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Effect of Class Size on Student Achievement in Secondary School

Christopher Eric Uhrain
Walden University

Walden University

COLLEGE OF EDUCATION

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Christopher Uhrain

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Dr. Jerita Whaley, Committee Member, Education Faculty
Dr. Beate Baltes, University Reviewer, Education Faculty

Chief Academic Officer

Eric Riedel, Ph.D.

Walden University
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Abstract

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MA, Virginia Commonwealth University, 2006

BS, Virginia Commonwealth University, 2000

Doctoral Study Submitted in Partial Fulfillment

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Abstract

The school board of a school district in South Carolina has proposed to increase class size in all schools due to mandatory budgetary reductions. However, at the secondary school level, the literature on the effect of larger class size on student achievement is conflicting. The theoretical framework by Lazear suggested that the minimization of negative externalities (i.e., problematic behavioral and academic characteristics of students) achieved through the mechanism of smaller class size impacts student learning. Reducing the number of students in a classroom alters the entire classroom environment, creating a more positive learning environment in which students are able to forge better relationships with classmates and teachers. The research question for this study examined whether class size in secondary school predicted student achievement as measured by teacher-issued end-of-course numerical student grades (TIECNSG). The study used a correlational design with a sample of 17,582 TIECNSG from 5 secondary schools in the district. The effect of smaller class sizes on TIECNSG was determined through the use of a linear regression model. For 9 course offerings, an increase in class size resulted in a decrease in TIECNSG, whereas for 8 course offerings, an increase in class size resulted in an increase in TIECNSG. The results of this study, therefore, were inconclusive, suggesting that other unaccounted confounding variables may have affected student achievement. This study can be used to promote positive social change by creating a dialogue between parents and school administrators who often have opposing points of view in terms of the effects of class size. In addition, it is recommended that a district's school board should authorize additional studies prior to taking any course of action that would affect class size at the secondary school level.

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Dedication

I would like to dedicate this to Shana, Karissa, Ryan, and Victoria. Without their love and support, none of this could ever be possible.

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Section 1: Introduction to the Study

Introduction

Historically, school administrators have reduced class size with the expectation that smaller class size will increase student achievement. In 1996, the California legislature passed a law reducing all K–2 classrooms to a maximum of 20 students (California Education Code, 1996). In 1998, the South Carolina legislature limited disadvantaged K–3 schools to a maximum of 15 students per classroom (Act number 400, 1998). In 2002, the Florida legislature passed a constitutional amendment limiting the size of kindergarten through third grade classes to 18 students, fourth through eighth grade classes to 22 students, and ninth through 12th grade classes to 25 students (Editorial Projects in Education, 2010). Notwithstanding, administrators of the school district in South Carolina where this study was conducted have proposed increases in average class size at all grade levels; however, it is unclear if and how these changes will impact student achievement.

There is no clear consensus in the educational research literature whether increasing average class size will have an effect on student achievement. Some researchers have suggested that changing class size can have an impact on student standardized achievement scores. The Tennessee student-teacher achievement ratio (STAR) study showed a significant increase in student achievement when class sizes were reduced in Grades K–3 (Word et al., 1990). Atta, Jamil, Ayaz, Shah, and Shah (2011) found that secondary class sizes under 20 students have a significant impact on student achievement, and Brühwiler and Blatchford (2011) concluded that a one student

reduction in class size resulted in a half point increase in student grade point average at both the primary and secondary level. However, other studies have shown that reduction in class size had little to no impact on student achievement. Corak and Lauzon (2009) analyzed scores of Canadian 15 year olds in the Program for International Student Assessment. They found that class size made no consistent impact on student achievement. Owoeye and Yara (2011), as well as Wyss, Tai, and Sadler (2007), found no statistical differences in student achievement between large and small classes at the secondary level. The research on the impact of class size on student achievement is conflicting and inconclusive.

Problem Statement

In the district where this study was conducted, one of the recommendations for the 2012-2013 school budget was to increase class sizes in fifth through 12th grades by one student (Grooms, 2011). The purpose of this recommendation was to reduce the total number of teachers hired by the district which would in turn reduce the total operational costs. I hypothesized that increasing class size would negatively affect student academic achievement as measured by teacher-issued end-of-course numerical student grades (TIECNSG).

Nature of the Study

This study used a correlational design and was modeled using linear regression. Green and Salkind (2011) recommended the use of a linear regression test to assess how well an independent (predictor) variable can predict a dependent (criterion) variable. The

predictor variable in this study was class size and the criterion variable was TIENCNSG (ranging from 0-100).

The academic subjects analyzed in this study were the core high school subjects of English language arts, math, science, and social studies. Teachers have some discretion in the makeup of course assignments and how much each assignment counted toward the end-of-course grades (ECG); however, similar courses taught at the same school were required to have aligned grading standards. Moreover, across the district, curriculum coordinators made sure that all schools align grading standards for similar courses. Other electives were excluded from the study because there could be less consistency in the grading methodology from teacher to teacher than there were with the core subjects.

Research Question and Hypothesis

I investigated the effect of increasing class size through the following research question (RQ) and hypotheses:

RQ: Does class size in secondary school predict student achievement as measured by TIECNSG?

H_0: Class size in secondary school can predict student achievement as measured by TIECNSG.

H_1: Class size in secondary school cannot predict student achievement as measured by TIECNSG.

Purpose of the Study

Based on the increases in class size being considered in the district under study, it was important to determine the potential impact these changes could have on student

academic achievement as measured by TIECNSG. The purpose of this study was to determine the effect of changing class sizes on TIECNSG. This knowledge can be used by administrators when making decisions about class size.

Theoretical Framework

The theoretical framework for this study is the minimization of negative externalities (i.e., problematic behavioral and academic characteristics of students) achieved through the mechanism of smaller class size (Ready, 2008), which impacts student learning. The effectiveness of class size reduction (CSR) is based on the idea that reducing the number of students in a classroom alters the entire classroom environment, creating a more positive learning environment. Pritchard (1999) stated that the student-teacher dynamic, student-student dynamic, and teacher-parent dynamic are all improved in smaller classrooms. In addition, teachers have more time, resources, and incentive to create improved lesson plans with greater levels of differentiation.

Pritchard (1999) stated that after being assigned into smaller classes, teachers reported that students received more individualized attention. Teachers got to know individual students better and kept track of individual student progress. In turn, students became more engaged because of this increased, personalized learning environment. Additionally, teachers spent less time on classroom management, which offered additional instructional time for all students in the classroom. Din (1999) confirmed that in smaller classes, students received more individualized help from teachers. Blatchford, Bassett, and Brown (2011) conducted a study at both the primary and secondary school level and found that in larger classes, student interaction with teachers decreased, which

resulted in a lower level of student engagement confirming Pritchard's theory. Englehart (2007) and Fan (2012) confirmed that in smaller classes, time spent on classroom management was decreased which led to improvement in academic achievement.

Pritchard (1999) theorized that smaller classes resulted in a more positive environment due to students developing better relationships with each other. Higher achieving students encouraged and assisted their peers, resulting in a higher performing classroom. Gottfredson and Dipetro (2011) confirmed this theory as they found that student-student classroom dynamics improved in smaller classrooms, which in turn led to a more effective teaching environment. In addition, O'Brennan, Bradshaw, and Furlong (2014) found that student perceptions were improved in smaller classrooms.

Pritchard (1999) posited that another main reason for increased student achievement in smaller classrooms was that parents and teachers developed stronger relationships. Having fewer students allowed teachers more time to contact and develop positive relationships with parents. Graue, Raushcer, and Sherfinski (2009) confirmed that smaller classes did give teachers more opportunities to reach out to parents and include them in the educational process. Rodriguez and Elbaum (2014) found that the strongest predictor of parental participation into the educational process was class size.

The final rationale for improved student achievement in smaller classrooms as theorized by Pritchard (1999) was that teachers had more time, resources, and incentive to create improved lesson plans with greater levels of differentiation. Teachers spent less time grading, which allowed more time for lesson planning. In addition, teachers had more opportunities for collaboration with other teachers and had more room available to

transition classes into a larger variety of teaching formats. DiBiaise and McDonald (2015) confirmed that smaller classes did increase teacher curriculum development.

Definitions

Academic achievement: The level of knowledge acquisition that occurs in a given course as defined by end-of-course grade point average (South Carolina Department of Education, 2007).

Class size reduction (CSR): Reducing the student-teacher ratio in a particular classroom (Funkhouser, 2009).

Teacher-issued end-of-course numerical student grade (TIECNSG): The numerical grade given to a student at the completion of a course based on his or her work and knowledge acquisition throughout the course. This numerical grade is a weighted average of all assignments completed in the course, and values range from 0 to 100 (South Carolina Department of Education, 2007).

Assumptions

The primary assumption in this study was that TIECNSG effectively measured student achievement in the course. While studies typically use standardized test results to measure student achievement, TIECNSG could be more indicative of student achievement for the content actually taught in class. Unlike standardized tests, Geiser and Santelices (2007) stated that TIECNSG consist of multiple forms of assessment to measure student achievement. Process understanding, high level integration of content knowledge, and classroom participation are included in TIECNSG. Therefore, TIENCNSG could reflect a more inclusive and comprehensive method of measuring

student achievement than standardized test scores, which only test one particular skill. While TIECNSG are not standardized and grading practices can vary from teacher to teacher, I assumed that TIECNSG are objectively determined and that grades from different teachers of like subjects are approximately equivalent.

Limitations

Due to the research design, this study faced several limitations. Random assignment was impossible because the data analyzed were archival in nature. Without random assignment, Lodico, Spaulding, and Voetgle (2010) stated that the internal validity threat of differential selection can occur. While this threat could not be completely controlled, differences in group dynamics were minimized by using the entire population of students in five different schools within the district.

Another major limitation in this study was the internal validity threat of instrumentation. Because TIECNSG were not standardized, variation from teacher to teacher in terms of grading procedure can occur. This threat could not be completely controlled; however, it was minimized by the use of data from the entire population of five secondary schools, which included multiple classes from each teacher as well as multiple teachers. Also, the district had adopted a uniform grading structure for all teachers of the same subjects. This uniform structure should have resulted in TIECNSG that are approximately equivalent across the same subject.

The last major limitation in this study was generalizability. This study was designed to look specifically at the effect of class size on TIECNSG in five secondary schools in a specific school district. Because of the ex post facto design, I cannot claim

generalizability to all high school students. It is up the to the reader to decide whether the results may be transferable to other schools with similar demographics as the high schools used in this study; however, schools with different demographic makeups may present confounding variables that were not addressed in this study.

Scope

The scope of this study was limited to one school district in South Carolina with data used from five of the nine secondary schools in the district. I only analyzed the effect of TIECNSG in the core subjects of English language arts, math, science, and social studies. A total of 17,582 TIECNSG were used in this study.

Delimitations

This study had several delimitations. I chose to use only TIECNSG in lieu of other measurements of achievement such as standardized test scores. I chose to use TIECNSG because they may reflect a more inclusive and comprehensive method of measuring student achievement than standardized test scores, which only test one particular skill set (Geiser & Santelices, 2007). I also chose to focus on five of the nine secondary schools in my school district due to their demographic similarities. Finally, I chose to include only grades in core subject areas due to the lack of consistency of grading in elective courses.

Significance of the Study

In the district where this study was conducted, one of the recommendations for the 2012-2013 school budget was to increase the size of classes in fifth through 12th grades by one student (Grooms, 2011). While district administrators have not

implemented an official policy increasing class size for the last 3 budget years, the number of teachers has decreased while the number of students has remained nearly constant, resulting in an increase in average class size. During the same 3-year period, the pass rate of the High School Assessment Program (HSAP) test, which all 10th grade students are required to take, has dropped by 2.2%. This trend can be seen in Table 1.

Table 1

Comparison of Number of Teachers to Number of Students and HSAP Pass Rate

Fiscal Year	Teachers	Students	Average	HSAP[a]
2008-09	2,655	37,636	14.1	83.5%
2009-10	2,577	37,407	14.5	81.3%
2010-11	2,514	37,520	14.9	81.3%

Note. Adapted from *Official Budget 2010-2011 Fiscal Year*, by County Schools, 2010, p. 272.
[a]Adapted from "SC Annual School Report Card," by South Carolina Department of Education, 2008-2012, http://ed.sc.gov/data/report-cards.

