DOCUMENT RESUME

ED 456 554 EA 031 256

AUTHOR	Laine, Sabrina W. M., Ed.; Ward, James G., Ed.
TITLE	Using What We Know: A Review of the Research on Implementing Class-Size Reduction Initiatives for State and Local Policymakers.
INSTITUTION	North Central Regional Educational Lab., Oak Brook, IL.
SPONS AGENCY	Office of Educational Research and Improvement (ED), Washington, DC.
PUB DATE	2000-00-00
NOTE	107p.
CONTRACT	RJ96006301
AVAILABLE FROM	North Central Regional Educational Laboratory, 1120 East Diehl Rd., Suite 200, Naperville, IL 60563. Web site: http://www.ncrel.org.
PUB TYPE	Collected Works - General (020)
EDRS PRICE	MF01/PC05 Plus Postage.
DESCRIPTORS	*Class Size; *Cost Effectiveness; Educational Policy; Elementary Secondary Education; Labor Market; Public Schools; *Teacher Effectiveness; Teacher Salaries

ABSTRACT

This book contains a collection of essays involving new research on class-size reduction. Six chapters include: (1) "Reducing Class Size in Public Schools: Cost-Benefit Issues and Implications" (John F. Witte); (2) "Making Policy Choices: Is Class-Size Reduction the Best Alternative?" (Doug Harris and David N. Plank); (3) "Smaller Classes, Lower Salaries? A Study of the Effects of Class Size on Teacher Labor Markets" (Eric Hanushek with Javier Luque); (4) "Smaller Classes, Better Teaching? Effective Teaching in Reduced-Size Classes" (John Zahorik and others); (5) "Implementing a Class Size Reduction Policy: Barriers and Opportunities" (Ray Legler); and (6) "Implications of Class-Size Reduction Research for Practice and Policy" (James G. Ward and Sabrina W.M. Laine). The book ends with an annotated selection of books, journal articles, and Web sites. (RT)

Using What We Know

A Review of the Research on Implementing Class-Size Reduction Initiatives for State and Local Policymakers

NCREL
North Central Regional Educational Laboratory
"Applying Research and Technology to Learning"

Using What We Know

A Review of the Research on Implementing Class-Size Reduction Initiatives for State and Local Policymakers

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This work was produced in whole or in part with funds from the Office of Educational Research and Improvement (OERI), U.S. Department of Education, under contract number RJ96006301. The content does not necessarily reflect the position or policy of OERI or the Department of Education, nor does mention of trade names, commercial products, or organizations imply endorsement by the federal government.

Acknowledgements

This project would not have been possible without the significant contributions of some key NCREL staff and some critical external friends. Bill Quinn and Arie van der Ploeg were instrumental in the original design and review of research for this document. Carol McElvain, Ray Legler, and Chris Otto transformed this project from several separate research papers into a coherent whole. Jim Ward from the University of Illinois at Urbana-Champaign, Neil Theobald from Indiana University, and Paul Kimmelman, former superintendent of Illinois School District 31, all provided ongoing external reviews of the substance and content of the research studies included in this project. Finally, we express our gratitude to the many contributors to this volume for having worked under pressure to meet incredibly short deadlines.

In addition, we would like to acknowledge the contributions of the following* NCREL *staff members:

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Using What We Know:
A Review of the Research on Implementing Class-Size Reduction Initiatives for State and Local Policymakers

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Introduction

A recent article in *Education Week*, "The Class Size Pendulum," asks whether class-size reductions are here to stay. This question highlights the fact that the relationship between class size and student achievement has been controversial for more than two decades in the United States. Although some studies have concluded that reducing class size brings moderate improvement in long-term achievement, others have found no such improvement. Although class size has been a prominent feature of the educational landscape for many years, debate over the effectiveness of reducing class size has increased since 1999, when Charles Achilles and his colleagues conducted their groundbreaking study of Tennessee's Project STAR (Achilles, 1999). The subsequent analysis of the data from this study and others has enriched the debate, especially in the area of costs versus benefits.

