stage of sampling from small-class size setting. Additionally, the same number of males enrolled in high school and males enrolled in junior high were randomly chosen from the regular-class size setting to match the first stage of sampling from small-class size setting.

Analytical Methods

To test the three null hypotheses, three 2 x 2 factorial ANOVAs were conducted. According to Morgan, Leech, Gloeckner, & Barrett (2011), a factorial ANOVA is the best test for significance involving more than one independent variable. The three hypotheses used class size setting and gender, class size setting and socioeconomic status, and class size setting and school configuration as the independent variables, respectively. Algebra I achievement was measured using scale scores on the Arkansas End of Course Exam for Algebra I and served as the dependent variable for all three hypotheses. As is common in educational and sociological studies, an alpha level of .05 was set for the two-tailed test of each null hypothesis. A Bonferroni correction was also used because multiple comparisons were being employed (.05/3 = .017).

Limitations

The limitations noted in this study include time, the ever changing Arkansas Frameworks, and the fact that this research was conducted using a nonexperimental strategy. Additionally, the availability of schools to participate who qualified according to the research variable of small-class size setting further limited the size of the sample in the study. This led to further limitations of the diversity of the populations of students who were assigned to Algebra I classes of a particular size. The limitation of which schools qualified to participate in the study according to the research variable of small-class size setting also led to the limitation of differences within the school systems being studied.

Time was a limitation in part because the Algebra I End of Course Exam is no longer used in Arkansas as an assessment tool. Furthermore, Arkansas Framework changes were also a limitation because the Arkansas Content Standards for Grades K-8 have undergone significant revisions in the last several years and are projected to continue being reviewed for the foreseeable future. It should be noted that, although the Algebra I content frameworks have not been altered, the K-8 mathematics frameworks have been through a succession of changes, which provide the foundation for Algebra I. This makes it more difficult to attribute students' mean scale scores to the variable of class size and not background knowledge, the major determining factor for using 2013-2014 test data.

Another unavoidable limitation existed due to the nonexperimental strategy used in this study. A nonexperimental strategy was the only opportunity to carry out this study; however, this led to only being able to study classes already in existence. The availability of schools who qualified to participate in the study according to the research variable of small-class size setting was limited in itself. This is due to the fact that many schools did not have small-class size settings on their campuses. Moreover, schools that did have small-class size settings varied, as well as the reasons for their smaller-class sizes. The way students were assigned to the classes scheduled in a small-class size setting led to further difficulty in attributing students' mean scale scores to the variable of class size and not background knowledge.

As previously noted, since the sampling strategy used forced a limitation only to schools who had both class size settings on their campuses, small and regular size settings, differences between schools could not be controlled for, nor could differences in student demographic characteristics. Furthermore, not only was the scheduling of small-class size setting not controlled for, but it was often times created due to scheduling issues or background characteristics of students.

For example, one superintendent who agreed to participate in the study chose to implement small-class size settings for the Algebra I classes on his campus only for students who were classified as English Language Learners or who qualified for Special Education. Other superintendents who agreed to participate in the study did not necessarily choose to implement small-class size settings for the Algebra I classes on their campuses. Some of the classes simply ended up being small based on the master schedule and availability of classes/teachers in the school system. For example, more or less students may be forced into a particular class period of Algebra I due to their enrollment in an art class. Those not participating in art would then be the ones scheduled in another class period of Algebra I.

Course electives, especially in smaller schools, generally cause some classes to be larger or smaller depending on the master schedule. For example, if an Algebra I class is only offered during the same period as the only Art I class, it might naturally be smaller because the only students available to take that class that period are students who are not enrolled in art. These factors also contributed to the variability of schools participating in the study, the number of classes offered on a campus, and the number of participants in the study.

CHAPTER IV

RESULTS

To test the null hypotheses associated with the purpose statements in this study, three between-group factorial ANOVAs were conducted, one for each of the three null hypotheses. Data for each analysis were obtained from existing school records gathered from four schools in Arkansas. The dependent variable for each of the analyses was Algebra I achievement; the independent variables included class size setting, gender, socioeconomic status, and school type.

Hypothesis 1

Hypothesis 1 stated that there will be no difference by gender in Algebra I achievement as measured by the Arkansas End of Course Examination for Algebra 1 for ninth-grade students in small class settings versus ninth-grade students in regular class settings at rural schools in Arkansas. Data were screened for data entry errors and missing values. No cases of data entry errors or missing values were found. The Kolmogorov-Smirnov (KS) statistics and histograms were used to test the assumption of normality. An examination of the statistics and histogram for each group confirmed a normal distribution. Results from the KS tests revealed no violation for the mathematics performance distribution of small-class size setting for females, $D(43) = 0.09$, $p = .200$; regular-class size setting for females, $D(43) = 0.12$, $p = .128$; small-class size setting for males, $D(51) = 0.08$, $p = .200$; and for regular-class size setting for males, $D(51) = 0.10$,

p = .200. Table 2 presents a summary of the group means and standard deviations for this analysis.

Table 2

Descriptive Statistics for Algebra I Scale Scores by Class Size Setting and Gender

	Ninth-Grade							
Gender	Female			Male			Total	
Class Setting	*N*	*M*	*SD*	*N*	*M*	*SD*	*M*	*SD*
Small	43	188.16	47.48	51	190.47	40.55	189.41	43.63
Regular	43	214.79	38.34	51	195.67	37.30	204.41	38.77
Total	86	201.48	44.94	102	193.07	38.85	196.91	41.84

Finally, to test the assumption of equality of variances, Levene's test was conducted within ANOVA and indicated that the assumption of variances was not violated. Levene's test was not significant, $F(3, 184) = 1.92$, $p = .128$. Further, examination of the data revealed no significant outliers. Having checked all the assumptions associated with ANOVA, Hypothesis 1 was tested using a 2 x 2 factorial ANOVA to evaluate the effects of small-class size setting and gender on Algebra I achievement as measured by the 2014 Arkansas End of Course Examination for Algebra 1 for the ninth-grade students. Results of this analysis are displayed in Table 3.

Table 3

Factorial ANOVA Results for Algebra I Scale Scores by Class Size Setting and Gender

Source	*SS*	*Df*	*MS*	*F*	*p*	*ES*
Class size setting	11813.81	1	11813.81	7.05	.009	0.04
Gender	3298.67	1	3298.67	1.97	.162	0.01
Class Setting*Gender	5357.96	1	5357.96	3.20	.075	0.02
Error	308195.02	184	1674.97			

These results revealed no significant interaction between class size setting and gender on the Algebra I achievement as measured by the Arkansas End of Course Examination for Algebra 1 for ninth-grade students, $F(1, 184) = 3.20$, $p = .075$, $ES = 0.02$. Given there was no significant interaction between the variables of gender and class size setting, the main effect of each variable was examined separately. The main effect for class size setting was significant with a small effect size, $F(1, 184) = 7.05$, $p = .009$, $ES = 0.04$. The main effect for gender was not significant with a small effect size, $F(1, 184) = 1.97$, $p = .162$, $ES = 0.01$. See Figure 1 for the mean Algebra I achievement scores as measured by the Arkansas End of Course Examination for Algebra 1 for the ninth-grade students.