Before district administrators decide to implement the recommended increase in class size, the effects on student achievement should be studied. It is important that district administrators be made aware of the potential effects of changing class size on student achievement. With this information, they can make an informed decision on any proposal that would officially change class size.

Schools have an implicit responsibility to provide the best possible learning conditions for all students. If increasing class size were to have a negative outcome on student achievement and student learning, then studying the impact of class size on student achievement is important. Students could be at a disadvantage relative to students in other districts because they might not acquire as much knowledge and skills in larger classes than their peers in smaller classes. This disadvantage could impact a student's

ability to gain access to a college or university, and ultimately impact his or her future earning potential. Moreover, if increasing class size were to have little to no effect on student achievement, then money could be saved by increasing class size and using the money on programs that could increase student achievement.

Word et al. (1990) suggested that in the Project STAR study, CSR had a major impact on student achievement. However, states such as California that have implemented statewide class size reduction initiatives in elementary schools have not seen changes in student achievement (Jespen & Rivkin, 2009). As a result, this current study was needed to determine the effect of class size on student achievement.

Summary

In this section, I described my study designed to test the effects of class size student achievement as measured by TIECNSG. This study was based on the theory that reducing class size alters the entire classroom environment, creating a more positive learning environment. In Section 2, I review the relevant literature, analyzing past studies conducted to examine the effects of class size on academic achievement. In Section 3, I discuss the methodology of this study. This includes descriptions of the overall design, setting, population, and data collection and analysis procedures. In Section 4, I discuss the results from this study, and in Section 5, I discuss the ramifications of these results, offer follow up recommendations, and suggest the potential impact of the finding on social change.

Section 2: Review of the Literature

Introduction

In the following review of the literature, I examined studies analyzing the effects of class size on student achievement conducted at all levels of K–12 public education: elementary schools (Grades K–5), middle schools (Grades 6–8), and secondary schools (Grades 9–12). Several studies which I discuss in this literature review have shown a significant effect of class size on student achievement, while others have shown little to no effect. For example, the seminal study on this subject, the Project STAR study, conducted at the early elementary level, showed a significant improvement in student achievement; however, in later analyses of the STAR data, I review studies in which researchers have questioned the results of the Project STAR study.

In addition, other studies have shown that class size manipulation by principals can affect the results of any CSR analysis on student achievement. However, there is strong evidence that students benefit from CSR at all levels of education in other aspects of the learning process. Additionally, studies have shown that in smaller classes better teacher-student relationships are developed, students have greater access to resources, more individualized student learning occurs, and students have greater success after leaving school.

I reviewed literature from a wide range of sources, such as information found on websites using the Google search engine and peer-reviewed journal articles retrieved through GoogleScholar and the e-databases of Walden University Library, primarily using EBSCO, ERIC, and ProQuest. I used the following key words to find websites and

journal articles: *class size, class size reduction, student achievement, linear regression, disadvantages of using standardized tests, effect of achievement on class size,* and *student achievement*.

Class Size Reduction in Elementary Education

In this section, I examined studies conducted at the elementary level (Grades K–5). This level of education has been the most studied in terms of the effect of class size on student achievement. Several studies have shown that student achievement is positively affected by a reduction in class size, while other studies have shown the effects to be minimal to none and call into question the validity of studies showing significant improvements.

Project STAR

In 1984, researchers conducted a study in the state of Tennessee to determine the effects of class size on student achievement known as the student-teacher achievement ratio (STAR; Word et al., 1990). The researchers conducted a 4-year longitudinal study with a randomized control and experimental sample. It involved 79 elementary schools from all parts of Tennessee and included 330 K–3 classrooms separated into three groups. These groups consisted of small classes (13–17 students), regular classes (22–25 students), and regular classes with a teaching aide (22–25 students). To avoid school effects (i.e., significant differences due to the school attended), a within-school design was used where both experimental and control groups were present in all of the schools in the study. The results of the study showed that when compared to students in regular

size classes, first graders in classes under 17 had a percentile ranking increase of 11 points in reading and 11 points in math. The results can be seen in Table 2.

Table 2

Results of the STAR Study in Math and Reading at the First Grade Level

Class Size	Percentile Ranking in Reading	Percentile Ranking in Math
Small (13–17)	64th	59th
Regular (22–25)	53rd	48th
Regular With Aid	58th	51th

Note. Adapted from "The Tennessee Study of Class Size in the Early School Grades," by F. Mosteller, 1995, *The Future of Children*, *5*, p. 122.

The researchers found increases in other grade levels as well, although none were as pronounced as in first grade (Word et al., 1990). In addition, the researchers concluded that increases in student achievement were equal for trained and untrained teachers, that staff development opportunities conducted during the research had little effect on student achievement compared to class size, and that African American students tended to benefit more than Caucasian students when class size was reduced. Based on these results, the official recommendation adopted by the Tennessee legislature was to implement class size reduction in phases, starting in kindergarten and first grade where the results were most prominent, and limit class size to no more than 15 students.

Additional studies using Project STAR data. Shin and Raudenbush (2011) used the Project STAR data to determine if reduced class size increased achievement in reading, mathematics, listening, and word recognition skills and whether these effects differed from school to school. Using an extended Rubin's causal model, they found that reducing class size increased student achievement in grades K–3; although in second

grade, only a minimal improvement was found. In addition, Shin and Raudenbush found that these effects did not differ from school to school. Konstantopoulos (2008) also used the Project STAR data to investigate whether decreasing class sizes could close the achievement gap between high and low level achievers. Konstantopoulos's findings did not show that the achievement gap was closed. However, the reason for this outcome was not that CSR did not help low achieving students, but that it helped high achieving students even more. McKee, Sims, and Rivkin (2015) investigated patterns of heterogeneity in the effects of class size on student achievement in the Project STAR classes that showed improvement. They found that students in higher poverty schools and academically gifted students both benefitted from smaller class size. The researchers conjectured that in higher poverty classrooms, there are a larger number of interruptions and classroom management issues that can be minimized with smaller class sizes. In academically gifted classrooms, smaller classes can result in more individualized and challenging instruction. Shin (2012) used the Project STAR data to determine if African American students benefited more from smaller classes than Caucasian students. Shin found that at the kindergarten level, both Caucasian and African American students benefited equally from smaller classes while in first through third grade, African American students benefitted more from smaller classes.

Ding and Lehrer (2010) also found that smaller class sizes had a positive effect on student achievement in their analysis of the Project STAR data that statistically accounted for student attrition and transitions of students between test and control groups from Grades K–3. The researchers found that small class size had a statistically significant

effect on student achievement in Grades K–1, although there was no statistically significant improvement from students being in a small class in both kindergarten and Grade 1 over being in a small class in just kindergarten. They suggested that this was the result of individual student needs being identified in the initial small classroom so that subsequent experiences in small classes would have little to no additional impact on student achievement. Konstantopoulos and Li (2012) also used the Project STAR data to determine if being in smaller classes for longer than 1 year could have a greater influence on student achievement. They analyzed data from students who had participated in the Project STAR study from grades K–3. The researchers found that there was no statistically significant increase in student achievement from being in a smaller class more than one1 year. However, they also found that the original increase in student achievement from being in a smaller class is not permanent and if a child is subsequently placed in a larger class, any increases in student achievement resulting from the smaller class would be reversed.

After 4 years, the Project STAR study was ended and the Lasting Benefits Study was undertaken. This study followed the participants of the Project STAR study through Grades 4–8 to see if the gains in student achievement from K–3 remained (Konstantopoulos & Chung, 2009). Konstantopoulos and Chung (2009) used these data to determine the long-term effects of small classes in early grades. They used quantile regression to compare student test scores in mathematics, reading, and science in third grade to scores in subsequent grades. The researchers found that at a .10 confidence level, throughout Grades 4–8, all student sample groups in small class sizes in previous grades

had a significant improvement in test scores when compared to students in regular size classes in previous grades. At a .05 confidence level, over half of the sample groups showed a statistically significant improvement.

Studies questioning the results of Project STAR. Sohn (2010, 2015) argued that the Project STAR study was flawed and conjectured that the researchers were biased from the outset toward showing that class reduction had an impact on student achievement. The majority of the improvements reported in the STAR study were found at a very small number of schools, and more schools showed negative effects than positive effects. Sohn (2010, 2015) found that three times as many schools showed no effect (ineffective schools) than positive effects (effective schools). Sohn (2010, 2015) contended that the Project STAR study's student assignments were not randomized, but in fact were intentionally distributed to achieve a desired result. To support this claim, Sohn pointed out that there were a statistically higher number of children receiving free lunch in regular size classes compared to the number receiving free lunch in small classes. Furthermore, in the small classes where improvements were shown, there was a much higher percentage of teachers with advanced degrees than in the small classes that did not show improvement. Additionally, when analyzing only ineffective schools, there were not any improvements in academic achievement resulting from CSR. Konstantopoulos (2011) confirmed that possibly the Project STAR data appeared not to have used random assignment of students and could have been manipulated to obtain certain results. Konstantopoulos found that in some of the small classes there was a great deal of improvement; however, in other small classes there was little to no improvement.

Mueller (2013) found contradictory results to the Word et al. (1990) findings, specifically that teacher experience had little to no effect on improvement to student achievement. Mueller found that in classes with rookie teachers, little to no improvement was obtained by reducing class size. However, in classes with experienced teachers, student achievement improved greatly. Mueller conjectured that this was a result of experienced teachers having the ability to implement differing learning strategies in smaller classes while rookie teachers might not have the skill set to implement these strategies. In addition, Bedard and Kuhn (2008) contended that the inability to conduct follow-up, large-scale, experimental designs, such as the Tennessee Project STAR study, has resulted in no generalizable results on the effect that class size has on student achievement at any level of education from elementary to postsecondary education.

California Class Size Reduction

Based on the results of the Project STAR study, states across the country began to implement CSR programs, adopting laws limiting class size. California adopted the CSR program in 1996, which reduced all K–3 classrooms in the state to a maximum class size of 20 (California Education Code, 1996). In 1998, the South Carolina Legislature passed a law that required a maximum class size of 15 in disadvantaged kindergarten through third grade schools (Act number 400, 1998). The Florida legislature passed a constitutional amendment in 2002 limiting class sizes to 18 for kindergarten through first grade, 22 for fourth through eighth grade, and 25 for ninth through 12th grade (“District,” 2010).

While the results of the Project STAR study showed that reduction in class size resulted in increases in student achievement as evidenced by a 11 percentile improvement in reading scores and math scores (Word et al., 1990), the results of these CSR programs in other states did not always produce the desired effects of improvement in student achievement. As a result of the California CSR program, all K–3 classrooms were reduced from 30 to 20 students, which cost the state over 1 billion dollars per year to implement (Jespen & Rivkin, 2009). However, after implementation of CSR, the state's standardized test scores showed no appreciable change.

Studies examining the results of the California CSR program. Jespen and Rivkin (2009) determined that the reduction in class size based on the California CSR program did have an impact on student achievement; however, this impact was negated by the negative effect of the hiring of untrained teachers. They found that a CSR of 10 students resulted in an average increase in standardized test scores of 0.10 standard deviations in math and 0.06 standard deviations in reading when teacher experience was not taken into account. However, in classes taught by teachers without at least 2 years of teaching experience, they found a reduction of test scores of 0.10 standard deviations in math and 0.07 standard deviations in reading. Because the California CSR program resulted in 25,000 new teaching positions, a number of inexperienced teachers without proper credentials were placed in classrooms, eliminating any positive results gained by the reduction of class size in experienced teachers' classrooms. Bressoux, Kramarz, and Prost (2009) confirmed this conjecture in a quasi-experimental study of CSR in relationship to untrained teachers. They surmised that having a trained teacher versus an

untrained teacher had the same impact on student achievement as a reduction of 10 students in the classroom.

Sims (2008, 2009) studied two additional factors that could have explained the lack of positive results in the California CSR program. Sims (2008) stated that the lack of qualified teachers in California could not have explained the patterns shown in standardized test scores. Using the California Standardized Testing and Reporting (CSTAR) data for 1998-2000, Sims (2009) found that a reduction of an average of 9.5 students in first and second grade classes resulted in an increase in class size in fourth and fifth grade classes. Sims found that this increase led to a -0.07 standard deviation effect in student scores in mathematics at the fourth grade level and a -0.03 standard deviation effect in student scores at the fifth grade level. Using the same CSTAR data as well as classroom observations, Sims (2008) found that many elementary schools created combination classes (classes with more than one grade level present) to meet budgetary demands. Sims found that combination classes lowered second grade test scores by 0.04 to 0.05 standard deviations when measured as an effect size and third grade test score effect sizes by 0.09 to 0.10 standard deviations when measured as an effect size.