The costs and benefits of class-size reduction were the topic of a research forum sponsored by the North Central Regional Educational Laboratory (NCREL) in October 1999. The forum brought together leading scholars on class-size reduction from a variety of perspectives and disciplines to discuss the potential benefits and costs of class-size reduction. However, the discussion often centered on the practical challenges of reducing class size rather than the more theoretical question of whether class-size reduction is a good idea. Indeed, the conversations raised the participants' awareness of wider issues not directly related to costs, including the following: What are the relative benefits of reducing class size compared to other types of reforms? How do the changes in instructional approach and school organization that accompany smaller classes affect student achievement? Can schools improve achievement by implementing these instructional and organizational changes without actually reducing class sizes? What practical advice does research offer policymakers and school administrators in states where reducing class size is educational policy?

Answering some of these questions to help state and local policymakers implement class-size reduction policies is the primary goal of this project. Following a year of study funded by NCREL, researchers from Michigan State University, Stanford University, and the University of Wisconsin-Milwaukee present new information on the costs and benefits of reduced class size and offer practical advice on implementing class-size reduction

policies. In addition to their new research, this collection of essays includes interviews with local educational administrators and real-world examples of how class-size reduction policies at the state and district level are affecting instructional practice. These essays examine this significant educational issue from a variety of perspectives.

The book begins with an overview of the research on this important educational trend. In chapter one, John Witte from the University of Wisconsin-Madison examines the cost-benefit issues involved in class-size reduction. This chapter compares three programs that provide the most recent data on class-size reduction: Tennessee's Student/Teacher Achievement Ratio (STAR) study, Wisconsin's Student Achievement Guarantee in Education (SAGE) program, and the Class Size Reduction (CSR) program in California. Each program is distinct and in a different stage of analysis, but all three enhance our knowledge of this policy.

There is little doubt that reducing class size benefits both teachers and students, but so can providing better textbooks, improving technology, expanding professional development opportunities for teachers, and increasing teacher salaries—all options that policymakers must consider. However, budget constraints in most districts require policymakers to make tough choices from among these programs. Making those choices even tougher is the lack of information available to policymakers to help them decide which combination of changes will best serve their district or school.

In chapter two, Doug Harris and David Plank of Michigan State University examine the use of cost-effectiveness analysis to support more informed policy decisions. Comparing policies aimed at increasing the *number of teachers* (decreasing class size) with those intended to increase the *quality of teachers*, they question whether reducing class size is the most cost-effective way to improve student achievement. After examining the costs and benefits of these two policies, Harris and Plank suggest that greater improvements in student performance might be achieved by enhancing teacher quality rather than reducing class size.

As researchers study class-size reduction from a policy perspective, they often focus on the effects of smaller class size on student performance. However, research generally neglects the effects of smaller class sizes on teachers. The literature tends to concentrate on teaching techniques that accompany smaller classes, such as classroom management and time-on-task, to which achievement gains are largely attributed. But how does class size affect overall teacher satisfaction? What are its implications for teacher labor markets?

Chapter three, written by Eric Hanushek and Javier Luque at Stanford University in California, examines how class-size policy—along with other working conditions—affects the teacher's salary and the teacher labor market. To estimate the cost of specific policy changes, they argue, it is essential to understand how a range of working conditions affect salaries and teacher retention.

One of the fundamental questions raised by class-size reduction policies is whether or not smaller class sizes help teachers teach more effectively. In chapter four, John Zahorik,

Alex Molnar, Karen Ehrle, and Anke Halbach from the University of Wisconsin-Milwaukee examine effective teaching in reduced-size classes. A close look at a study of the Student Achievement Guarantee in Education (SAGE) program in Wisconsin suggests how class size influences teacher effectiveness.

SAGE illustrates the results of reducing class size to 15 students in approximately 300 first-grade classrooms across Wisconsin. Early results of the program indicate that reducing class size improves student academic performance. The study observed achievement gains in reduced-size classes in reading, language arts, and mathematics that are significantly higher than gains in larger first-grade classes.