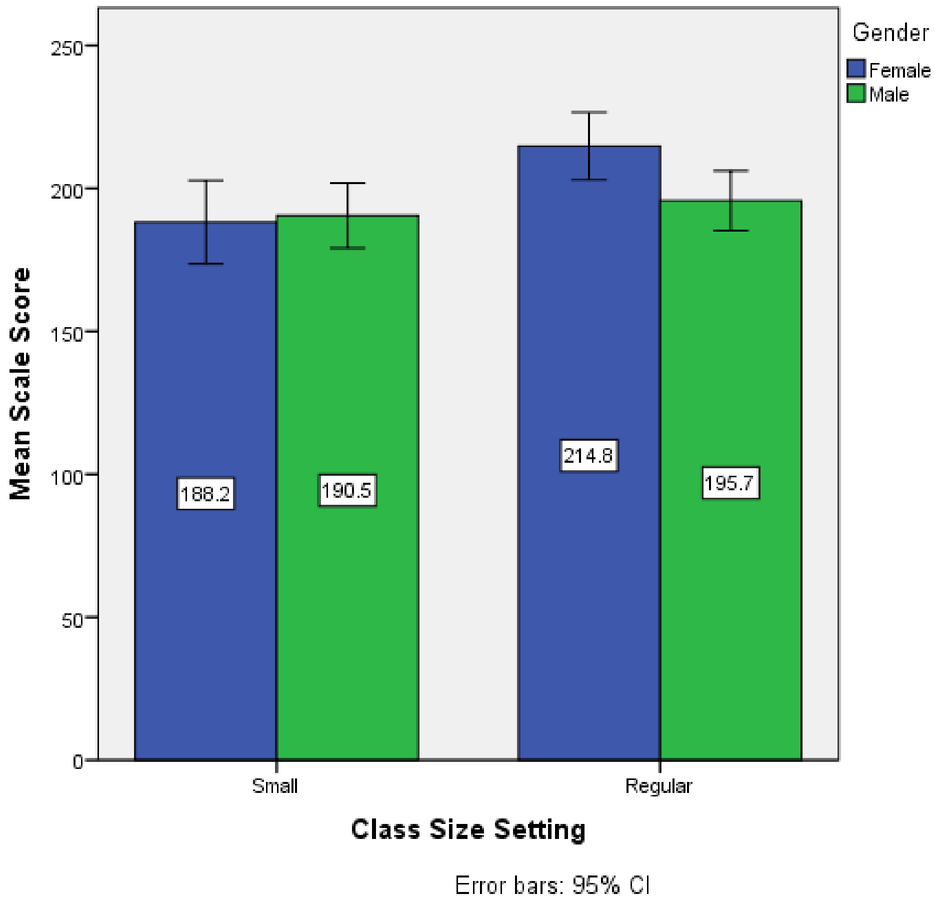

Figure 1. Mean Algebra I scale scores by class size setting and gender.

On the basis of these results, the null hypothesis could not be rejected for the interaction between gender and class size setting. Furthermore, the null hypothesis for the main effects of gender could not be rejected, but the null hypothesis for the main effects of class size setting was rejected. These results suggest that, in the population, males and females perform similarly, regardless of the type of class size setting. However, overall students in small-class size settings and students in regular-class size settings performed differently.

Hypothesis 2

Hypothesis 2 stated that there will be no difference by socioeconomic status in Algebra I achievement as measured by the Arkansas End of Course Examination for Algebra 1 for ninth-grade students in small class settings versus ninth-grade students in regular class settings at rural schools in Arkansas. Before conducting the ANOVA, data were screened for data entry errors and missing values. No cases of data entry errors or missing values were found. Given that the assumption of independence of cases could be assumed from the design of the study, the KS statistics and histograms were used to examine the assumption of normality. An examination of the statistics and histograms for each of the four groups confirmed that this assumption was met. Results from the KS tests revealed no violation of the assumption for the Algebra I achievement distribution in the small-class size setting group for students identified as participating in free and reduced lunch program (low socioeconomic status), $D(75) = 0.06$, $p = .200$; for students in small class settings who were identified as non-participants in the free or reduced lunch program (high socioeconomic status), $D(19) = 0.12$, $p = .200$; for regular-class size setting students identified as low socioeconomic status (participating in the free or reduced lunch program), $D(21) = 0.15$, $p = .200$; and for regular-class size setting for students identified not participating in the free or reduced lunch program, $D(73) = 0.10$, $p = .056$. Table 4 presents a summary of the group means and standard deviations for this analysis.

Table 4

Descriptive Statistics for Algebra I Scale Scores by Class Size Setting and Socioeconomic Status

	Ninth-Grade Algebra I							
Lunch Participation	No			Yes			Total	
Class Setting	*N*	*M*	*SD*	*N*	*M*	*SD*	*M*	*SD*
Small	19	221.53	27.74	75	181.28	43.28	189.41	43.63
Regular	73	206.51	36.00	21	197.14	47.48	204.41	38.77
Total	92	209.61	34.86	96	184.75	44.47	196.91	41.84

Finally, to test the assumption of equality of variances, Levene's test was conducted within ANOVA. The results of this analysis indicated that the assumption of was not violated as Levene's test was not significant, $F(3, 184) = 2.32$, $p = .077$. Having checked all the assumptions associated with ANOVA, Hypothesis 2 was tested using a 2 x 2 factorial ANOVA to evaluate the effects of small-class size setting and socioeconomic status on Algebra I achievement as measured by the 2014 Arkansas End of Course Examination for Algebra 1 for the ninth-grade students. Results of this analysis are displayed in Table 5.

Table 5

Factorial ANOVA Results for Algebra I Scale Scores by Class Size Setting and Socioeconomic Status

Source	*SS*	*Df*	*MS*	*F*	*P*	*ES*
Class size setting	5.59	1	5.59	0.00	.953	0.00
Lunch Program	19336.37	1	19336.37	12.23	.001	0.06
Class Setting*Lunch Program	7492.92	1	7492.92	4.74	.031	0.03
Error	290866.68	184	1580.80			

These results revealed no significant interaction between class size setting and socioeconomic status on the Algebra I achievement as measured by the Arkansas End of Course Examination for Algebra 1 for ninth-grade students $F(1, 184) = 4.74$, $p = .031$, $ES = 0.03$. Further examination of the results revealed that the main effect for class size setting was not significant with a small effect size, $F(1, 184) = 0.00$, $p = .953$, $ES = 0.00$. However, the main effect for socioeconomic status was significant with a small effect size, $F(1, 184) = 12.23$, $p = .001$, $ES = 0.06$.

The contrast results revealed that mean differences between participants in the free and reduced lunch program ($M = 181.28$, $SD = 43.28$) and non-participants in the free or reduced lunch program ($M = 221.51$, $SD = 27.74$) in the small-class size setting were statistically significant $t(184) = 3.94$, $p < .001$. On the contrary, the mean differences between participants in the free and reduced lunch program ($M = 197.14$, $SD = 47.48$) and non-participants in the free or reduced lunch program ($M = 206.51$, $SD = 35.99$) in the regular-class size setting were not statistically significant $t(184) = 0.95$,

p = .343. See Figure 2 for the mean Algebra I achievement scores as measured by the Arkansas End of Course Examination for Algebra 1 for ninth-grade students.