Funkhouser (2009) argued that the CSR program did not show positive results because class size had very little effect on student achievement. Funkhouser compared kindergarten student achievement immediately before program implementation and immediately after. Funkhouser found a slight improvement in reading equivalent to a 0.10 standard deviation improvement and a statistically insignificant 0.05 standard deviation improvement in mathematics.

Canada Primary Class Size Reduction

In the 2007-2008 school year, Ontario, a province in Canada, implemented the Primary Class Size Reduction (PCSR) initiative in all its primary (elementary) schools (Mascall & Leung, 2012). This law required all classes to be reduced to a maximum class size of 20 students. Much like the California CSR, the implementation of this law did not produce the anticipated results as found in the Project STAR study. Bascia and Faubert (2012) examined how this law was implemented to determine if implementation affected the results of the initiative. Their study encompassed 24 schools in all eight school districts in the province of Ontario. They found many positive outcomes from implementation in the elementary grades including improved student-teacher relationships, more individual support for "at risk" students, more resources devoted to all levels of elementary classes, additional teacher training, and increased personal space which allowed for more diverse learning strategies to be introduced. However, they also found that while the elementary grades benefitted from this initiative, the upper grade levels received fewer resources. For upper grades, the PCSR initiative resulted in larger class sizes, less individual support for "at risk" students, and a reduction in personal space and teacher training. Based on Konstantopoulos and Li's (2012) findings that gains resulting from CSR are not permanent, this could explain the lack of substantial improvement in the PCSR initiative. In their study of the school districts in Ontario, Mascall and Leung (2012) found that different school districts had drastically different

results in terms of increases in student achievement. They found that school districts which used available funds effectively and had a plan in place that maximized all available resources for implementation had positive results from the PCSR initiative while districts that did not have such a plan in place saw little to no improvement in student achievement.

Other Studies in Elementary Education

Other studies showed similar results to the STAR study to varying degrees. Cho, Glewwe, and Whitler (2012) analyzed the Minnesota Comprehensive Assessment test of all third and fifth grade students in Minnesota. They found that reducing class size had a positive impact on student performance in reading and mathematics. However, the researchers' analysis of the data showed only a minimal increase with a 10-student decrease in class size, resulting in a 0.04 to 0.05 standard deviation increase in the distribution of student standardized test scores.

Breton (2014) used scores from the Trends in International Mathematics and Science Study (TIMSS), a standardized test given to fourth and eighth grade students in 41 different countries. Briton chose to analyze the mathematics data for fourth grade students in Columbia exclusively. In Columbia, fourth grade class sizes ranged from six to 80 students. Briton found that increasing class size resulted in a statistically significant drop in test scores. A one student increase in class size resulted in a 0.03 standard deviation decrease in test scores. In addition, Briton conjectured that reducing all classes to 20 students or less would result in a 12% increase in student achievement. Breton concluded that CSR was six times more effective than the results obtained by Cho et al.

(2012). Briton pointed out, however, that the results from Columbia were significantly higher than other countries that participated in TIMSS, possibly due to the large variance in class sizes found in that country.

Kassile (2014) conducted a study to look at the effects of various resources on student achievement. Kassile analyzed the effect of student-teacher ratio on pass rates on the Primary School Leaving Examination in Mainland Tanzania. Kassile found that student-teacher ratio had a statistically negative effect on student achievement with a Pearson correlation coefficient of 0.74176 and $p = .0001$.

Vaag, Iversen, and Bonesrønning (2013) conducted a study of all Norwegian fourth grade students to determine if smaller size classes helped disadvantaged students in elementary school. They analyzed data from standardized tests in math and reading administered to 55,322 participants. There were two types of disadvantaged students analyzed in this study. The first type was students who had neither parent finish secondary school. The second type was students who came from divorced households. In both cases, the researchers' analysis detected a small but significant improvement in student achievement from reducing class size. An eight student decrease in class size resulted in a 0.04 standard deviation improvement in achievement of students with neither parent finishing secondary school and a 0.06 standard deviation improvement in achievement of students from divorced households.

Between 2000 and 2003, researchers at the Institute of Education conducted a study of English primary schools to determine the effects of a 2001 law limiting class sizes to 30 in all infant classes which is the English equivalent of the United States preK–

2 (Department for Education, 2011). This was a longitudinal study that grouped classes into large (30 students and over), large medium (26–29 students), small medium (20–25 students), and small (under 20 students). Students were randomly selected from all English schools. Literacy and mathematics achievement were examined to determine the impact of CSR. The researchers found that class size had a positive impact on student achievement in early grades and that smaller classes had more teacher-student interactions, while larger classes had more student-student interactions. However, the positive impact of smaller classes was somewhat small and diminished over time.

Galton and Pell (2012) conducted a 4-year longitudinal study of 36 primary schools in Hong Kong that showed similar results to the British Department for Education (2011) study. Galton and Pell separated class sizes into normal classes (approximately 38 students) and small classes (25 students and under). They measured student achievement in English, Chinese, and mathematics by a test constructed specifically for this study by the Hong Kong Education Department. Using multi-level regression, they found no long-term statistically significant effect on student achievement for class size. There was some academic improvement in students in small classes; however, this improvement disappeared upon students' inclusion in larger classes.

Milesi and Gamoran (2006) conducted a study of kindergarteners and found classroom size had no effect on student achievement. They analyzed data gathered in the Early Childhood Longitudinal Study of Kindergarten Class 1998-1999. The data consisted of pretest and posttest scores in reading and math of kindergarten students across the United States. A total of 21,600 students were included from 1,000

kindergarten classrooms. Using hierarchical linear models, Milesi and Gamoran found that class size had no statistically significant effects on student achievement. Konstantopoulos and Traynor (2014) found similar results in their study of fourth grade reading test scores on the Progress in International Reading Literacy Study (PIRLS) in Greece. They found a small association between CSR and student achievement; however, the association was not statistically significant.

Conclusion for Elementary Grades

Research at the elementary level has shown that effects of class size on student achievement are largely inconclusive. The researchers involved in the STAR study found that CSR led to significant improvements in student achievement, while other researchers did not find this result. In terms of subject taught, the majority of studies used standardized data that only investigated effects of class size on math and reading skills. A number of confounding variables, such as subject taught (Galton & Pell, 2012), differences in schools (Sohn, 2010), differences in teacher skill (Jespen & Rivkin, 2009; Mueller, 2013), and even CSR implementation methodology (Bascia & Faubert, 2012; Mascall & Leung, 2012) were present in most studies at the elementary level. In addition, the STAR study showed varying levels of student improvement at different grades, with first grade having the most pronounced change (Word et al., 1990). However, the results of elementary level studies cannot be generalized to other grade levels. Accordingly, it is necessary to examine studies on the impact of CSR on student achievement at the middle (6–9) and secondary (10–12) grade levels.

Class Size Reduction in Middle Grades

Next, I focused on studies conducted at the middle grade level (Grades 6–9). CSR in middle school has not been studied nearly as extensively as at the elementary level, and results of student achievement are largely inconclusive.

Florida Class Size Reduction Initiative

In response to the results of Project STAR, the Florida legislature passed a constitutional amendment reducing class size in middle school to 22 students in 2002 ("Districts," 2010). Chingos (2012) examined student scores on the Florida Comprehensive Assessment Tests (FCAT), a standardized test taken by all Florida students. Chingos evaluated the student population at both the district and school-wide levels by separating districts and schools into two groups: (a) those that were not reduced or were only marginally reduced in class size by the statewide mandate (an average reduction of 1.4 students at the district level and 1.1 students at the school level) and (b) those that had a large reduction in class size (an average reduction of 3.0 students at the district level and 3.4 students at the school level). The researcher, using multiple regression, found only a minimal improvement in student scores at both the school and district levels that could be directly attributed to CSR. This initiative seemed to show the same lack of increase in student achievement as the California CSR.

Other Middle Grade Studies

Analysis of other middle school data confirmed the results of the Florida study. Leuven, Oosterbeek, and Ronning (2008) conducted a quasi-experimental study in

Norway in Grades 7–9. They measured student achievement via scores on the centralized exit exams all ninth graders are required to take. In Norway, Grades 7-9 were limited to a maximum size of 30 students so the effects of larger class sizes were not taken into account. Using a regression discontinuity design at a 95% confidence level, they found that class size had no statistically significant effect on student achievement.

Altinok and Kingdon (2012) used TIMSS test data for eighth grade students and found that out of 41 countries, decreasing class size only had a statistically significant effect on 20. In seven of the 41 countries, increasing class size actually had a positive effect on student achievement. Overall, they found that a one standard deviation reduction in class size would increase student achievement by only 0.03 standard deviations.

In addition, Akabayashi and Nakamura (2014) examined sixth grade Japanese standardized language arts tests scores by comparing tests given at the beginning and the end of the school year. Using a value-added model to estimate causal effects and to control for unobserved fixed effects, they found class size to have little to no effect on student achievement. A one student reduction in class size increased test scores by only 0.0112 standard deviations. In addition, they found no evidence that a universal class size reduction policy would have any effect on closing the achievement gap between poor and wealthy students.

Other researchers, however, found that smaller class size did have a positive effect on student achievement. Tienken and Achilles (2009) examined the effect of class size on writing skills. They conducted a non–experimental, explanatory, longitudinal

study of 123 middle school children in New Jersey to determine if reducing class sizes from large classes (23–26 students) to small classes (12–18 students) would have an effect on students' abilities to learn writing skills. Tienken and Achilles used a control group design and only included students in the study who attended the same school. The researchers analyzed pre/posttest data from student writing assessments using one-way analysis of variance (ANOVA). They found that after 3 years of smaller class sizes, students performed significantly better on standardized writing exams. In addition, students who spent sixth grade in small classes followed by seventh and eighth grade in large classes still performed better than students who spent all 3 years in large classes, although this increase was not as large. One difference in this study compared to other studies that showed no improvement was that this study investigated writing skills exclusively.

Dee and West (2011) also found that decreasing class size had a positive effect on student achievement; however, instead of looking at test scores, student achievement was defined as a retention of noncognitive skills, which referred to work habits such as effort and self-control as well as behavioral traits such as confidence and emotional stability that are not measured by standardized tests but are crucial for long-term educational success. The researchers examined 24,599 eighth grade students from over 1,000 schools in the United States. Dee and West used data collected from the National Education Longitudinal Study of 1988. They found that CSR resulted in statistically significant improvements in retention of noncognitive skills. Nationwide, students in small classes had an increased rate of retention of 4.6% higher than in large classes. In urban schools,

the increased level of retention was 7.9%. Dee and West found that while CSR may not always show immediate results in student achievement, improvements in skills that are essential for long-term success were improved.

Conclusion for Middle Grades

Studies performed in the middle grades on the effect that class size had on student achievement offered inconclusive evidence about the actual effects on student achievement. Researchers that examined standardized test scores such as Chingo (2012), Leuven et al. (2008), and Altinok and Kingdon (2012) tended to find little to no improvement in student achievement as a result of CSR. However, Tienken and Achilles (2009), examined a specific subject and showed an improvement in test scores, and Dee and West (2011) found that CSR improved retention of important noncognitive skills.

Class Size Reduction in Secondary Education

There have been very few studies conducted at the secondary level (Grades 10–12). The results of those studies have varied greatly. Similar to studies conducted in elementary and middle schools, some have shown that CSR resulted in a positive effect on student achievement, while other studies have shown CSR had no effect on student achievement.

Positive Effects of Class Size Reduction

Atta et al. (2011) studied the attitudes of 400 male 10th graders from four rural and four urban high schools in District Dera Ismail Khan, Pakistan. The researchers used a questionnaire as an instrument to gain the opinions of students in regard to the effect that class size had on student achievement. They analyzed the questionnaires using a chi-

square distribution, and the confidence level for this experiment was .05. Any chi-square value greater than 3.841 was deemed to show that class size was believed to have a significant impact on student achievement. The researchers found that students opined that small class sizes (fewer than 20 students) had a significant impact on student achievement. The researchers calculated a chi-square value of 94.46 which was indicative of a very significant relationship between small class size and the belief that this would lead to higher student achievement. Nonetheless, actual achievement was not verified, so the findings must be interpreted cautiously.