Overall, first-grade students in the SAGE program performed better than students from comparable schools outside of the program, although there were variations in test score gains among the SAGE schools. Some SAGE first-grade teachers clearly are having more success than others. This study strives to find out why.

The question that Ray Legler from NCREL addresses in chapter five is how class-size reduction is implemented at the school and district level. This essay offers practical words of caution, advice, and encouragement from the Milwaukee district superintendent, other leading administrators, and a school principal who all have lived and worked through the nuts-and-bolts of reducing class size at the ground level.

Jim Ward and Sabrina Laine discuss the implications of class-size research for school leaders in chapter six. This chapter offers insights on the major issues as well as practical suggestions for school leaders involved in class-size reduction. Most important, Ward and Laine list questions that state and federal policymakers should ask and answer while considering additional funding for new class-size reduction initiatives or expanding existing state- and district-level pilot programs, such as those in Michigan and Wisconsin.

Chapter six is followed by a list of resources and references that includes an annotated selection of books, journal articles, and Web sites for practitioners seeking additional information on the costs and benefits of class-size reduction policies and the effects of class size on achievement.

Whether you are implementing class-size reduction policies at the school or district level, considering new state legislation to reduce class size, or studying existing class-size reduction initiatives, this collection of essays will enhance your decision-making process. Few educational policies have the staying power of class-size reduction initiatives—due in large part to their intuitive appeal to parents and teachers—and therefore the research on this issue needs to go beyond debating the pros and cons to real examples of how class-size reduction works in practice. As a regional educational laboratory, NCREL serves audiences ranging from parents and teachers to congressional staffers in our seven-state region. For that reason, this book is intended to serve a variety of audiences struggling to decide how best to allocate resources to benefit teachers and students at every level of the educational system.

Reducing Class Size in Public Schools:
Cost-Benefit Issues and Implications

A Review of the Research

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The effect of class size on achievement, along with the larger question of whether the amount of money spent on K-12 education is related to achievement levels, has been controversial for more than two decades in the United States. The literature of Hanushek (1979, 1986, & 1997); Hedges, Laine, & Greenwald (1994); and Hedges & Greenwald (1996) reviews more than one hundred experimental and quasi-experimental studies. These studies reach conclusions ranging from no long-term achievement gains to modestly positive long-term effects.

The largely academic debate that centered on tying achievement to expenditures and class size has been overshadowed in recent years by state and national policies to reduce class size. By 1995, 11 states had passed some form of legislation to reduce class sizes in some schools (Bracey, 1995). The National Conference of State Legislators reports that 30 states are engaged in some form of class-size reduction effort. National legislation in 1998 provided $1.2 billion for class-size reductions, and proposed 1999 legislation sought to provide another $20.8 billion over ten years.

This nationwide movement toward smaller classes was undoubtedly affected by a class-size reduction experiment begun in 1985 in Tennessee called the Student/Teacher Achievement Ratio, or STAR, study. The positive and lasting effects on achievement reported in that study received widespread publicity. Since then, projects and evaluations also have occurred in Wisconsin (the Student Achievement Guarantee in Education, or SAGE, program), California (the Class Size Reduction, or CSR, program), and other sites. These three state-level projects are compared and reviewed later in this chapter.

Because of the potential benefits and increased costs of class-size reduction, the Regional Educational Policy Research Consortium, convened under the auspices of the North Central Regional Educational Laboratory (NCREL), sponsored a conference on recent research on class-size reduction programs. This conference was held in Chicago on October 1, 1999. The purpose of the conference was to address four central questions:

1. What are the benefits of smaller class sizes? What are the short-term and long-term costs to school districts?

2. What pedagogical and other classroom changes are needed to improve achievement through class-size reduction?
3. How does reducing class size compare with other reform strategies?
4. What implications does class-size reduction have for teacher quality and availability?