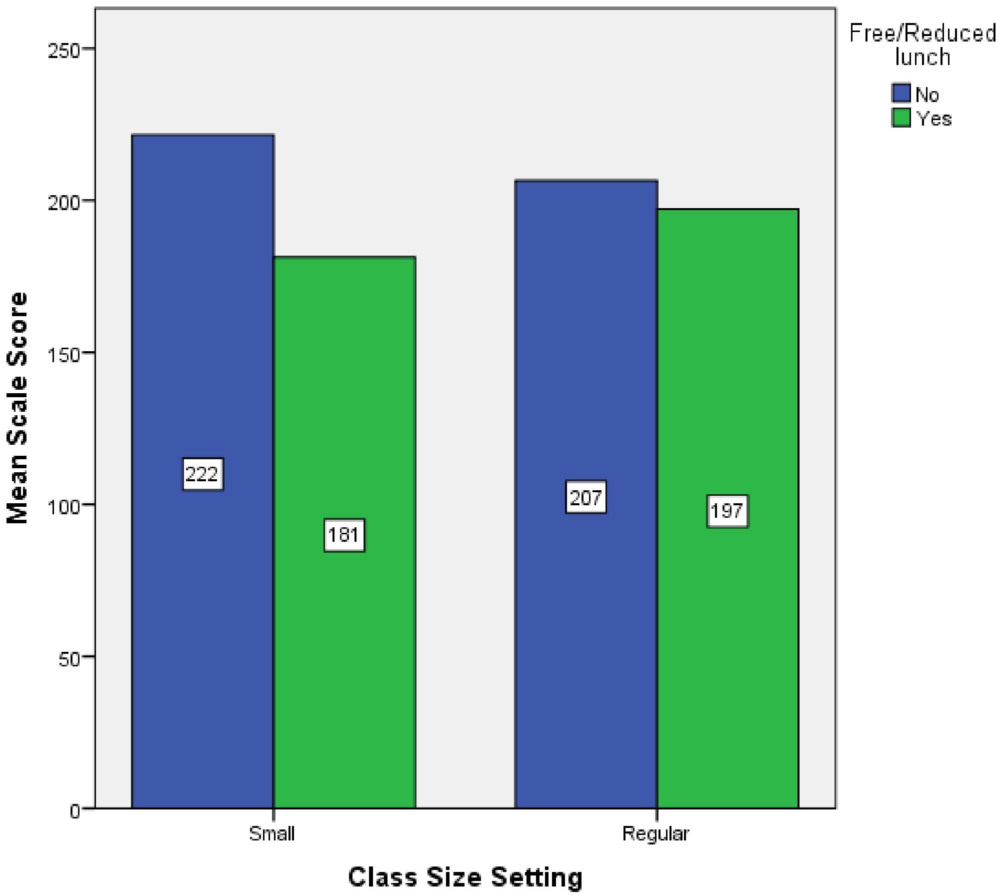

Figure 2. Mean Algebra I Scale Scores by class size setting and socioeconomic status.

On the basis of these results, the null hypothesis could not be rejected for the interaction between socioeconomic status and class size setting. Furthermore, the null hypothesis for the main effects of class size setting could not be rejected, but the null hypothesis for the main effects of socioeconomic status was rejected. These results suggest that in the population, while there is no interaction effect between class size setting and socioeconomic status, overall, students from low socioeconomic status and students not from low socioeconomic status performed differently.

Hypothesis 3

Hypothesis 3 stated that there will be no difference by school type in Algebra I achievement as measured by the Arkansas End of Course Examination for Algebra 1 for ninth-grade students in small class settings versus ninth-grade students in regular class settings at rural schools in Arkansas. Data were screened for data entry errors and missing values. No cases of data entry errors or missing values were found. The KS statistics and histograms were used to test the assumption of normality. An examination of the statistics and histogram for each group confirmed a normal distribution. Results from the KS tests revealed no violation for the mathematics performance distribution of small-class size setting for high school students, $D(61) = 0.08$, $p = .200$; for the regular-class size setting for high school students, $D(61) = 0.14$, $p = .007$; for the small-class size setting for junior high school students, $D(33) = 0.12$, $p = .200$; and for the regular-class size setting for junior high school students, $D(33) = 0.10$, $p = .200$. Table 6 presents a summary of the group means and standard deviations for this analysis.

Table 6

Descriptive Statistics for Algebra I Scale Scores by Class Size Setting and School Configuration

	Ninth-Grade Algebra I							
	High School			Jr. High School			Total	
Class Setting	*N*	*M*	*SD*	*N*	*M*	*SD*	*M*	*SD*
Small	61	182.28	47.03	33	202.61	33.31	189.41	43.63
Regular	61	206.08	33.03	33	201.33	48.04	204.41	38.77
Total	122	194.18	42.20	66	201.97	41.02	196.91	41.84

Finally, to test the assumption of equality of variances, Levene's test was conducted within ANOVA and indicated that the assumption of variances was not violated. Levene's test was not significant, $F(3, 184) = 4.85$, $p = .003$. Further examination of the data revealed no significant outliers. Having checked all the assumptions associated with ANOVA, Hypothesis 3 was tested using a 2 x 2 factorial ANOVA to evaluate the effects of small-class size setting and school type on Algebra I achievement as measured by the 2014 Arkansas End of Course Examination for Algebra I for ninth-grade student participants. Results of this analysis are displayed in Table 7.

Table 7

Factorial ANOVA Results for Algebra I Scale Scores by Class Size Setting and School Configuration

Source	*SS*	*df*	*MS*	*F*	*p*	*ES*
Class Setting	5435.38	1	5435.38	3.25	.073	0.02
School Type	2598.67	1	2598.67	1.56	.214	0.01
Class Setting* School Type	6732.91	1	6732.91	4.03	.046	0.02
Error	307520.07	184	1671.31			

These results revealed no significant interaction between class size setting and school type on the Algebra I achievement as measured by the Arkansas End of Course Examination for Algebra 1 for ninth-grade students $F(1, 184) = 4.03$, $p = .046$, $ES = 0.02$. Given there was no significant interaction between the variables of school type and class size setting, the main effect of each variable was examined separately. The main effect for class size setting was not significant with a small effect size, $F(1, 184) = 3.252$, $p = .073$, $ES = 0.02$. The main effect for school type was also not significant with a small effect size, $F(1, 184) = 1.56$, $p = .214$, $ES = 0.01$. On the basis of these results, the null hypothesis could not be rejected for the interaction between school type and class size setting. Further, neither the null hypothesis for the main effects of school type, nor the main effects of class size setting could be rejected. Figure 3 details the mean Algebra I achievement scores as measured by the Arkansas End of Course Examination for Algebra I for ninth-grade students.