Brühwiler and Blatchford (2011) found similar results to Atta et al. (2011) in a combined study of 26 primary and 23 secondary Swiss schools. They used data consisting of teacher questionnaires to determine class size and pretest/posttest design to determine student achievement. They found that, on average, a one student reduction in class size resulted in a half point increase in student test scores. The researchers noted that Swiss schools on average already had small class sizes, with the average class size being 19 or fewer students, which implied that even with small classes, class reduction could still be effective in increasing academic achievement.

Heinesen (2010) studied all Danish ninth graders who took French classes and found that smaller class size had a statistically significant impact on end-of-course examination scores. In addition, in class sizes ranging from six to 20 students, Heinesen found that the effects of class size on exam grades tended to be linear in nature. This study is unique in that it did not use data from standardized tests and it focused on the specific subject of French. The statistically significant impact of class reduction in this

study suggests that subjects requiring high interactivity, such as learning a foreign language, could have affected the results of class size reduction on student achievement.

Krassel and Heinesen (2014) examined the effects of class size in Danish secondary schools. They used administrative registry data to determine class size and 10th grade exit exams in Danish, math, and English to measure student achievement. The total sample size was 46,267 students and in Denmark, 10th grade is an optional year designed for at risk students. They found that reducing class size offered a statistically significant but small effect on student achievement.

Celik and Koc (2015) examined the correlation of class size and student achievement in Turkey. They used student scores on the Transition to Higher Education test, an exit exam taken at the end of high school, from 81 different cities to determine student achievement. Celik and Koc determined class size by taking the number of students attending each high school and dividing it by the number of classrooms. They used a Spearman's correlation to determine the level of relationship between class size and student achievement. At a .001 significance level, they calculated a Spearman's rho correlation of -.366. This indicated a relatively moderate inverse correlation between class size and student achievement.

Harfitt (2012b, 2013, 2014) conducted three studies in Hong Kong secondary schools. In Harfitt's first study, Harfitt (2012b) examined student perspective on class size. Harfitt (2012b) interviewed a total of 191 students about their experiences in their English classes. Even after controlling statistically for the confounding variable of teacher teaching ability, Harfitt (2012b) found that students reported smaller classes had

better classroom management, more time on task, and better teacher-student relationships. Students felt a higher level of closeness and community, and felt more comfortable asking the teacher for assistance. Harfitt (2012b) conducted classroom observations after the interviews, and the data supported the perception that students in small classes had a higher level of participation. In the second study, Harfitt (2013) focused on teacher perceptions instead of student perceptions and came to the same conclusions. Harfitt (2013) conducted a case study of four English teachers, which included multiple interviews and classroom observations. The research team observed that teachers changed pedagogical practices in smaller classrooms and that their relationship with students was much closer. Teachers reported and observers confirmed that in smaller classes, teachers had a better understanding of their students and could customize lessons to individual needs much more than in larger classes. In the third study, Harfitt (2014) focused on the pedagogical changes made in reduced-size secondary classrooms. These changes were based on recommendations of 43 10th grade students as brokered by the researcher. Students suggested that teachers adopt more group work to take advantage of the smaller classroom and to engage more students by varying types of coursework. Observations showed that these changes created a greater sense of unity and belonging in the classroom that could directly relate to increases in student achievement.

No Effects of Class Size Reduction

Similar to elementary and middle school levels, some studies at the secondary level showed that CSR had little to no effect on student achievement as measured by standardized tests. Shin and Chung (2009) conducted a meta-analysis of 17 studies in

four separate states in the United States. They found a great inconsistency in results with overall student achievement increasing slightly, but with 10th grade students, smaller class size actually had a negative effect on achievement.

Corak and Lauzon (2009) used PISA data of 15-year-old students in Canada to determine the effects of class size and time-in-term on student achievement as measured by scores on the PISA test. They only examined scores from the reading portion of the test, and differences from other subject matter were not investigated. The total student population of this study was 30,000, and a random sample of students within a targeted school sample was used. When analyzing the different provinces in Canada, results were inconclusive. The researchers found that students in some provinces exhibited improvement of test scores from CSR while others showed little to no change.

Wyss, Tai, and Sadler (2007) conducted a study of approximately 7,000 students in 31 different U.S. states to determine if class size in high school science classes had a lasting impact on student achievement. They analyzed student grades in freshman-level college science classes. The researchers found little to no change until class sizes fell below 11 students. This study, unlike the one at the middle school level in which student achievement was also studied in a specific subject area not using a standardized test, showed no change in student achievement.

Owoeye and Yara (2011) conducted a study of 50 secondary schools in Nigeria to determine if class size had an effect on student achievement at the secondary level. The researchers used a *t* test to analyze student scores on the West African School Certification Examination from 1990 to 1997. At a .05 confidence level, they found that

class size had no statistically significant effect on student achievement, and there was no significant difference in achievement between small classes and large classes in both urban and rural communities.

Jakobsson, Persson, and Svensson (2013) focused on mental health problems in lieu of student. In a study of 2,755 ninth grade Swedish students, they found that class size had no effect on mental health problems. While this may seem to contradict the improvements in classroom dynamics seen in other studies, it should be noted that researchers of this study used a voluntary questionnaire to collect data and the issue of self-reporting could have had an impact on the validity of the results.

Conclusion for Secondary Education

Similar to results seen in elementary and middle school studies, the effect of class size on student achievement for secondary school students were inconclusive. Atta et al. (2011), Brühwiler and Blatchford (2011), Heinesen (2010), and Krassel and Heinesen (2014) showed statistically significant improvements while Shin and Chung (2009), Corak and Lauzon (2009), Wyss et al. (2007), Owoeye and Yara (2011), and Jakobsson et al. (2013) showed little to no improvement. Of the studies at the secondary level showing that class size had little to no effect on student achievement, the only one that did not use standardized test scores was the Wyss et al. study. This study was unique in that the researchers focused on sustained improvement after high school as opposed to improvement while students were in the actual smaller classes. Shin and Chung, Corak and Lauzon, as well as Owoeye and Yara, used standardized test results to measure student achievement. By way of comparison, Atta et al. used teacher and student surveys

to determine changes in academic achievement, and using this type of self-report instrument may have impacted the result of the study. While studies have shown conflicting evidence about the effect of class size on student achievement, other studies have shown that reducing class size can have other potential positive effects.

Other Potential Benefits of Class Reduction

Gottfredson and DiPietro (2011) pointed out that CSR could have other benefits beyond just student achievement like class grades or standardized test scores. Their study included 253 public secondary schools from across the United States and used data from teacher and student surveys as well as from the National Study of Delinquency Prevention in Schools. Using a hierarchical linear modeling approach to analyze the data, the researchers found that students who attended schools with smaller student-teacher ratios reported lower levels of student victimization than students who attended schools with larger classes. They found that classroom dynamics in smaller classrooms led to a much more effective teaching environment.

O'Brennan, Bradshaw, and Furlong (2014) examined the effect of teacher and student perceptions on school climate. They used data from 1,881 fifth grade students and 90 teachers from 37 Maryland elementary schools. The researchers found that student perceptions had a major influence on school climate and that one of the main contributing factors to student achievement was student-teacher ratio.

Englehart (2007) conducted a qualitative study to gain a greater understanding about why a reduction in class size could have a significant effect on student achievement. Englehart'study took place in an Ohio middle school and consisted of

observations completed in two different subject classrooms, one small (15 students) and one large (23 students). The two classrooms were different subjects and eight students were members of both classes. Englehart interviewed the eight students in addition to completing the observations. Englehart found that students were able to transition from one task to another quicker in the small class and spent a greater amount of time engaged in the material presented. In addition, the students interviewed stated that in the small class, the atmosphere was much more conversational and familial. This helped facilitate their learning by opening lines of communication between teachers and students.

Handal, Watson, and Maher (2015) reported similar results in a study of secondary school math teachers' perspectives on class size in New South Wales, Australia. They found that the preferred class size of nearly half of the respondents was 16–20 students. In addition, all of the 12 teachers interviewed for the study believed that smaller class size was beneficial to student achievement. They believed that smaller class sizes led to a decrease in classroom management issues which would be particularly beneficial to lower achieving students. Harfitt (2012a) conducted a qualitative study of three secondary school English teachers in Hong Kong who also reported they held the same beliefs as the teachers in the Handal et al. study. He found that teachers reported they were able to foster more intrapersonal relationships with students, could spend more time for review of material if needed, and had fewer discipline problems in smaller classes.

Blatchford, Bassett, and Brown (2011) found that student engagement increased in smaller classrooms. They used observations to determine the amount of classroom

engagement and student-teacher interactions at both the secondary and primary level. The study was conducted in England at 49 different schools with eight students observed in each class. At the primary level, the average class size was 23, and at the secondary level, the average class size was 18. Blatchford et al. found that in larger classes, student interaction with teachers decreased at all grade levels, and additionally, at the secondary level, lower achievers were off-task much more.

Din (1999) conducted a study of 55 Chinese rural teachers from 132 schools with a population of 41,200 students. The average class size in the study was 48 students. Din found that students in smaller classes tended to help the teacher with classroom management, had more positive student-teacher interactions, and received more individualized help from teachers. Fan (2012) obtained similar results in a meta-analysis of CSR studies. The researcher found that smaller classes gave students more access to computers and additional space, and teachers were able to spend less time on classroom management, which in turn led to greater student achievement. Konstantopoulos and Sun (2014) analyzed data from the Project STAR study and found that teacher effects (teaching skills and practices) had a larger impact on student achievement in smaller classrooms than regular size classrooms.

Smaller class sizes were also shown to give teachers an opportunity to increase parental involvement and improve teacher curriculum planning and development. DiBiase and McDonald (2015) surveyed 275 middle and secondary school science teachers from four North Carolina school districts about their attitudes towards inquiry based learning and obstacles that they might face in implementing inquiry based learning

curriculums. While over 90% of respondents stated that inquiry based learning was a highly effective learning tool, 68% also stated that large class size greatly hindered their ability to implement inquiry based learning into their curriculums. Graue Hatch, Rao, and Oen (2009) and Graue, Rauscher, and Sherfinski (2009) performed analyses of the Student Achievement Guarantee in Education (SAGE) program which lowered class sizes in K–3 in Wisconsin. The researchers found that smaller classes gave teachers more opportunities to reach out to parents and include them in the educational process. They looked at three specific schools in the SAGE program that were chosen due to their unusually large increases in student achievement after SAGE implementation. The researchers conducted seven half-day observations in classrooms, and interviews were conducted with the school staff at the three schools. They found that teachers who used smaller classes to differentiate and individualize their curriculums showed significant gains in student achievement. Rodriguez and Elbaum (2014) analyzed the role of student-teacher ratio in parental perceptions in Florida schools ranging from elementary to secondary education. They determined student-teacher ratios by taking the total number of students and dividing it by the total number of teachers. Rodriguez and Elbaum collected parental perceptions from a state-wide database of parental interactions. The researchers found that student-teacher ratio was the strongest predictor of parental engagement when compared to school size, grade level, and social economic status. They surmised that teachers with smaller class sizes had more time to interact with parents and to develop more personal bonds.

Fredriksson, Öckert, and Oosterbeek (2013) analyzed the long-term effects of class size on teenagers' (ages 13–16) cognitive and noncognitive achievement, and their wages and earnings as adults (ages 27–42). The researchers analyzed fourth through sixth grade classrooms in Sweden. They found that smaller class sizes had a statistically significant impact on earnings and abilities. A one student reduction in class size resulted in a 0.8% increase in the chance of earning a college degree and a 1.2% increase in earnings relative to the average. In addition, at age 13, students who were in small classes in Grades 4 through 6 had an increase in cognitive abilities of 0.23 standard deviations, and a one student decrease in class size increased noncognitive ability by 0.026 standard deviations. By age 16, a one student decrease in class size when in Grades 4 through 6 yielded an increase in student achievement of 0.023 standard deviations. These findings indicate that an increase in the cost of education from CSR for the state would result in an increase in future wage earnings for its constituents.

Class Size Manipulation

Barrett and Toma (2013) examined whether principals adjust class size based on teacher effectiveness by either increasing or decreasing the number of students in a class. They used class size data from 10 Kentucky school districts for the years 2000 through 2008. Math courses from elementary level to high school level were included in the study. The researchers used teacher-student observations as well as standardized test scores to determine teacher effectiveness. Effective teachers had larger class sizes than less effective teachers. In a study of all high school seniors in Israel for the 2003 school year, Cohen-Zada, Gradstein, and Reuven (2013) found similar principal manipulation of

class size occurring. Using a regression discontinuity analysis of 64,429 students, Cohen-Zada et al. found that principals not only allocated students based on student strength, but even tried to manipulate maximum class size rules to give disadvantaged students smaller classes.