As an overview of the cost and benefit issues related to class-size reduction, this chapter first summarizes the discussion concerning the three programs in Tennessee, Wisconsin, and California that provide the most recent data on class-size reduction. As will be shown, each is distinct and in a different stage of analysis, but each adds to our knowledge of this policy intervention.

Next is a discussion of the framing questions listed above and a look at some of the observations and conclusions that can be drawn from the NCREL conference. (Question 4 is subsumed under the first question because the discussion of benefits and costs at the NCREL conference included a lengthy discussion of the effects of smaller classes on teacher quality and demand.) The chapter closes with a summary of the research issues and priorities indicated by conference participants.

This chapter will not minimize points of contention among educators concerning what we know and what the data show. However, its purpose is to note areas of agreement and identify where future research should be directed.

A Comparison of Tennessee, Wisconsin, and California Programs and Experiments With Class-Size Reduction

Three relatively large-scale experiments or programs in class-size reduction have been completed or are ongoing in the United States: Tennessee's STAR study, Wisconsin's SAGE program, and California's CSR program.

Tennessee's Student/Teacher Achievement Ratio (STAR)

The Tennessee STAR study was actually a constellation of studies, beginning with the DuPont Pilot Project in 1984, which was a pilot for the STAR experiment from 1985 to 1990; the Lasting Benefits Study from 1989 to 1995; and follow-up work that continues today. The main study began in fall 1985. Schools volunteered for the program, and 79 schools were selected representing a mixture of school areas (rural, suburban, urban, inner-city). To be eligible for selection, schools had to be large enough to have three kindergarten classes (57 students) and to accommodate at least one control and two treatment groups (a small class and a regular class with a teacher and an aide). Students were added to the experiment as the first class progressed into first grade (kindergarten

was not required in Tennessee). New students also were admitted to program groups laterally in the higher grades. Students were randomly assigned to classes and treatment groups, and teachers were randomly assigned to groups each year. No other interventions were conducted in order to provide as little disruption as possible and provide as uncontaminated a test of smaller classes as possible.

After the four-year experiment, follow-up data collection occurred as part of the Lasting Benefits Study as students entered higher grades and returned to normal classroom situations. To date, analysis of data through Grade 8 is available. A range of outcome measures were used, including both norm- and criterion-referenced achievement tests, retention in grade, class behavior, class disruptions (pull-outs), and teacher and aide assessments of classroom conditions and satisfaction. Considerable classroom observation took place, and data were collected on each school.

Part of the Tennessee class-size reduction efforts was the Challenge project, which was directed at the state's 16 poorest districts. These districts were given grants to reduce the sizes of K-3 classes all at one time. Study of that program is at the aggregate district level (1989-1995).

Wisconsin's Student Achievement Guarantee in Education (SAGE)

The SAGE program in Wisconsin, discussed in greater detail later, grew out of a state commission headed by Alex Molnar that was charged with studying and recommending policies on improving urban education and reducing youth violence. Based on their own research, as well as the STAR study reports, the commission members conceived of the idea of reducing class size for the purposes of increasing meaningful contact between youth and adults. The commission proposed the class-size reduction program, along with other school interventions, and the legislature funded the program in 1995. The SAGE program began in the 1996-97 school year in 30 volunteer schools in which at least 30 percent of the students lived below the poverty line. No schools were turned down in the first year, and the program employed a range of classroom treatments. It established the class size at 15 students with a single teacher. The program also required other changes in the school—using rigorous curricula, extending school days, opening schools to students and the community in the evening, increasing staff development, and improving teacher accountability. Up to $2,000 per low-income pupil was provided for the program classes.

The research design did not include randomization. Rather, it relied on a "matched" set of control schools (on family income, reading achievement, size, and racial composition) from the same districts as the experimental schools but where no programmed interventions took place. The experimental intervention began in kindergarten and Grade 1 and continued as students progressed to Grades 2 and 3. The Terra Nova Comprehensive Test of Basic Skills was administered in both October and May in Grade 1 and in May for Grades 2 and 3. Additional information was obtained from teacher questionnaires and surveys, teachers' logs, classroom observations, and student administrative records. The

study pilot program and the study itself continue for five years, through 2001-02. However, in 1997 and again in 1998, the legislature increased the size of the program.