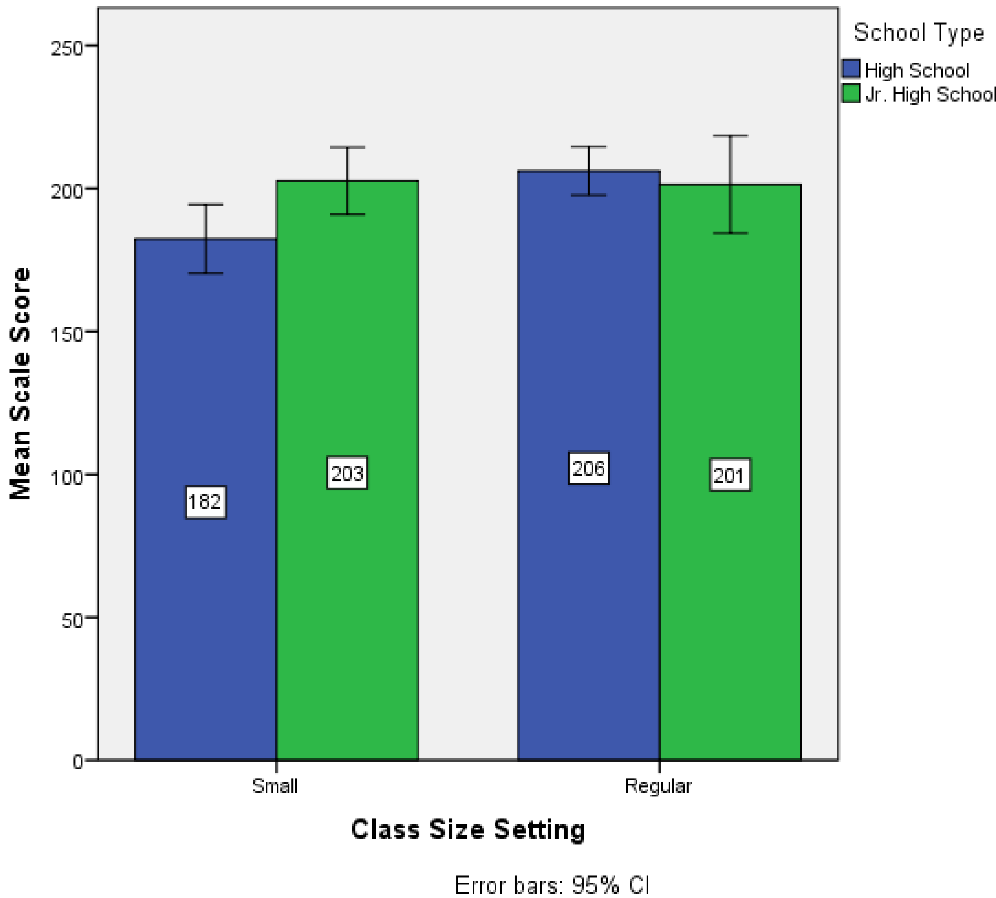

Figure 3. Mean Algebra I Scale Scores by class size setting and school configuration.

On the basis of these results, the null hypothesis could not be rejected for the interaction between school type and class size setting. Furthermore, neither the null hypothesis for the main effects of class size setting nor the null hypothesis for the main effects of school type could be rejected. These results suggested, in the population, high school students and junior high school students perform similarly, regardless of the school type and/or class size setting. Furthermore, students in a small-class size setting and students in a regular-class size setting performed similarly, regardless of school type.

Summary

For Hypothesis 1, test results revealed no significant interaction between class size setting and gender on the Algebra I achievement as measured by the Arkansas End of Course Examination for Algebra 1 for ninth-grade students. Additionally, the main effect for gender was also not significant with a small effect size. However, the main effect for class size setting was significant in Hypothesis 1, with a small effect size. On the basis of these results, the null hypothesis could not be rejected for the interaction between gender and class size setting. Further, the null hypothesis for the main effects of gender could not be rejected, but the null hypothesis for the main effects of class size setting was rejected. These results suggested that within the ninth-grade population, males and females perform similarly regardless of the type of class size setting, but students in a small-class size setting and students in a regular-class size setting performed differently regardless of gender (see Figure 1).

For Hypothesis 2, test results revealed no significant interaction between class size setting and socioeconomic status on the Algebra I achievement as measured by the Arkansas End of Course Examination for Algebra 1 for ninth-grade students. Further examination of the results revealed that the main effect for class size setting was not significant with a small effect size. However, the main effect for socioeconomic status was significant with a small effect size. On the basis of these results, the null hypothesis could not be rejected for the interaction between socioeconomic status and class size setting. Further, the null hypothesis for the main effects of class size setting could not be rejected, but the null hypothesis for the main effects of socioeconomic status was rejected. These results suggested that within the ninth-grade population, students in small-class size setting and students in regular-class size setting perform similarly, regardless of socioeconomic status. However, students from low and not low socioeconomic status performed differently regardless of class size setting (see Figure 2).

For Hypothesis 3, test results revealed no significant interaction between class size setting and school type on the Algebra I achievement as measured by the Arkansas End of Course Examination for Algebra 1 for ninth-grade students. Given there was no significant interaction between the variables of school type and class size setting, the main effect of each variable was examined separately. The main effect for class size setting was not significant with a small effect size. The main effect for school type was also not significant with a small effect size. On the basis of these results, the null hypothesis could not be rejected for the interaction between school type and class size setting. Further, neither the null hypothesis for the main effects of school type nor the main effects of class size setting could be rejected. These results suggested that within the ninth-grade population, high school students and junior high school students perform similarly regardless of the type of school or type of class size setting. Students in a small-class size setting and students in a regular-class size setting performed similarly regardless of school type (see Figure 3).

CHAPTER V

DISCUSSION

Prior to, and especially with the enactment of the No Child Left Behind Act, the effectiveness of class size reduction as a means of improving student performance had been an issue of ongoing debate among educational leaders. A key issue in this debate has been the possibility of teacher shortages that could accompany the implementation of class size reduction. Krueger (2002a) suggested such negative outcomes could be avoided by initially reducing class sizes for student populations that would benefit the most from such an intervention. Furthermore, Achilles (2003a) suggested that smaller size classes could serve as an incentive to attract and keep teachers in the field. These recommendations have led researchers to explore class size reduction in specific settings, suggesting greater benefits from smaller-class sizes for several student populations and class settings. For example, Miller-Whitehead (2003) and Sharp (2003) suggested that students' academic achievement was most affected by class size reductions in Grades K-3. Miller-Whitehead (2003) further proposed that diverse student populations gained the most benefits from reduced class sizes. Similarly, Tomlinson (1990) suggested minority students benefited most from smaller size classes. It was further suggested that enrolling/scheduling specific populations into classes with a reduced number of students might also avoid the dilemma of possibly widening the achievement gap between student groups. Some suggest this could happen if all students were given the advantage of smaller-class sizes.

This study builds upon earlier work which suggested positive effects of small-class size on student achievement (Achilles, 2003b; Krueger, 2002), as well as Chatterji's (2005) suggestion that smaller size classes led to positive impacts specifically related to mathematics achievement. In line with these findings, a major focus of this study was to examine the effectiveness of class size reduction in a subject-specific setting among a population of ninth-grade students. A specific focus of this study was the effects of class size reduction in instructional settings for Algebra I students when considered in light of other student demographic characteristics such as gender, socioeconomic status, and school configuration This chapter will discuss the findings and conclusions of the three overall purposes to this study.

The first purpose of this study was to determine the impact of small versus regular-class size setting by gender on mathematics achievement as measured by the Arkansas End of Course Exam for Algebra I students in four rural schools in Arkansas. Second, this study was used to determine the impact of small versus regular-class size by socioeconomic status on mathematics achievement as measured by the Arkansas End of Course Exam for Algebra I students in four rural schools in Arkansas. Furthermore, this study was used to determine the impact of small versus regular-class size by school configuration on mathematics achievement as measured by the Arkansas End of Course Exam for Algebra I students in four rural schools in Arkansas. After detailing conclusions of this study, each hypothesis will be addressed individually, followed by implications and recommendations. Recommendations will include future research considerations.

Conclusions

To address the purposes of this study, three null hypotheses were developed and tested for statistical significance. A summary of the findings drawn from these analyses are now presented.

Hypothesis 1

This hypothesis stated that there will be no difference by gender in mathematics achievement as measured by the Arkansas End of Course Examination for Algebra I for ninth-grade students in small class settings versus ninth-grade students in regular class settings at rural schools in Arkansas. The results of testing this hypothesis revealed no combined impact of class size setting and gender on the mathematics achievement of ninth-grade students. The results also indicated that in the population, male and female students can be expected to have similar mathematics achievement, regardless of the type of class size setting. However, based on these results, students in a small-class size setting and students in a regular-class size setting in the population can be expected to perform differently.