Principal manipulation of class size could have a significant impact on any studies in which researchers are attempting to determine the impact of class size on student achievement. Petrilli and Northern (2014) conducted a study to determine if students could achieve more in larger classes with high performing teachers than in small classes with lower performing teachers. Using fifth and eighth grade test score data in North Carolina, they found that over a 4 year period, when 12 additional students were assigned to effective teachers, it would be the equivalent of adding two and a half weeks to the school year. Giving lower performing teachers smaller classes also showed an improvement in student grades, indicative that class size does have an effect on student achievement although not as significant as teacher ability.

Bosworth (2014) conducted a study to determine not only whether class size manipulation was occurring, but also whether this manipulation on class size would have an impact on student achievement. He used end-of-grade test results in math and reading from fourth and fifth grade students in North Carolina and demographic data taken from the North Carolina Education Research Center. Bosworth found that classrooms exhibited significant evidence of non-random assignment based on income, learning level, parental education, and student ability. In addition, he found that African American, free and reduced-price lunch, and learning disabled students were assigned to

smaller classes. This means that students who traditionally struggle in school were assigned to smaller classes at a much higher rate than students who performed well in school. When classroom composition was not taken into account, smaller class size showed no effect on student achievement. However, when class composition was taken into account, Bosworth found a small but statistically significant effect. A one student decrease in class size resulted in a 0.0052 standard deviation increase in student achievement.

Confounding Variables Impacting Student Achievement

Studies undertaken by researchers at all levels of education investigating the effect that class size had on student achievement has offered inconclusive evidence about the actual effects on student achievement. As a result, other confounding variables not accounted for in these studies may have had an effect on student achievement. Parenting, teaching strategies, school principals, school size, and the emotional state of the students themselves all may have had an effect on student achievement.

Chen (2015), Arefi, Naghibzadeh, and Boloki (2014), and Bong Joo, Hyun Suk, Se Hee (2014) studied the effect of parenting on student achievement. Chen examined the effects of two types of parenting styles in China, authoritative (rational, democratic, and flexible) and authoritarian, on students' GPA, an outcome measure of student achievement. Chen found that students with authoritative parents had statistically significant higher GPAs than students with authoritarian parents. With a sample of 270 participants, ages 13–19, in Urmia Iran, Arefi et al. studied the effect of parental emotional attachments on student achievement. The researchers used questionnaires to

determine emotional attachment and academic achievement and then used Pearson correlation to test their research questions. They found a positive, statistically significant correlation between parental emotional attachment and student achievement. Bong Joo et al. studied the effects of parenting behaviors on low and high income households. They conducted the study in Korea using the Korean Welfare Panel Study, a nationwide, longitudinal survey. A total of 609 participants were included, ages 14–16. The researchers found that for both low and high income earners, parenting behaviors had a statistically significant effect on student achievement.

Ercan (2014) studied the effect of teacher use of multimedia in the classroom on student achievement. He used a pretest/posttest model with 62 fifth grade Turkish student participants. Ercan found that teacher utilization of multimedia had a statistically significant positive impact on student achievement. Rashidi and Moghadam (2014) studied the effect of teacher self-efficacy on student achievement. They conducted the study in Shiraz, Iran, with 16 instructors and 225 middle school student participants. Using multiple regression, Rashidi and Moghadam found that teachers with a high level of self-efficacy had students with a high level of academic achievement and student satisfaction. Ngware, Oketch, and Mutisya (2014) studied the effects of teaching style on student achievement. They conducted the study in the six lowest achieving Kenyan primary schools. The researchers used the Kenya Certificate of Primary Education to measure student achievement and a combination of questionnaires and observations to determine teaching style. Ngware et al. found that teaching experience greatly increased student achievement and that the effect was far greater than that of class size reduction.

Ekembe (2014) studied the effect of teaching methodology on foreign language classrooms. He focused his investigation on two teaching styles, direction instruction and teacher-led interaction, and used a pretest, posttest, and delayed posttest experimental design. Ekembe found a higher level of student achievement from the students who had direct-instruction while the students in the teacher-led interaction group had a higher level of long-term retention as measured in the delayed posttest.

Tatlah, Iqbal, Amin, and Quraishi (2014) studied the effect of principal behaviors on the academic achievement of tenth grade students in Punjab, Pakistan. Sixty-four principals and 1,920 students participated in the study. They measured academic achievement using annual examination results. Using multiple regression analysis, Tatlah et. al found that different principal leadership behaviors had a statistically significant impact on student achievement. Walker, Lee, and Bryant (2014) studied the effect of specific principal leadership styles on academic achievement in secondary schools in Hong Kong. One hundred seventy-nine staff members and 2,037 students from 42 different schools took part in the study. They used surveys to determine leadership style and standardized tests to determine academic achievement. The researchers studied three different leadership styles: utilization of communication structures, quality assurance and accountability, and resource management. Walker et. al found that utilization of communication structures leadership style had a statistically significant positive impact on student achievement while both the quality assurance and accountability and resource management leadership styles had a negative impact on student achievement.

Gershenson and Langbeing (2015) studied the effect of school size on student achievement of fourth and fifth grade students in North Carolina. They used end-of-grade tests to determine student achievement. Overall, they found that school size had no statistically significant effect on student achievement. However, Gershenson and Langbeing did find that in terms of students with learning disabilities and low income, school size did have a statistically significant effect on student achievement. When separating school size into individual grades, they found that a 10 student increase in grade size decreased reading and math scores by 0.015 standard deviations.

Costa and Faria (2015), Tulbure (2014), and Wang et al. (2014) conducted studies investigating the effect of the emotional state of the students themselves on academic achievement. Costa and Faria examined the effect of emotional intelligence on academic achievement. They conducted the study in Portugal with 380 10th–12th grade student participants. The researchers found that emotional intelligence had a very strong ability to predict academic achievement. In a study of 284 students ranging in age from 18–25, Tulbure (2014) found that lower academic achievement was associated with isolationism, emotional instability, and negative self-image. Higher academic achievement was associated with conformity, conscientiousness, and positive self-image. In a study of 1,023 fifth grade students from 50 schools in Ontario, Canada, Wang et al. (2014) found that peer victimization had a significant effect on student achievement. They found that this effect on student achievement was not moderated by an otherwise positive school climate.

Implications

Proponents of small class sizes have argued that decreasing class size is the simplest, most direct approach to improving student achievement (Classes, 2011). While many researchers have found that class size had an impact on student achievement, the specific class size was very much in dispute, and there was little to no consensus about what the optimal size would be and how much of an improvement could actual be gained. Funkhouser (2009) suggested that there were two competing forces at work when reducing class size. Increases in teacher-to-student interactions would produce an improvement in student achievement while a decrease in student-to-student interaction would create a negative result. Jirjahn, Pfeifer, and Tsertsvadze (2009) argued that it was impossible to determine the effects of class size without taking into account instructor fixed effects. In cases where students were allowed to choose their teachers, more highly qualified teachers would have larger class sizes and as Bosworth (2014) found, principals often manipulate class size, giving highly qualified teachers larger classes. This would mitigate the effects of larger class sizes on student grades.

Skeptics have argued that given the substantial cost of CSR and the lack of definitive improvements in student achievement, there were far better and more cost effective ways to improve student achievement (Classes, 2011). Normore and Ilon (2006) conducted a cost effectiveness analysis of Florida's class reduction law and found that reducing class size was the single most expensive way to attempt to increase student achievement and recommended that investing in other strategies such as teacher quality could produce the same or better results at a lower cost. However, Cheung and Chan

(2008) analyzed data from the International Institute for Management Development's 2004 yearbook and found a positive correlation between countries that spent more on education by investing in smaller class sizes and higher world rankings in math and reading. Also, the cost of CSR was, in some cases, overstated. The cost of implementing the Florida legislation that limited class size to 20 students per teacher in Grades 1–3 actually came in below the original predicted estimates (Januszka & Dixon-Krauss, 2008). Given the great deal of uncertainty of the benefits of class size reduction at all levels of education, the purpose of this study was to determine the effects of class size at the secondary school level in a school district in South Carolina.

Summary

The benefit of CSR on student achievement from primary to secondary education is inconclusive. Some studies indicate that CSR has a large positive impact on student achievement while other studies show little to no impact on student achievement. At the elementary school level, the Project STAR study showed a significant improvement in student achievement when class sizes were reduced. However, later re-analysis of the Project STAR study data offered conflicting results with some studies supporting the Project STAR study's findings while others finding major flaws with the methodology used that called into question the report's results. At the middle school level, Chingo (2012) analyzed standardized test scores and found little to no improvement in student achievement while Heinesen's (2010) study focused on specific subjects and showed an improvement. At the secondary level, Atta et al. (2011) and Brühwiler and Blatchford (2011), Heinesen (2010), and Krassel and Heinesen (2014) showed statistically

significant improvements in academic achievement while Wyss et al. (2007), Shin and Chun (2009), Corak and Lauzon (2009), and Owoeye and Yara (2011) showed little to no improvement.

While the effects of CSR on student achievement are inconclusive, research does show that CSR can have positive effects on student engagement. In addition, parents, students, and teachers believe that smaller class size creates a more positive learning environment for students. While these effects may not translate into higher standardized test scores, they may result in students in smaller classes achieving higher ECG. Based on the inconclusive findings in the literature, further study is warranted to determine the effect of class size on student ECG. In the next section, Section 3, I discuss the research design that was used to conduct this study.

Section 3: The Methodology

Introduction

The purpose of this quantitative study was to determine the effect of class size on student achievement in secondary school as measured by TIECNSG. To address this purpose, the following research question guided the study: Does class size have an effect on student achievement in secondary school as measured by TIECNSG? In this section, I described the methodology that was used to answer this research question, specifically the research design and approach, setting and sample, instrumentation and materials, data collection and analysis, and the role of the researcher.

Research Design and Approach

In this study, I used a correlational research design, specifically testing a linear regression model to answer the research question. In South Carolina, all grades are recorded on a 100-point grading scale, so raw scores of student grades were used as the criterion variable. In this study, the academic subjects analyzed were the core high school subjects of English language arts, math, science, and social studies. Teachers have some discretion in the makeup of course assignments and how much each assignment counts toward the ECG; however, similar courses taught at the same school are required to have aligned grading standards. Across the district, curriculum coordinators make sure that all schools align grading standards for similar courses. Other electives were excluded from the study because there might be less consistency in the grading methodology from teacher to teacher than there are with the core subjects.

Setting and Sample

The participants for this study were the students in five of the nine secondary schools in the South Carolina district under study. These five secondary schools were chosen because the selected demographic variables were least dissimilar among the five schools than other high schools within the district. Figure 1 shows a comparison of the ethnicities of students at the selected secondary schools. While each school is not exactly similar in its ethnic composition, combined, they are representative of the population of the county.