California's Class Size Reduction (CSR)

The California Class Size Reduction (CSR) program is not an experiment at all. The legislature enacted Governor Pete Wilson's proposal to reduce class size throughout the state in spring 1996, and the CSR program began that fall. The program affected K-3 classes and provided per-student funding for small classes for all classes in a school if all K-3 classes were limited to 20 students. If this reduction in class size was achieved, the districts received $650 per student (raised the following year to $800). They also received facilities grants of $25,000 (raised the following year to $40,000). Schools that already had classes at the 20-student limit were eligible for funding. In the second year (1997-98), 1.6 million students were in small classes at an annual cost of $1.5 billion (Brewer et al., 1999). It is estimated that the program eventually will affect 2.6 million students.

A CSR Research Consortium study of the program provides the first outcome measures through the 1998-99 year. The study design included 432 schools and surveys of 1,485 teachers, 336 principals, and 2,113 third-grade parents. Because all schools were offered small classrooms, the study compared those that implemented the program with those that did not. There was no random assignment, and therefore schools could only be matched on whether or not they had implemented small class sizes. Data collection included Stanford Achievement Test scores; administrative data; data on students with disabilities; parent, teacher, principal, and district superintendent surveys; and classroom observations and case studies.

Summary

These three prominent programs in class-size reduction vary considerably. The STAR study was meant to be a random-assignment, isolated-effects study of two treatments: small sizes or normal sizes with a teacher and an aide in the classroom. It included a within-school randomization in an attempt to control for school-level effects.

The SAGE study targeted low-income students, but did not employ random assignment and involved a range of interventions in addition to reduced class size. The evaluation employs a matched-school comparison.

The CSR program is a statewide, nontargeted program that will affect every school district in the state. The evaluation study compares schools that did not implement class-size reduction in the first years with those that did.

Although this variety of programs and evaluations seems problematic for making generalizations, the variations also provide unique information, which does require confirmation but makes strong suggestion regarding both the benefits and costs of these programs.

Benefits and Costs of Class-Size Reduction Programs

A number of states had class-size reduction programs before the recent surge (Texas, 1985; Indiana, 1985; Oklahoma, 1989; and Utah, 1990). Tennessee, Wisconsin, and California, however, provide the most useful information. Evidence from the SAGE and CSR programs covers only the first years of those evaluations. In addition, many of the crucial issues are just beginning to be addressed and considerably more research and analysis are required. Later in this chapter, we will try to highlight points of general agreement among educators, but current data are inadequate to understand more subtle issues, seriously contested issues, and unexplored questions for further research.

Benefits

Although most educators recognize the limitations of relying solely on achievement test data to measure educational success and many evaluations are attempting to analyze other measurement criteria, most evaluations have focused on test scores. All three studies provide some evidence for standardized test advantages for small classes. The advantage on a yearly basis was at least 0.1 standard deviations. The findings covered language arts and mathematics in all grades, and science and other subjects in several grades.

The STAR study claimed such benefits over four years and that the beneficial effects lasted at least through Grade 8. The SAGE results were reported for first- and second-grade students, representing the first two years in a five-year evaluation. Similarly, the CSR Research Consortium reports only first-year results for third-grade students. SAGE estimates were based on value-added measures, meaning that prior achievement was controlled for, and achievement can be viewed as added education over a year. They also used standard regression analysis and hierarchical linear models that estimated small classroom differences after controlling for individual student differences.