Hypothesis 2

The second hypothesis in this study stated that there will be no difference by socioeconomic status in mathematics achievement as measured by the Arkansas End of Course Examination for Algebra 1 for ninth-grade students in small class settings versus ninth-grade students in regular class settings at rural schools in Arkansas. Results showed that class size setting and socioeconomic status, were not significantly related in either the small class setting or the regular class setting, showing no interaction between these two factors. Further examination of the results revealed that even when socioeconomic status was ignored, class size setting was not a significant factor in distinguishing students' mathematics performance. This means that in the population, students in small and regular-class size settings could be expected to show similar mathematics performance. These findings regarding the effect of class size setting contradict the findings from the analysis of Hypothesis 1. However, unlike the findings in Hypothesis 1 regarding class size setting and gender, the main effect for socioeconomic status was found to be statistically significant. These results suggested that in the population, students from low socioeconomic status (participation in free and reduced lunch programs) could be expected to perform differently from students who are not from low socioeconomic status (do not participate in free and reduced lunch programs).

Hypothesis 3

Finally, the third hypothesis in this study stated that there will be no difference by school type in mathematics achievement as measured by the Arkansas End of Course Examination for Algebra 1 for ninth-grade students in small class settings versus ninth-grade students in regular class settings at rural schools in Arkansas. The findings here are that class size setting and school type do not interact in affecting the outcome of mathematics achievement. Similarly, neither the main effects of school type, nor the main effects of class size setting were found to have significant independent effects on the outcome. This would suggest relative to the population of students within rural schools in Arkansas, ninth-graders in high school settings and ninth-graders in junior high school settings can be expected to perform similarly. The same can also be inferred for the effect of class size setting on the population of ninth-graders at rural schools in Arkansas.

Table 8

Summary of Findings by Hypotheses

		Effect of Factors		
H_o	Outcome	Interaction Effect	Main Effect 1	Main Effect 2
1	Mathematics Achievement	CSS x Gender	CSS	Gender
2	Mathematics Achievement	CSS x SES	CSS	SES*
3	Mathematics Achievement	CSS x Sch. Configuration	CSS	Sch. Configuration

Note. CSS = Class Size Setting; SES = Socioeconomic status; * = statistically significant finding.

Summary

Overall, these findings suggested that class size setting on its own does not appear to impact the mathematics achievement of ninth-grade students. Although class size setting did show significance in Hypothesis 1, the effect size was small, and no significance was found in either of the other two hypotheses. Furthermore, whatever minimal impact class size setting may have on the mathematics achievement of ninth-grade students, such an impact is not moderated by gender, socioeconomic status, or school type. Similar to these findings, no significant independent effect of either gender or school type on the mathematics achievement of ninth-grade students was revealed in this study. Ultimately, the results of this study identify socioeconomic status as the only factor that explained differences found in mathematics achievement among ninth-grade students. These differences were such that participation in free and reduced lunch programs was an indicator of lower achievement in mathematics when compared to nonparticipation.

The findings in this study with regards to the impact of gender on mathematics achievement are somewhat at odds with those of some earlier studies. For instance, many previous researchers have suggested a clear difference in mathematics achievement based on gender (Kimball, 1989; Spencer et al., 1999; Royer et al., 1999). These findings, however, are more in synchrony with some contemporary findings about the effect of gender on mathematics achievement (Chambers & Schreiber, 2004). It is, therefore, safe to say that these findings may reflect a trend toward closing the achievement gap in regards to gender in certain areas of student achievement such as mathematics.

The convergence of these findings with other areas of the literature is somewhat more ambiguous. For instance, Gregg (2011) presented strong evidence of correlations between students’ academic achievement, school configurations, and school size, regardless of student background. Likewise, although Ramsey (2009) found no relationship between school configuration and student achievement at the elementary level, evidence of such a relationship was reported for the middle school grades. Moreover, Schwerdt and West (2011) indicated that students placed in high school settings at the ninth grade experienced a lesser academic decline than those who first experienced such settings at a later grade level. They further noted that for the ninth-grade students entering high school, such declines were typically a temporary one-time event that improved by the 10th grade.

Although findings regarding students’ mathematics achievement depending on their socioeconomic status vary significantly in the literature, evidence in this study appears to corroborate contemporary findings that socioeconomic status is an important influence of students' mathematics achievement (Zyngier, 2014). Similarly, earlier studies regarding class size suggested a greater benefit of small classes for economically disadvantaged students (Achilles, 2012; Hood, 2003; Krueger, 1999). Although such a pattern was not revealed in the current study, the finding that socioeconomic status significantly affects mathematics achievement continues to highlight the importance of socioeconomic status as a factor in mathematics achievement.

A case could be made that the current findings validate earlier findings that the significant academic gains reported with smaller classes at the elementary level (Glass & Smith, 1979; Zyngier, 2014) do not necessarily appear to apply to the secondary grades. For example, this investigation is in contrast to reports made by Chingos and Whitehurst (2011), Krueger (1999), and Hood (2003) suggesting that students in small size classes outperformed students in regular size classes each year of their research. In effect, unlike conclusions drawn from earlier studies where researchers proposed that small classes had positive impacts on student achievement, including higher test scores, these findings appear to challenge the temptation to extend such generalizations to higher grade levels. Additionally, some researchers previously suggested a greater benefit of small classes to male students (Achilles, 2012; Hood, 2003; Krueger, 1999), which this study found no evidence to support. This gives credence to what critics of class size reduction initiatives have noted all along: research results have indeed been mixed (Hanushek, 1999a; Johnson, 2002). In fact, Chingos and Whitehurst (2011) reported that reductions in class sizes "are expensive [and have] been shown to work for some students in some grades in some states and countries, but its impact has been found to be mixed or not discernable in other settings and circumstances that seem similar" (p. 2). Continuing, Chingos and Whitehurst (2011) contended that since schools are diverse in such a variety of ways, findings might not accurately be attributable solely to class size reduction.

Implications

There are many implications that can be drawn from this study. However, two of these implications seem most obvious. First, the current study adds to the rather limited evidence regarding the effects of class size beyond the elementary grades. It is worth noting that little evidence has been found to support the magnitude of class size outcomes documented in the literature beyond the elementary grades. Furthermore, much of the recent class size research beyond the elementary grades has been conducted among populations outside the United States such as Ghana (Enu, Danso, & Awortwe, 2015), Poland (Koniewski, 2013), the United Kingdom (Pedder, 2006) and Bangladesh (Asadullah, 2005). In regard to these findings, therefore, this study provides insights into the possible effects of class size at this level among a population of students located in the United States. It also provides a meaningful addition to the sparse literature pertaining to the direct exploration of class size at the secondary level in the United States.