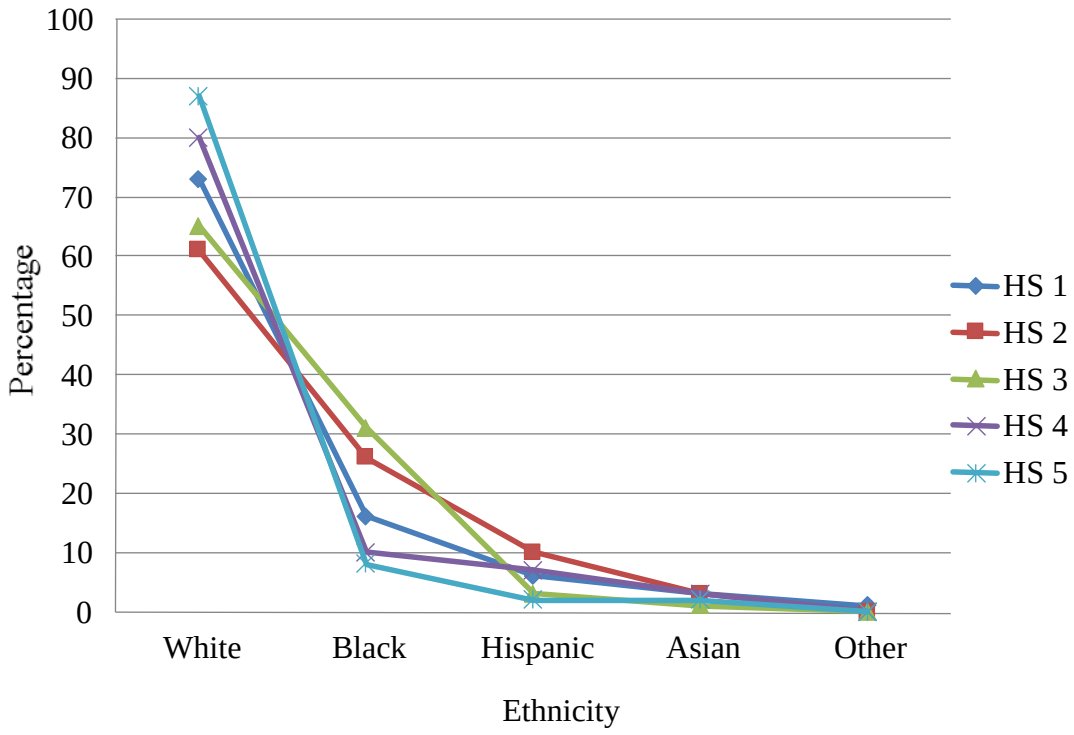

Figure 1. School breakdown by ethnicity during the 2010-2011 school year. Adapted from "School Detail for County," by National Center for Education Statistics, 2012, http://nces.ed.gov/ccd/schoolsearch/school_detail

Figure 2 displays the average HSAP scores for 10th graders for the years from 2005 to 2012. Excluding the one outlier for High School (HS) 3, in 2005, the remaining data points vary in magnitude from 79% to 88%.

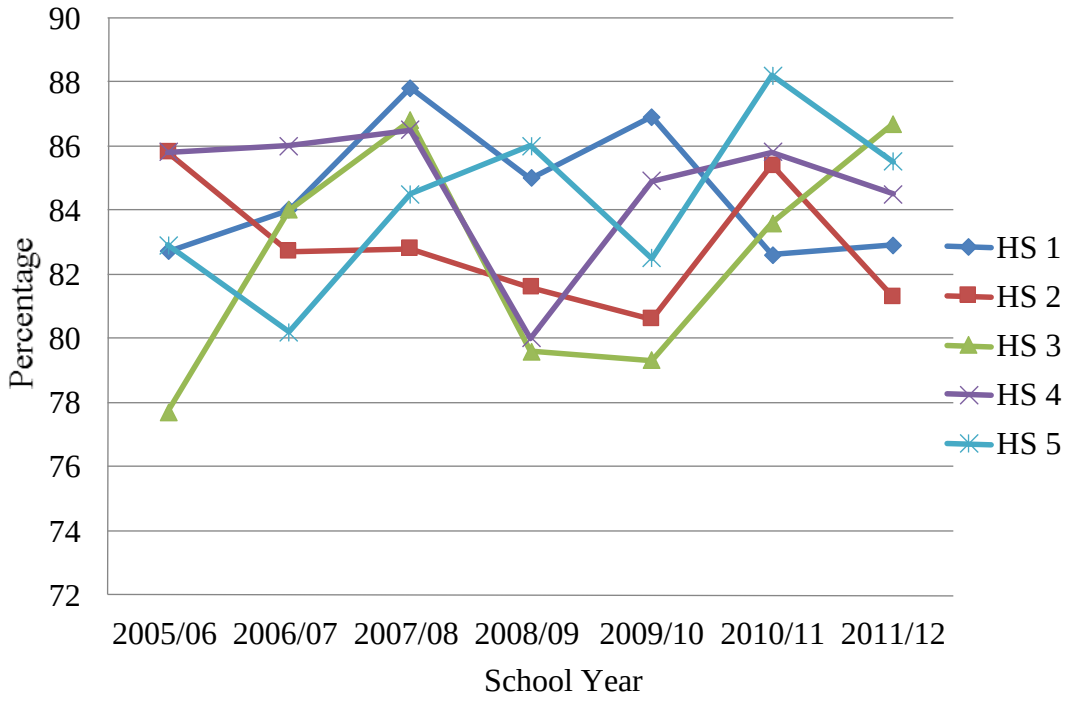

Figure 2. High School Assessment Program (HSAP) scores for 10th graders from 2005 to 2012 for each school. Adapted from "SC Annual School Report Card," by South Carolina Department of Education , 2008-2012,http://ed.sc.gov/data/report-cards.

Figure 3 shows the graduation rates of the five secondary schools from 2007 to 2012. While HS 1 is an outlier, consistently having the lowest graduation rate, the HSAP scores for HS 1 were among the highest of the five high schools. In the 2010-2011 and the 2011-2012 school years, three of the schools were very tightly clustered in their graduation rates.

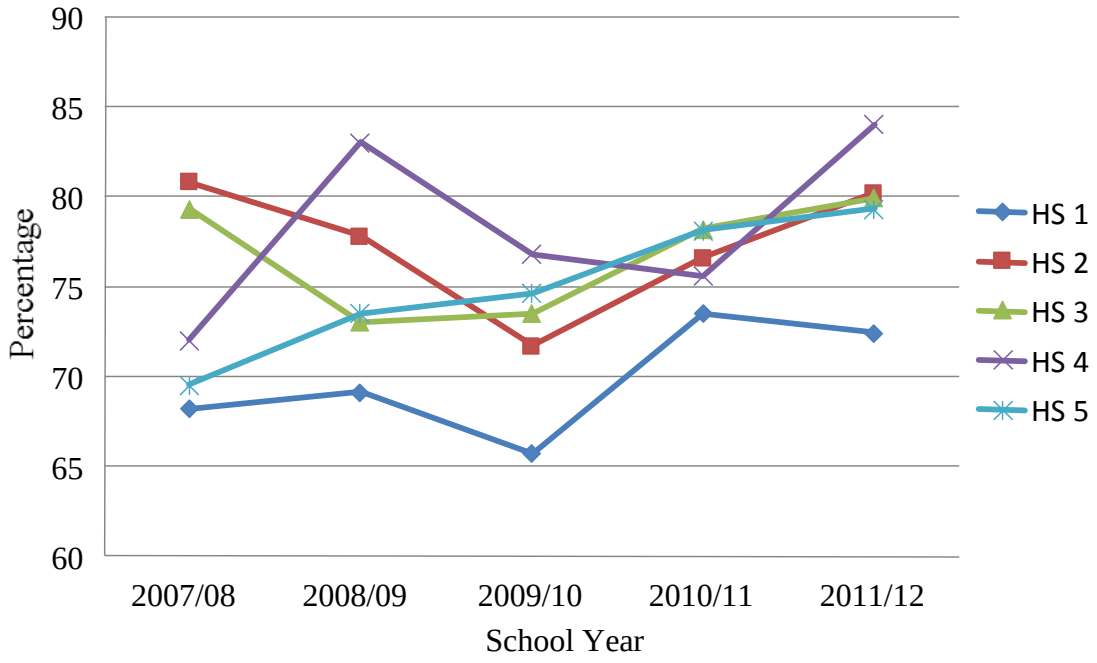

Figure 3. Graduation rates from 2007 to 2012 for each school. Adapted from "SC Annual School Report Card," by South Carolina Department of Education, 2008-2012,http://ed.sc.gov/data/report-cards.

Figure 4 displays the number of eligible students for free lunches for the 2009-2010 school year for the five secondary schools under study. This is the most recent year for which these data are available. Between 33% to 49% of the students in these schools receive free lunches, which is a proxy measure of socioeconomic status. While HS 3 and HS 2 have the highest percentage of students receiving free lunches, they also have some of the highest graduation rates.

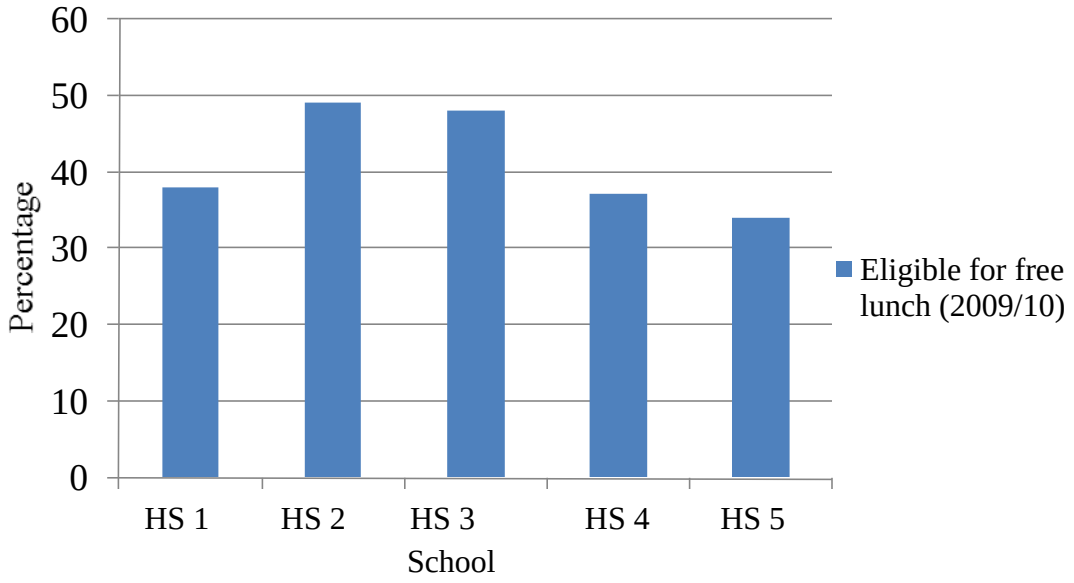

Figure 4. Each school's eligibility for free lunch during the 2009-2010 school year. Adapted from "School Detail for County," by National Center for Education Statistics, 2012, http://nces.ed.gov/ccd/schoolsearch/school_detail.

The total number of students enrolled in those schools during the 2012-2013 school year was approximately 7,300 (National Center for Education Statistics, 2012). In a given year, nearly each secondary student takes one of the four core courses, so the total number of student grades in mandatory courses was approximately 20,000. For the purpose of this study, students who dropped out of the course prior to completion were excluded from the sample. These students were identified because their ECG were labeled failure due to attendance. According to Wilson Van Voorhis and Morgan (2007), the minimum reasonable sample size for regression analysis is 50. Soper (2014) recommended that if a small effect size is anticipated, then a power of .80 and alpha value of .05 be used in priori sample size calculations. The minimum sample size is 385 for running a linear regression with one predictor for each class type (Algebra 1, Chemistry Honors, Global Studies 1, etc.). The total number of class types is 40 for the

four core subjects (English language arts, mathematics, science, and social studies) which would result in a total sample size of 15,400. Therefore, the entire population was used for this study which consisted of 17,582 TIECNSG.

Instrumentation and Materials

In this study, I determined the effect of class size on TIECNSG for secondary schools. Class size was the independent (predictor) variable. Student achievement as measured by TIECNSG, was the dependent (criterion) variable with numerical values from 0 to 100.

The data used to test the null hypotheses were archival in nature and consisted of TIECNSG and class size. These data, while not public, are stored at the district office and collected with grading software currently used by all secondary school teachers in the district. At the conclusion of each course, every teacher in the district uploads a spreadsheet for each class that consists of the number of students, the course taught, and the ECG for each student. ECG are calculated from assignments consisting of homework, class work, major projects, quizzes, and tests. Teachers have some discretion in the makeup of these assignments and how much each assignment counts toward the ECG; however, similar courses taught at the same school are required to have aligned grading standards and across the district, curriculum coordinators make sure that all schools align grading standards for similar courses.

Data Collection and Analysis

Prior to data collection, approval was received from Walden's IRB (approval number 03-18-14-0171335).The data for this study were collected from the district

database and electronically copied by class size and class type into a single data file by the director of program evaluation and assessment of the district. I analyzed the collected data using SPSS 22.0 for Windows. The effect of class size was examined using a linear regression test. Green and Salkind (2011) recommended the use of a bivariate linear regression test to assess how well an independent (predictor) variable can predict a dependent (criterion) variable. The predictor variable in this study was class size and the criterion variable was teacher-issued end-of-course numerical student grade (ranging from 0-100).