Both the STAR and SAGE studies report considerably higher achievement differences of smaller classes for minority students than for white students. For example, Finn and Achilles (1999) report for STAR that after kindergarten, minority student achievement gains from small classes were at least twice as great as the gains of white students in reading and close to that level in mathematics. Similarly, Molnar et al. (1999) report that African-American students in first grade in the SAGE schools gained more on all subtests than African-American students in the control schools. For the total test score, the advantage is approximately 50 percent. African-American students also gained more than white students in the SAGE schools (Molnar et al., 1999).

The CSR study, however, did not find any differences between groups of students. It concluded that "[r]elative to students in larger classes, third-grade students in smaller classes showed, on average, a small positive achievement gain. The level of gain was similar for all groups of students, regardless of ethnicity, income status, or English language ability" (CSR Research Consortium, 1999, p. 1).

Study findings also differed for classroom configurations other than single-teacher, small classes. The CSR study did not analyze any configuration other than small versus regular classes. However, the STAR and SAGE studies had alternative models. The STAR study concluded that adding a teacher aide in a regular classroom had no statistically significant effect over a single-teacher, regular-size class. In an analysis of 1996-97 SAGE first-year classes, SAGE reports a similar effect on the post-achievement results for both single-teacher, small classes and a two-teacher, 30-student class. Hierarchical/linear modeling in both configurations produced positive results compared to the control classrooms (Molnar et al., 1999). This finding, if supported by further study, is potentially very important, because it provides policymakers with an option that could reduce costs of adding new facilities.

Other benefits also were claimed for some of the small-size class experiments. The STAR study found that teachers reported more positive classroom behavior in the smaller classes during the experiment. In addition, a follow-up study in the fourth grade found better learning behavior for small-class students than others. The study included measures of effort, initiative, and nonparticipatory behaviors (disciplining). The effects ranged from 0.11 to 0.14 standard deviations (Finn & Achilles, 1999). STAR also found fewer class pull-outs (for disabled students and others), less retention in grade, and positive effects on parental involvement and teacher satisfaction for small classes. STAR researchers estimated that 383 fewer teachers were needed after the program because fewer students were retained.

Similar results over much less time were reported for SAGE and CSR. SAGE reported improved classroom discipline and other pedagogical benefits that will be discussed below. Statistical significance was not discussed (Molnar, Smith, & Zahorik, 1998). Similarly, the CSR study reported that less time was spent on disciplining students, and that parents of children in reduced-size classes were more satisfied than parents of children in larger classes (CSR Research Consortium, 1999). However, the report did not indicate statistical significance. The researchers did report that differences in parental involvement between large and reduced-size classes were not statistically significant.

Issues, Differences, and Uncertainties Concerning Benefits

Discussion of the limitations and issues in these studies revolves primarily around research design and achievement test score results. Eric Hanushek of Stanford University, while lauding the general approach of the STAR study and its value as a random-assignment experiment, points out that the results deviated from a considerable amount of prior research and that within the experiment there were a series of problems. The prior studies of whether money affected academic achievement were not reviewed, but the debate is well known (Hanushek, 1979, 1986, & 1997; Hedges, Laine, & Greenwald, 1994; Hedges & Greenwald, 1996). Charles Achilles of the STAR study challenges this literature as being based on nonexperimental data and teacher-pupil ratios, which he argues do not reflect actual class size.

Hanushek's concerns about potential biases in the STAR research focus on school selection; inadequate data on teacher randomization and quality; inadequate checks on randomization of students, especially the lack of prior achievement tests; and student attrition and switching from treatment categories.

The school selection issue is based on two concerns. The first, which also applies to SAGE and CSR, is that schools had to volunteer for the program. This requirement introduces potential selection bias in the factors that might be associated with volunteering and nonvolunteering schools. This problem could affect the within-school randomization if there are systematic characteristics that distinguish volunteering schools from others. No evidence of these differences was introduced, however.

Hanushek also notes that, although teachers were to be randomly assigned to the various treatment and control groups, the study contained little information on how this assignment was done or on the critical characteristics of teacher quality. In his 1999 article, he counters a finding by Krueger (1997) that showed no differences in teacher experience, race, or degree level between the groups, noting that those variables are not very highly correlated with teacher quality. No differences that would indicate nonrandom teacher assignment were described, however.