A second important implication of the current study is the introduction of the concept of class size setting. As previously mentioned, the traditional definition of class size assumes that students are in the prescribed classroom setting for the entirety of the school day as opposed to just a part of the day. Although this distinction might appear minor, it was important in light of earlier misuses of class size at the elementary school level when in actuality pupil-teacher ratio was implied. The introduction of this concept should help draw a distinction as this body of knowledge is extended to the secondary grades. As Ehrenberg, Brewer, Gamoran, and Willms (2001) suggested, it is ideal to define class size as the true measure of the number of students in a class, but this becomes especially difficult in the middle and upper secondary grades where class sizes tend to vary greatly by subject, class period, day, and so forth. Similarly, Achilles (2012) noted that much class size research in the United States was done at the elementary level; therefore, by nature, the definition of small-class size in past studies has been used as an indication of the number of students who would attend a small class for the majority, if not all, of the school day. To further indicate the significance of the definition of class size within the research, whereas Hanushek (1999a) rationalized that reduced class sizes have not produced a significant gain in student achievement, he then supported a reduction in pupil-teacher ratios in the United States. Achilles (2012) and Hood (2003) have since maintained that analyses of data utilizing pupil-teacher ratio has undeniably revealed little effect on student achievement, while they further contend however, that analyses of class size data indicated considerable positive effects on both short and long-term student outcomes.

For this reason, the term class size setting was chosen to operationalize the unique situation in this study where the small and regular class configurations were not maintained throughout the school day. A similar attempt at constructing language to clearly distinguish the differences between these situations was made by Enu et al., (2015) using the term *small group setting* to distinguish between the traditional small-class size and a similar setting at the secondary level. The case for the use of small-class size setting over small group setting is that it keeps the language similar to that used in the investigation of other levels of schooling, thereby facilitating a comparison of findings at all levels. Whatever the case, the introduction of this concept in the current study should help mitigate confusion about small-class sizes that result from reductions limited to a particular setting (class size setting) with small-class sizes that are maintained throughout the school day. Ultimately, this study should hopefully provide school administrators with a better understanding of the impact that class size settings may have on students' academic outcomes.

Recommendations

It is clear that multiple factors affect student achievement at the ninth-grade level. Some of these factors, studied here: class size, time spent in small classes, and school configuration, among others, are amendable to experimental control; while others such as gender, ethnicity, and socioeconomic status are not. It is also obvious that ideally, rigorous research into the effects of such factors, particularly those in the former group, require appropriate experimental control. As Ehrenberg et al. (2001) noted, the best methods to control for these other factors are true experiments using data from randomly assigned students/teachers/class sizes or to use methods that would appropriately account for factors other than class size. Although it was not possible to directly apply such controls in the current study, attempts were made to adequately account for the effect of such factors using nonexperimental strategies. Even with this, some of these attempts may have been weaker than they should be. For instance, the groups scheduled for small-class size settings in this study were more typically comprised of students identified as either English Language Learners, or as members in the Special Education population. Furthermore, at least one school had an extremely high percentage of students identified as low socioeconomic status. This example only goes to magnify the idea that there are clear limits to what can be accomplished and the definitive knowledge claims that can be made when research is not of an experimental nature.

An important recommendation for further studies, therefore, would be that, when applicable, better experimental control be introduced in order to gain enhanced understanding of the effect of small-class size setting on students such as those in this study. Likewise, further studies should be conducted using more robust analytical techniques that are able to account for not only differences due to the effect of fixed factors but also those difference that may result from variations in relevant random factors (such as students background characteristics).

Additionally, as Hanushek (1999b) suggested, experiments in the medical sciences, which undergo many stringent methodologies, still always require repetitions to ensure validity and reliability. In the same manner therefore, social experiments, which are generally more complex and challenging, create the improbability that a single study would produce definitive answers. Consequently, more studies need to be conducted in order to draw the most truthful conclusions regarding class size setting. In addition, longitudinal studies, especially to compare student’s academic growth over time would be an area to do further research with relation to small-class size setting. Longitudinal studies on a particular group of students over time could provide sustainable evidence of the true impact of class size setting on the mathematics achievement of ninth-grade students. Furthermore, since a large percentage of students enrolled in small-class size setting in this study included participants from special education and limited English proficiency populations, yet significant differences were not found among student achievement results, a prudent focus for further research would be to examine if the lack of a significant difference between student outcomes was a benefit of small-class size setting.

Beyond that, future research that also recognizes and adopts the concept of small-class size setting to uniquely identify certain class assignments at the secondary level, as opposed to the generic class size label, would be meaningful. This suggestion would be also advisable for the replication of past studies that may have inaccurately labeled the concept and possibly led to differing results in meta-analyses utilizing such studies. On a different note, it may be meaningful to explore teachers' attitudes toward small-class size setting since it has been suggested that class size reduction is an incentive for teacher retention. Doing so may be a better measure of the benefits of class size reduction than student achievement. Finally, since positive teacher-student relationship building has been implicated in terms of student success, perhaps surveying students relative to smaller-class size settings may also be beneficial.

REFERENCES

Achilles, C. M. (1999). *Let's put kids first, finally: Getting class size right.* Thousand Oaks, CA: Corwin Press.

Achilles, C. M. (2003a). *Class size and student learning*. Retrieved from http://www.encyclopedia.com/doc/1G2-3403200116.html

Achilles, C. M. (2003b). *How class size makes a difference: What the research says. The impact of class size reduction (CSR)*. Retrieved from ERIC database. (ED475012)

Achilles, C. M. (2003c). *Testimony and evidence to support small classes, K-3.* Retrieved from ERIC database. (ED 474641)

Achilles, C. M. (2012). Class size policy: The STAR experiment and related class size studies. *NCPEA Policy Brief, 1*(2), 1-10.

Achilles, C. M., Finn, J. D., & Bain, H. P. (1997). Using class size to reduce the equity gap. *Reaching for Equity, 55*(4), 40-43.

Achilles, C. M., Finn, J. D., & Bain, H. P. (1998). Using class size to reduce the equity gap. *Educational Leadership, 55*(4), 40-43.

American Psychological Association. (2007). *Report of the APA Task Force on socio-economic status*. Washington, DC: Author.

Angrist, J. D., & Lavy, V. (1999). Using Maimonides' Rule to estimate the effect of class size on scholastic achievement. *Quarterly Journal of Economics, 114*(2), 533–575.

Arkansas Department of Education. (2003). *Consolidated state application accountability plan.* Retrieved from http://www.arkleg.state.ar.us/education/K12/AdequacyReports/2008/2008-0206/16-NCLB%20edited%20accountability%20workbook%20June%202006.doc

Arkansas Department of Education. (2014). *Spring end-of-course examinations for algebra I, geometry, and biology raw to scale score conversion tables spring 2014 administration.* Retrieved from http://www.arkansased.gov/public/userfiles/Learning_Services/Student%20Assessment/2014/EOC_All_14/Raw_to_Scale_Score_Conversion_Table.pdf

Arkansas Department of Education. (2015). *Test scores by year.* Retrieved from http://www.arkansased.gov/divisions/learning-services/student-assessment/test-scores/year?y=2015

Asadullah, M. N. (2005). The effect of class size on student achievement: Evidence from Bangladesh. *Applied Economics Letters, 12*(4), 217-221.

Bain, H. P., Achilles, C. M., Zaharias, J. B., & McKenna, B. (1992). Class size does make a difference. *Phi Delta Kappan*, *11*, 253-256.

Biddle, B. J., & Berliner, D. C. (2002). Small class size and its effects. *Educational Leadership*, *59*(5), 12–23.

Brown, E. L. (2004). *The effect of number of school-to-school transitions on district performance* (Doctoral dissertation, Ohio University). Retrieved from https://www.ohio.edu/orgs/resig/upload/brown.pdf

Ceci, S. J., & Konstantopoulos, S. (2009, January 30). It's not all about class size. *Chronicle of Higher Education, 55*(21), p. A30.