The typical confidence level used in educational research is .05 (Hadzi-Pavlovic, 2009), which I used in this study. The equation I used to model the relationship between TIECNSG and class size is as follows:

$$y = x\beta + \varepsilon$$

y is the dependent variable (TIECNSG), *x* is the independent variable (class size), β is the regression coefficient, and ε is the error term. The error term was used to account for any factors that might have affected the dependent variable besides the independent variable. To calculate β, an ordinary least squares approach was used (Mendenhall & Sincich, 1996).

Role of the Researcher

The main ethical concern in this study was that private student records were accessed. To maintain confidentiality and to protect the anonymity of students, student names were deidentified from their grades. This step was completed by the director of program evaluation and assessment at the district office prior to my receiving the data. I

was given the data, which consisted of TIECNSG, class size, and subject on a flash drive in a password protected zip file. The password was only known by me. From this flash drive, I copied the data onto my district-issued, password protected laptop.

All data were analyzed on my district-issued laptop, which had protections in place to protect sensitive student data already on the laptop. These preventions included a password that was only known by me as well as tracking software that can determine the exact location of the laptop at all times. The laptop remained in my possession during the entirety of this study. In addition, I was the only individual to access the laptop throughout the study.

I entered and analyzed all data using my district-issued laptop. Backup copies of the raw and analyzed data were stored on a flash drive in a password protected file. Throughout the entire process, I was the only person with access to the data both before and after they were analyzed. The data were deleted from the laptop immediately following the analysis of the data and will remain on the flash drive in a locked cabinet in my home office at my personal residence for 5 years.

Conclusion

To answer the research question of whether class size has an effect on student achievement in secondary schools (Grades 9–12) as measured by TIECNSG, a correlational design was used, and linear regression was performed to analyze the data. Class size was the independent (predictor) variable and student achievement, as measured by TIECNSG, was the dependent (criterion) variable. The sample consisted of 17,582 TIECNSG from the five schools examined in this study. The main ethical concern was

that private student records would be accessed. To maintain confidentiality and to protect the anonymity of students, their names were deidentified from their grades prior to my access to the data.

The next section presents an in-depth summary of the results of analyzing the data. The research question is addressed and answered based on the results of the data analysis.

Section 4: Results

Introduction

The purpose of this quantitative study was to determine the effect of class size on student achievement in secondary school as measured by TIECNSG. To address this purpose, the following research question guided the study: Does class size have an effect on student achievement in secondary school as measured by TIECNSG? This section describes the results of analyzing the data using a linear regression model. The data were first organized by subject, and then linear regression was performed for each class type.

English

The English courses taught at the five high schools participating in this study consisted of eight class types: English 1, English 1 Honors, English 2, English 2 Honors, English 3, English 3 Honors, English 4, and English 4 Honors. A total of 5,430 grades were used, which consisted of all grades for the 2012-2013 school year, excluding failures due to absences and special education students in pull-out, single person courses. As shown in Table 3, of the eight courses, only English 2, English 2 Honors, and English 4 yielded results that were statistically significant ($p < .05$). Of these three class types, English 2 and English 2 honors yielded negative *B* values of -0.37 and -0.27, respectively; this indicates that as class size increases, TIECNSG decreases. However, English 4 yielded a positive *B* value of 0.31 indicating that as class size increases, TIECNSG increase as well. English 2 yielded a *R* value of .09, English 2 Honors a *R* value of .11, and English 4 a *R* value of .10. An *R* value of .10 indicates a small effect size (Foster, Barkus, & Yavorsky, 2006).

Table 3

Results of Linear Regression Analysis Predicting Impact of Class Size on Teacher-Issued Numerical Grades (English)

Course	Variable name	*B*	*SE B*	β	*t*	*p*
English 1	Class size[a]	0.03	.08	.01	0.39	.696
English 1 Honors	Class size[b]	0.14	.07	.09	1.93	.054
English 2	Class size[c]	-0.37	.13	-.09	-2.55	.006
English 2 Honors	Class size[d]	-0.27	.10	-.11	-2.71	.007
English 3	Class size[e]	-0.09	.12	-.02	-0.71	.480
English 3 Honors	Class size[f]	0.10	.14	.10	0.71	.480
English 4	Class size[g]	0.31	.11	.10	2.77	.006
English 4 Honors	Class size[h]	< -0.01	.06	< -.01	-0.06	.950

[a]*Note*. $R = .01$, $R^2 < .01$, adjusted $R^2 < .01$, $F(1, 868) = 0.15$, $p = .696$.
[b]*Note*. $R = .09$, $R^2 < .01$, adjusted $R^2 < .01$, $F(1, 459) = 3.74$, $p = .054$.
[c]*Note*. $R = .09$, $R^2 < .01$, adjusted $R^2 < .01$, $F(1, 1026) = 7.62$, $p = .006$.
[d]*Note*. $R = .11$, $R^2 = .01$, adjusted $R^2 = .01$, $F(1, 644) = 7.33$, $p = .007$.
[e]*Note*. $R = .02$, $R^2 = .01$, adjusted $R^2 < .01$, $F(1, 927) = 12.11$, $p = .480$.
[f]*Note*. $R = .04$, $R^2 < .01$, adjusted $R^2 < .01$, $F(1, 387) = 0.48$, $p = .480$.
[g]*Note*. $R = .10$, $R^2 < .01$, adjusted $R^2 < .01$, $F(1, 780) = 7.64$, $p < .006$.
[h]*Note*. $R < .01$, $R^2 < .01$, adjusted $R^2 < .01$, $F(1, 323) < 0.01$, $p = .950$.

The two negative *B* value results and one positive *B* value indicate no clear effect of class size on TIECNSG. Five of the eight class types showed no statistically significant results and of the three that did, one showed that smaller class size negatively affected TIECNSG, while two showed that smaller class size positively affected

TIECNSG. In all three cases, the effect size was small. Therefore, for the subject of English, based on these results, the null hypothesis that class size in secondary school cannot predict student achievement as measured by TIECNSG cannot be definitively rejected.

Mathematics

The mathematics courses taught at the five high schools participating in this study consisted of nine class types: Algebra 1, Algebra 1 Honors, Algebra 2, Algebra 2 Honors, Geometry, Geometry Honors, Pre-Calculus, Pre-Calculus Honors, and Probability and Statistics. A total of 4,171 grades were used, which consisted of all grades for the 2012-2013 school year, excluding failures due to absences and special education students in pull-out, single person courses. As shown in Table 4, of the nine courses, Algebra 1, Algebra 1 Honors, Algebra 2, Algebra 2 Honors, Pre-Calculus, and Pre-Calculus Honors all yielded results that were statistically significant ($p < .05$). Of these six class types, only Algebra 1 and Pre-Calculus yielded negative *B* values of -0.22 and -1.04, respectively; this indicates that as class size increases, TIECNSG decreases. However, Algebra 1 Honors, Algebra 2, Algebra 2 Honors, and Pre-Calculus Honors yielded positive *B* values of 0.29, 0.33, 0.28, and .26, respectively, indicating that as class size increases, TIECNSG increase as well.

Table 4

Results of Linear Regression Analysis Predicting Impact of Class Size on Teacher-Issued Numerical Grades (Mathematics)

Course	Variable name	*B*	*SE B*	β	*t*	*p*
Algebra 1	Class size[a]	-0.22	.06	-.14	-3.76	<.001
Algebra 1 Honors	Class size[b]	0.29	.14	.24	2.11	.039
Algebra 2	Class size[c]	0.33	.14	.08	2.49	.013
Algebra 2 Honors	Class size[d]	0.28	.13	.10	2.19	.029
Geometry	Class size[e]	0.08	.06	.04	1.24	.214
Geometry Honors	Class size[f]	-0.19	.14	-.06	-1.32	.186
Pre-Calculus	Class size[g]	-1.04	.23	-.38	-4.57	< .001
Pre-Calculus Honors	Class size[h]	0.26	.13	.11	2.04	.042
Probability and Statistics	Class size[i]	-0.03	.11	-.03	-0.22	.824

[a]*Note*. $R = .14$, $R^2 = .02$, adjusted $R^2 = .02$, $F(1, 687) = 14.17$, $p < .001$.
[b]*Note*. $R = .24$, $R^2 = .06$, adjusted $R^2 = .05$, $F(1, 70) = 4.44$, $p = .039$.
[c]*Note*. $R = .08$, $R^2 < .01$, adjusted $R^2 < .01$, $F(1, 858) = 6.17$, $p = .013$.
[d]*Note*. $R = .10$, $R^2 = .01$, adjusted $R^2 = .01$, $F(1, 497) = 4.77$, $p = .029$.
[e]*Note*. $R = .04$, $R^2 < .01$, adjusted $R^2 < .01$, $F(1, 797) = 1.55$, $p = .214$.
[f]*Note*. $R = .06$, $R^2 < .01$, adjusted $R^2 < .01$, $F(1, 442) = 1.75$, $p = .186$.
[g]*Note*. $R = .38$, $R^2 = .14$, adjusted $R^2 = .14$, $F(1, 124) = 20.91$, $p < .001$.
[h]*Note*. $R = .11$, $R^2 = .01$, adjusted $R^2 < .01$, $F(1, 373) = 4.16$, $p = .042$.
[i]*Note*. $R = .01$, $R^2 < .01$, adjusted $R^2 < .01$, $F(1, 305) = 0.05$, $p = .824$.

Algebra 1, Algebra 2, Algebra 2 Honors, and Pre-Calculus yielded *R* values of .14, .08, .10, and .11, respectively, indicating a small effect size. Algebra 1 Honors had an *R* value of .24, indicating a small-to-medium effect size, and Pre-Calculus had an *R* value of .38, indicating a medium effect size. An *R* value of .30 indicates a medium effect size (Foster, Barkus, & Yavorsky, 2006).

These two negative *B* value results and four positive *B* value indicate no clear effect of class size on TIECNSG. Three of the nine class types showed no statistically significant results and of the six that did, four showed that smaller class size negatively affected TIECNSG, while two showed that smaller class size positively affected TIECNSG. The only class type that showed smaller class size had a strong effect on TIECNSG was Pre-Calculus; however, there were conflicting results in four other classes. Therefore, for the subject of mathematics, based on these results, the null hypothesis that class size in secondary school cannot predict student achievement as measured by TIECNSG cannot be definitively rejected.

Science

The science courses taught at the five high schools participating in this study consisted of 13 class types: Anatomy, Anatomy Honors, Biology, Biology Honors, Chemistry, Chemistry Honors, Environmental Science, Marine Science, Marine Science Honors, Physical Science, Physical Science Honors, Physics, and Physics Honors. A total of 4,129 grades were used, which consisted of all grades for the 2012-2013 school year, excluding failures due to absences and special education students in pull-out, single person courses. As shown in Table 5, of the 13 courses, only Biology, Marine Science,

Physical Science, Physical Science Honors, and Physics Honors yielded results that were statistically significant ($p < .05$). Of these five class types, Biology, Marine Science and Physical Science yielded negative *B* values of -0.47, -0.34 and -0.49, respectively; this indicates that as class size increases, TIECNSG decreases. However, Physical Science Honors and Physics Honors yielded a positive *B* value of 0.30 and 0.65, respectively, indicating that as class size increases, TIECNSG increase as well. Biology, Marine Science, Physical Science, and Physical Science Honors yielded *R* values of .15, .15, .12, and .12 respectively. These values indicate a small effect size. Physics Honors yielded an *R* value of .27, indicating a small-to-medium effect size (Foster, Barkus, & Yavorsky, 2006).

These three negative *B* values and two positive *B* values indicate no clear effect of class size on TIECNSG. Eight of the 13 class types showed no statistically significant results and of the five that did, two showed that smaller class size negatively affected TIECNSG while three showed that smaller class size positively affected TIECNSG. The only class type that showed smaller class size had a strong effect on TIECNSG was Physics Honors, which actually showed that increasing class size had a positive effect on TIECNSG. Therefore, for the subject of science, based on these results, the null hypothesis that class size in secondary school cannot predict student achievement as measured by TIECNSG cannot be definitively rejected.