Chambers, E. A., & Schreiber, J. B. (2004). Girls' academic achievement: Varying associations of extracurricular activities. *Gender and Education*, *16*(3), 327-346.

Chase, C. I., Mueller, D. J., & Walden, J. D. (1986). *PRIME TIME: Its impact on instruction and achievement*. Indianapolis, IN: Indiana Department of Education.

Chatterji, M. (2005). Achievement gaps and correlates of early mathematics achievement: Evidence from the ECLS K-first grade sample. *Education Policy Analysis Archives*, *13*(46), 1-37.

Chingos, M. M., & Whitehurst, G. J. (2011). *Class size: What the research says and what it means for state policy*. Retrieved from http://www.brookings.edu/~/media/research/files/papers/2011/5/11-class-size-whitehurst-chingos

Commission for Arkansas Public School Academic Facilities and Transportation. (2015). *Rules for governing the academic facilities partnership program: Emergency rules.* Retrieved from http://arkansasfacilities.arkansas.gov/public/userfiles/documents/rules/Partnership_Emergency_Rule_-_092515.pdf

Davis, J., Stillman, L., & Alas, N. (2012). *Chief's pocket guide to class size.* Retrieved from http://www.ccsso.org/Documents/Class_Size_PocketGuide_for_LegCon.pdf

Diaz, V. (2008). Relationships between district size, socio-economics, expenditures, and student achievement in Washington. *The Rural Educator, 2*, 30-39.

Ehrenberg, R. G., Brewer, D. J., Gamoran, A., & Willms, J. D. (2001). Class size and student achievement. *Psychological Science in the Public Interest*, *2*(1), 1-30.

Enu, J., Danso, P.A., & Awortwe, P. K. (2015). Effects of group size on students' mathematics achievement in small group settings. *Journal of Education and Practice*, *6*(1), 119-122.

Finn, J. D. (2002). Small classes in American schools: Research, practice, and politics. *Phi Delta Kappan, 83*(7), 551-561.

Finn, J. D., & Achilles, C. M. (1999). Tennessee's class size study: Findings, implications, misconceptions. *Educational Evaluation and Policy Analysis 21*, 97-109.

Finn, J. D., Gerber, S. B., Achilles, C. M., & Zaharias, J. B. (2001). The enduring effects of small classes. *Teachers College Record, 103*(2), 145-183.

Finn, J. D., Gerber, S.B., & Boyd-Zaharias, J. (2005). Small classes in the early grades, academic achievement and graduating from high school. *Journal of Educational Psychology, 97*(2), 214-223.

Gerber, S., Finn, J., Achilles, C., & Boyd-Zaharias, J. (2001). Teacher aides and students' academic achievement. *Educational Evaluation and Policy Analysis, 23*(2), 123-143.

Glass, G. (1980). On criticism of our class size/student achievement research: No points conceded. *Phi Delta Kappan, 62*(4), 242-244.

Glass, G. V., & Smith, M. L. (1979). Meta-analysis of research on class size and achievement. *Educational Evaluation and Policy Analysis, 1*(1), 2-16.

Graue, E., & Rauscher, E. (2009). Researcher perspectives on class size reduction. *Education Policy Analysis Archives, 17*(9), 1-26.

Gregg, K. (2011). *Elementary school grade span configuration: New evidence on student achievement, achievement equity, and cost efficiency.* Retrieved from http://www.cityofportsmouth.com/school/centraloffice/eefc/4e.pdf

Grissmer, D. (1999). Conclusion: Class size effects: Assessing the evidence, its policy implications and future research agenda. *Educational Evaluation and Policy Analysis*, *21*(2), 231-248.

Hanushek, E. A. (1999a). Class size: Issues and new findings. *Educational Evaluation and Policy Analysis, 21*(2), 143-163.

Hanushek, E. A. (1999b). Some findings from an independent investigation of the Tennessee STAR experiment and from other investigations of class size effects. *Educational Evaluation and Policy Analysis*, *21*, 143–164.

Hanushek, E. A. (2002). Evidence, politics and the class size debate. In L. Mishel & R. Rothstein (Eds.), *The class size debate* (pp. 37-65). Washington, DC: Economic Policy Institute.

Hochschild, J. L. (2003). Social class in public schools. *Journal of Social Issues,59*(4), 821-840.

Hood, A. (2003). *A parent's guide to class size reduction. SERVE: improving learning through research and development.* Retrieved from ERIC database. (ED010015)

Huat, B., Gorard, S., & White, P. (2004). Teacher demand: Crisis what crisis? *Cambridge Journal of Education*, *34*(1), 103-123.

Huss, C. D. (2010). *The influence of small class size, duration, intensity, and heterogeneity on head start fade* (Doctoral dissertation, Seton Hall University). Retrieved from http://scholarship.shu.edu/cgi/viewcontent.cgi?article=2632 &context=dissertations

Johnson, B., & Christensen, L. (2008). *Educational research: Quantitative, qualitative, and mixed approaches.* Thousand Oaks, CA: Sage.

Johnson, K. (2002). The downside to small class policies. *Educational Leadership, 59*(5), 27–29.

Jordan, N. C., Kaplan, D., Locuniak, M. N., & Ramineni, C. (2007). Predicting first-grade math achievement from developmental number sense trajectories. *Learning Disabilities Research & Practice, 22*, 36–46.

Kimball, M. M. (1989). A new perspective on women's math achievement. *Psychological Bulletin, 105*(2), 198-214.

Klein, A. (2015). No Child Left Behind: An overview. *Education Week, 34*(27). Retrieved from http://www.edweek.org/ew/section/multimedia/no-child-left-behind-overview-definition-summary.html

Koniewski, M. (2013). Estimating the effect of class size on academic achievement by ex post facto experiment. *EDUKACJA Quarterly, 1*(6), 41-58.

Krieger, J. (2003). *Class size reduction: Implementation and solutions.* Retrieved from ERIC database. (ED475489)

Krueger, A. B. (1999). Experimental estimates of education production functions. *Quarterly Journal of Economics, 115*(2), 497–532.

Krueger, A. B. (2002a). Understanding the magnitude and effect of class size on student achievement. In L. Mishel & R. Rothstein (Eds.), *The class size debate* (pp. 7-35). Washington, DC: Economic Policy Institute.

Krueger, A. B. (2002b, August 2). Smaller classes help many. *U.S.A. Today*, p. 8A.

Krueger, A. B., & Whitmore, D. M. (2001). *Would smaller classes help close the Black-White achievement gap?* (Working paper #451). Princeton, NJ: Princeton University. Retrieved from http://www.irs.princeton.edu/pubs/pdfs/451.pdf

Lawrence, M., & Rothstein, R. (Eds.). (2002). *The class size debate*. Washington, DC: Economic Policy Institute.

Lee, V. E., & Smith, J. B. (1993). Effects of school restructuring on the achievement and engagement of middle-grade students. *Sociology of Education, 66*(3), 164-187.

Miller-Whitehead, M. (2003). *Compilation of class size findings: Grade level, school and district.* Retrieved from ERIC database**.** (ED 482693)

Mills, J. S. (1872). *The logic of the moral sciences.* Chicago, IL: Open Court Publishing.

Morgan, G.A., Leech, N. L., Gloeckner, G. W., & Barrett, K. C. (2011). *IBM SPSS for introductory statistics: Use and interpretation* (4th ed.). New York, NY: Taylor and Francis Group, LLC.

Mosteller, F. (1995). The Tennessee study of class size in the early school grades. *The Future of Children: Critical Issues for Children and Youth*s, *5*(2), 113–127.

Mosteller, F., Light, R. J., & Sachs, J. A. (1996). Sustained inquiry in education: Lessons from skill grouping and class size. *Harvard Educational Review, (66)*797-842.

Nye, B. A., Hedges, L. V., & Konstantopulos, S. (2001a). Are effects of small cumulative: Evidence from a Tennessee experiment, *Journal of Educational Research, 94*(6), 336-345.

Nye, B. A., Hedges, L. V., & Konstantopulos, S. (2001b). The long-term effects of small classes in early grades: Lasting benefits in mathematics achievement at grade nine. *Journal of Experimental Education, 69*(3), 245-258.

Nye, B., Hedges, L. V., & Konstantopoulos, S. (2002). Do low-achieving students benefit more from small classes? Evidence from the Tennessee class size experiment. *Educational Evaluation & Policy Analysis, 24*(3), 201-217.

Nye, B. A., Konstantopoulos, S., & Hedges, L. V. (2004). How large are teacher effects? *Education Evaluation and Policy Analysis*, *26*(3), 237-257.

Nye, B. A. & Others. (1991). *The lasting benefits study: A continuing analysis of the effect of small class size in kindergarten through third grade on student achievement test scores in subsequent grade levels: fourth grade* (Technical Report). Retrieved from ERIC database. (ED338440)

Nye, B. A. & Others. (1992). *Project challenge preliminary report: An initial evaluation of the Tennessee Department of Education "at risk" student/teacher ratio reduction project in seventeen counties*. Retrieved from ERIC database. (ED352180)

Nye, B. A. & Others. (1993). *The lasting benefits study, eighth grade technical report*. Retrieved from ERIC database. (ED 90913)

Odden, A. (1990). Class size and student achievement: Research-based policy alternatives. *Educational Evaluation and Policy Analysis*, *12*(2), 213-227.

Odden, A. (1997). *How to rethink school budgets to support school transformation* (Getting better by design series, Vol. 3). Arlington, VA: New American Schools.

Odden, A., & Picus, L. O. (2000). School finance: A policy perspective (2nd ed.). New York, NY: McGraw Hill.

Odden, A., Picus, L. O., & Fermanich, M. (2003). *An evidenced-based approach to school finance adequacy in Arkansas: Final report prepared for the Arkansas joint committee on educational adequacy*. Retrieved from http://picusodden.com/wp-content/uploads/2013/09/AR_2003_EB_Report.pdf

Parcel, T. L., & Dufur, M. J. (2001). Capital at home and at school: Effects on student achievement. *Social Forces*, *79*(3), 881-912.

Pate-Bain, H., Boyd-Zaharias, J., Cain, V. A., Word, E., & Binkley, M. E. (1997). *The student/teacher achievement ratio (STAR) project follow-up studies.* Retrieved from ERIC database. (ED419593)

Pedder, D. (2006). Are small classes better? Understanding relationships between class size, classroom processes and pupils' learning. *Oxford Review of Education, 32*(2), 213-234.

Peterson, P. E., & Ackerman, M. (2015). States raise proficiency standards in mathematics and reading: Commitments to Common Core may be driving the proficiency bar upward. *Education Next, 15*(3). Retrieved from http://educationnext.org/states-raise-proficiency-standards-math-reading/

Ramsey, W. J. (2009). *A quantitative examination of school configurations in Tennessee using sixth grade math, reading, science, and social studies standardized test scores*. Retrieved from http://dc.etsu.edu/etd/1830

Rivkin, S. G., Hanushek, E. A., & Kain, J. F. (2005). Teachers, schools, and academic achievement. *Econometrica, 73*(2), 417–458.

Robinson, G. E. (1990). Synthesis of research on the effects of class size. *Educational Leadership, 47*, 80-90.

Roekel, D. V. (2008). An NEA policy brief. Class size reduction: A proven reform strategy. Retrieved from http://www.nea.org/assets/docs/PB08_ClassSize08.pdf

Royer, J. M., Tronsky, L. N., Chan, Y., Jackson, S. J., & Marchant, H., III (1999). Math-fact retrieval as the cognitive mechanism underlying gender differences in math test performance. *Contemporary Educational Psychology, 24*, 181–266.

Schwerdt, G., & West, M. R. (2011). The impact of alternative grade configurations on student outcomes through middle and high school. Retrieved from ERIC database. (ED526953)

Sharp, M. (2003). *Summary of an analysis of pupil-teacher ratio and class size: Differences that make a difference and its implications on staffing for class-size reduction.* Retrieved from ERIC database. (ED476106)

Smith, P., Molnar, A., & Zahorik, J. (2003). Class size reduction a fresh look at the data. *Educational Leadership, 61*, 72-74.

Spencer, S. J., Steele, C. M., & Quinn, D. M. (1999). *Journal of Experimental Social Psychology, 35*(1), 4-28.

Steinmayr, R., Meibner, A., Weidinger, A. F., & Wirthwein, L. (2015). Academic achievement. Oxford Bibliographies: Your best research starts here. Retrieved from http://www.oxfordbibliographies.com/view/document/obo-9780199756810/obo-9780199756810-0108.xml

Stringfield, S., Ross, S., & Smith, L. (1996). *Bold plans for school restructuring: The new American schools designs*. Mahwah, NJ: Lawrence Erlbaum.

Tienken, C. H., & Achilles, C. M. (2009) Relationship between class size and students' opportunity to learn writing in middle school. *Research in the Schools, 16*(1), 13-24.

Tomlinson, T. (1990). Class size and public policy: The plot thickens. *Contemporary Education, 62*(1), 17-23.

Toth, L. S., & Montagna, L. G. (2002). Class size and achievement in higher education: A summary of current research. *College Student Journal, 36*(2), 253-260.

Wenglinksy, H. (1997). *When money matters: How educational expenditures improve student performance and how they don't.* Retrieved from https://www.ets.org/Media/Research/pdf/PICWMM.pdf

Zahorik, J., Halbach, A., Ehrle, K., & Molnar, A. (2003). Teaching practices for smaller classes. *Association for Supervision and Curriculum Development, 61*(1), 75-77.

Zyngier, D. (2014). Class size and academic results. *Evidence Base 1*(1), 1-23.

APPENDIX

HARDING
UNIVERSITY
INSTITUTIONAL REVIEW BOARD

Status of Request for Exemption from IRB Review

(For Board Use Only)

Date: 3/21/16
Proposal Number: 2016-029
Title of Project: Effect of Small Class Setting on the Algebra 1 Achievement of Ninth Grade Students
Principal Investigator(s) and Co-Investigator(s): Lisa Kissire lisa.kissire@ouachitasd.org

---

- [x] Research exempted from IRB review.
- [ ] Research requires IRB review.
- [ ] More information is needed before a determination can be made. (See attachment.)

I have reviewed the proposal referenced above and have rendered the decision noted above.
This study has been found to fall under the following exemption(s):

☐	☐	☐	■	☐	☐
1	2	3	4	5	6

In the event that, after this exemption is granted, this research proposal is changed, it may require a review by the full IRB. In such case, a ***Request for Amendment to Approved Research*** form must be completed and submitted.
This exemption is granted for one year from the date of this letter. Renewals will need to be reviewed and granted before expiration.
The IRB reserves the right to observe, review and evaluate this study and its procedures during the course of the study.

Rebecca O. Weaver

Chair
Harding University Institutional Review Board