Table 5

Results of Linear Regression Analysis Predicting Impact of Class Size on Teacher-Issued Numerical Grades (Science)

Course	Variable name	*B*	*SE B*	β	*t*	*p*
Anatomy	Class size[a]	0.28	.21	.13	1.31	.192
Anatomy Honors	Class size[b]	0.59	.38	.12	1.55	.123
Biology	Class size[c]	-0.47	.09	-.15	-5.08	< .001
Biology Honors	Class size[d]	-0.07	.07	-.05	-1.01	.313
Chemistry	Class size[e]	-0.24	.13	-.07	-1.83	.068
Chemistry Honors	Class size[f]	-0.05	.12	-.02	-0.39	.698
Environmental Science	Class size[g]	0.05	.23	.02	0.20	.843
Marine Science	Class size[h]	-0.34	.11	-.15	-3.13	.002
Marine Science Honors	Class size[i]	0.14	.11	.12	1.33	.187
Physical Science	Class size[j]	-0.49	.12	-.12	-4.13	< .001
Physical Science Honors	Class size[k]	0.30	.13	.12	2.42	.016
Physics	Class size[l]	0.26	.31	.09	0.84	.404
Physics Honors	Class size[m]	0.65	.24	.27	2.69	.008

[a]*Note*. $R = .14$, $R^2 = .02$, adjusted $R^2 = .01$, $F(1,96) = 1.73$, $p = 192$.
[b]*Note*. $R = .12$, $R^2 = .01$, adjusted $R^2 < .01$, $F(1, 180) = 2.40$, $p = .123$.
[c]*Note*. $R = .15$, $R^2 = .02$, adjusted $R^2 = .02$, $F(1, 1061) = 25.79$, $p < .001$.
[d]*Note*. $R = .05$, $R^2 < .01$, adjusted $R^2 < .01$, $F(1, 494) = 1.02$, $p = .313$
[e]*Note*. $R = .07$, $R^2 < .01$, adjusted $R^2 < .01$, $F(1, 679) = 3.33$, $p = .068$.
[f]*Note*. $R = .02$, $R^2 < .01$, adjusted $R^2 < .01$, $F(1, 395) = 0.15$, $p = .698$.
[g]*Note*. $R = .02$, $R^2 = .14$, adjusted $R^2 = .14$, $F(1, 157) = 0.04$, $p = .843$.
[h]*Note*. $R = .15$, $R^2 = .02$, adjusted $R^2 = .02$, $F(1, 449) = 9.82$, $p = .002$.
[i]*Note*. $R = .12$, $R^2 = .01$, adjusted $R^2 < .01$, $F(1, 122) = 1.77$, $p = .187$.
[j]*Note*. $R = .12$, $R^2 = .01$, adjusted $R^2 = .01$, $F(1, 1203) = 17.02$, $p < .001$.
[k]*Note*. $R = .12$, $R^2 = .01$, adjusted $R^2 = .01$, $F(1, 430) = 5.87$, $p = .016$.
[l]*Note*. $R = .09$, $R^2 < .01$, adjusted $R^2 < .01$, $F(1, 86) = 0.70$, $p = .404$.
[m]*Note*. $R = .27$, $R^2 = .07$, adjusted $R^2 = .06$, $F(1, 94) = 7.25$, $p = .008$.

Social Studies

The social studies courses taught at the five high schools participating in this study consisted of 10 class types: Global Studies 1, Global Studies 1 Honors, Global Studies 2, Global Studies 2 Honors, Government/ Economics, Government/ Economics Honors, U.S. History, U.S. History 2, World Geography, and World History Honors. A total of 3,852 grades were used, which consisted of all grades for the 2012-2013 school year, excluding failures due to absences and special education students in pull-out, single person courses. As shown in Table 6, of the 10 courses, only Government/Economics, Government/Economics Honors, and World Geography yielded results that were statistically significant ($p < .05$). Of these three class types, Government/Economics Honors and World Geography yielded negative *B* values of -0.13 and -0.64, respectively; this indicates that as class size increases, TIECNSG decreases. Government/Economics, however, yielded a positive *B* value of 0.34, indicating that as class size increases, TIECNSG increase as well. Government/ Economics yielded an *R* value of .15 and Government/Economics Honors yielded an *R* value of .12, indicating a small effect size. World Geography yielded an *R* of .22, indicating a small-to-medium effect size (Foster, Barkus, & Yavorsky, 2006).

Table 6

Results of Linear Regression Analysis Predicting Impact of Class Size on Teacher-Issued Numerical Grades (Social Studies)

Course	Variable name	*B*	*SE B*	β	*t*	*p*
Global Studies 1	Class size[a]	-0.33	.18	-.08	-1.82	.070
Global Studies 1 Honors	Class size[b]	-1.12	.85	-.15	-1.32	.191
Global Studies 2	Class size[c]	-0.17	.15	-.04	-1.18	.239
Global Studies 2 Honors	Class size[d]	0.08	.50	.02	0.17	.868
Government/Economics	Class size[e]	0.34	.07	.15	4.62	< .001
Government/Economics Honors	Class size[f]	-0.13	.06	-.12	-2.21	.028
US History	Class size[g]	-0.02	.08	-.01	-0.26	.793
US History 2	Class size[h]	0.30	.19	.10	1.55	.122
World Geography	Class size[i]	-0.64	.16	-.22	-4.04	< .001
World History Honors	Class size[j]	-0.46	.59	-.09	-0.77	.443

[a]*Note*. $R = .08$, $R^2 = .01$, adjusted $R^2 = .01$, $F(1, 490) = 3.30$, $p = .070$.
[b]*Note*. $R = .15$, $R^2 = .02$, adjusted $R^2 = .01$, $F(1, 80) = 1.74$, $p = .191$.
[c]*Note*. $R = .04$, $R^2 = .01$, adjusted $R^2 = .01$, $F(1, 725) = 1.39$, $p = .239$.
[d]*Note*. $R = .02$, $R^2 = .01$, adjusted $R^2 = .01$, $F(1, 82) = 0.03$, $p = .868$.
[e]*Note*. $R = .15$, $R^2 = .02$, adjusted $R^2 = .02$, $F(1, 919) = 21.33$, $p = .001$.
[f]*Note*. $R = .12$, $R^2 = .02$, adjusted $R^2 = .01$, $F(1, 325) = 4.87$, $p = .028$.
[g]*Note*. $R = .01$, $R^2 < .01$, adjusted $R^2 = .01$, $F(1, 1154) = 0.07$, $p = .793$.
[h]*Note*. $R = .10$, $R^2 = .01$, adjusted $R^2 = .01$, $F(1, 224) = 2.41$, $p = .122$.
[i]*Note*. $R = .22$, $R^2 = .05$, adjusted $R^2 = .04$, $F(1, 336) = 16.30$, $p = .001$.
[j]*Note*. $R = .09$, $R^2 = .01$, adjusted $R^2 = .01$, $F(1, 73) = 0.59$, $p = .443$.

The two negative *B* value results and one positive *B* value indicate no clear effect of class size on TIECNSG. Seven of the 10 class types showed no statistically significant results and of the three that did, one showed that smaller class size negatively affected TIECNSG, while two showed that smaller class size positively affected TIECNSG. The only class type that showed class size had a strong effect on TIECNSG was World Geography; however, there were conflicting results in the other two classes. Therefore, for the subject of social studies, based on these results, the null hypothesis that class size in secondary school cannot predict student achievement as measured by TIECNSG cannot be definitively rejected.

Conclusion

The research question explored in this study was: Does class size have an effect on student achievement in secondary school as measured by TIECNSG? Based on an analysis of the data using a linear regression model, the null hypothesis could not be definitively rejected. Moreover, the results were conflicting (i.e., smaller class size had a positive impact on TIECNSG in some courses, and in others, smaller class size had a negative impact). Therefore, class size does not have a clear impact on student achievement in secondary school as measured by TIECNSG.

In the next section, I will present an overview of this study, discussing why and how the study was done, reviewing the research question, and summarizing my findings. In addition, I will present an interpretation of my findings based on the results detailed in Section 4. Finally, I will provide implications for social change, recommendations for action, and recommendations for future research.

Section 5: Discussion, Conclusion, and Recommendations

Introduction

This section includes a summary of the study based on the results described in Section 4, a discussion of the findings based on those results, overall conclusions drawn from the study, and recommendations for future action and research on the effect of class size on student academic achievement as measured by TIECNSG. In the district where this study was conducted, one of the recommendations for the 2012-2013 school budget was to increase the class room size of fifth through 12th grades by one student (Grooms, 2011). However, there is no clear consensus in the educational research literature whether increasing average class size in secondary school would have an effect on student achievement. As a result, the purpose of this study was to predict the effect of changing class sizes on TIECNSG.

This study addressed the following research question: Does class size in secondary school predict student achievement as measured by TIECNSG? I used a correlational research design. I used linear regression to analyze the data to answer the research question.

Interpretation of Findings

All of the collected data were organized by subject, and a linear regression was performed on each class type. Based on the results obtained, the null hypothesis could not be rejected. Of the 40 different class types analyzed, only 17 of 40 yielded statistically significant results. Out of those 17, nine showed that increasing class size had a negative

impact on TIECNSG, while eight showed that increasing class size had a positive impact on TIECNSG.

These results were very similar in nature to the results found by Shin and Chung (2009) and Corak and Lauzon (2009) in their studies performed at the secondary level. In both studies, the researchers found a great inconsistency in results. Some of their results showed smaller class size to have a positive effect on student achievement while others showing a negative effect.

While smaller class size was not found to have a consistently positive effect on student achievement in this study, this result does not mean that the positive benefits of smaller class size described by Pritchard (1999) were not present. Studies undertaken by researchers at all levels of education, investigating the effect of class size on student achievement, have offered inconclusive evidence about the actual effects on student achievement. Some studies have shown that CSR had a significant effect on student achievement while others have shown that CSR had little to no effect. As a result, other confounding variables not accounted for in this study may have had an effect on student achievement. While parenting, teaching strategies, school principals, school size, and the emotional state of the students themselves all could have had an effect on student achievement; Bosworth (2014) described a practice that could be used to explain the lack of results in this study. Bosworth reported that principal manipulation of class size was occurring in public schools and that this manipulation could completely mask the positive effects of smaller class sizes on student achievement. For example, a principal may increase the class size of experienced, effective teachers while reducing the class size of

inexperienced, ineffective teachers. The effective teachers will compensate for any negative impact resulting from the increase in class size while the ineffective teachers, who lack the training and skill to take advantage of the opportunities to improve student achievement provided by the smaller classroom, have access to fewer students.

Implications for Social Change

Based on the results of this study, implications for social change are limited. The results showed that class size did not have a consistent statistically significant effect on student achievement. However, because of the number of conflicting variables that were not accounted for in this study, it cannot be assumed that class size does not have an effect on student achievement. The results of this study can be used to create a dialogue between parents and school administrators who may have opposing points of view in terms of the effects of class size. While the results of this study do not implicitly suggest a course of action, the fact that the results were inconclusive suggests that simply decreasing class size would not necessarily result in immediate, measurable improvements in student achievement. Conversely, increasing class size would not necessarily negatively impact student achievement.

Recommendations for Action

Since the results of this study were inconclusive, a course of action that increases or decreases class size cannot be recommended. Based on the inconclusive results of this study, I recommend that the district school board should authorize additional study of the impact of changing class size prior to taking any course of action that would affect class size at the secondary school level. Until the effects of various confounding variables such

as principal manipulation of class size and teacher experience are studied, the implications of reducing or increasing class size on student achievement are not clear.

Recommendations for Further Study

The purpose of this study was to predict the effect of changing class size on TIECNSG. Although the results of this study did not show that changing class size had a statistically significant effect on TIECNSG, further study needs to be conducted to determine if other contributing factors (i.e., confounding variables) may have had an impact on those student grades in addition to class size. Once I have determined the confounding variables, I recommend collecting new data and rerunning the analysis while controlling for confounding variables so I can determine the true effect of class size on TIECNSG.

Bosworth (2014) found that principal manipulation of class size was occurring where at risk students were assigned to smaller classrooms. Bosworth found that if class composition was not taken into account, smaller class size showed no effect on student achievement; however, when class composition was taken into account, smaller class size did show a positive effect on student achievement. In light of these findings, further research on class size reduction needs to be conducted and the effects of variables such as principal manipulation, class composition, teacher experience, etc. statistically controlled for, leaving only the effect of class size on the dependent variable. Moreover, I recommend using a more robust dependent variable. Using a standardized assessment for a dependent variable instead of teacher-issued grades would reduce the threat to internal validity.

Conclusion

The purpose of this study was to predict the effect of class size on TIECNSG. The results were inconclusive as to whether class size could predict TIECNSG. As a result, the school district where this study took place could use this study as a rationale for conducting further studies in the district prior to making any changes to class size at the secondary school level.

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