Hanushek also lamented the fact that prior achievement was not controlled for in the experiment (thus the estimates were not value-added estimates) and that the lack of prior tests prevented an adequate test of the random assignment of students. He says that he understood why this was difficult for the initial kindergartners, where testing is very difficult, but not on students who later entered in higher grades. STAR's Charles Achilles and others counter that a large-scale randomization experiment should not require a value-added model, because students would be randomly distributed in their initial ability and that, once in the program, students could be tracked by incorporating prior-year tests.

Hanushek also notes that overall attrition from the experiment was more than 50 percent. In addition, 10 percent of the students crossed over from one treatment group to another, and another 10 to 12 percent did not take tests in the last two years. He also cites the work of Goldstein and Blatchford (1998) and Krueger (1997) to indicate that the attrition was not random. Furthermore, students in both groups who dropped out were not doing as well as students who remained, and those dropping out of regular classes were farther below average than those in small classes. Hanushek speculates that this difference may be due to higher retention in grades among students in regular-size classes. But whatever the reason, the differential should work against the small classes following attrition because a larger percentage of poorly achieving students would have left the regular classes. Students also switched from the control to the treatment group (and to a lesser degree from the small to regular-size group). This movement also could produce bias, but it at least raises questions concerning the precision of the randomization process.

Achilles, however, cites a recent paper by Nye, Hedges, and Konstantopoulus (1999) that attempts to answer both of these problems. They estimated separate achievement models for those actually receiving the treatment to which they were assigned and for those who switched and did not follow through in the assigned category. They argue that this method should understate results for small classes unless the small classes are detrimental to achievement. The achievement advantages compared to students in regular-size classes for these two categories were similar in mathematics, reading, and science in Grades 3, 4, 6, and 8 (Nye et al., 1999).

To answer the potential attrition problem, Nye et al. (1999) provide mean third-grade test scores in math, reading, and science for both actual assignment and initially assigned students broken down by those who were present or not present in the eighth-grade follow-up. Although, as with other studies, those who left both small and regular classes were doing considerably worse in Grade 3, the researchers discern no differences between the groups for either actual or assigned—only treatment groups. They conclude: "As a result, it is implausible that attrition made small classes appear more favorable than if there were no attrition" (Nye et al., 1999, p. 133).

There are differences of opinion concerning substantive findings of the STAR study. Probably the most relevant is the question of when the small-size class effect occurs. For example, Hanushek argues that the effect seems to occur in kindergarten and perhaps Grade 1, but there is no effect following those grades. He supports this argument by noting that the differences between small- and regular-size classes appear after kindergarten and improve slightly after Grade 1, but the gaps then remain the same in Grades 2 and 3. He also notes a major difference between annual cohort advantages and the test advantages of small classes for those who remain for four years in the treatment groups. The annual cohort advantages increase each year. However, the advantages for the four-year group appear approximately the same for each succeeding grade (K-3) in reading, but decline considerably in math in Grades 2 and 3 (Hanushek, 1999). He interprets this finding as "consistent with a one-time effect of smaller classes that either erodes or can be made up for over time in regular classes" (Hanushek, 1999, p. 155). This argument is countered by Finn and Achilles (1999), who reported growth in achievement in each year for those students in small classes.

A one-year effect also was reported in the SAGE program. Specifically, in the second-year small class, students did not improve on their first-year advantages over students in comparison classes. However, that result might have been caused by late implementation of second-year small classes in many SAGE schools (see below). And this finding might not persist for the last three years of the experiment (Molnar, Smith & Zahorik, 1998).

Achilles again counters these conclusions for the STAR study by referring to their understanding of the increasing variance over grades of the test measures used and points to a recent study by Krueger that controls for that variance. The Krueger study, however, finds a similar result to Hanushek's for students entering kindergarten and staying in the pro-

gram for four years. But that effect is not held up when he analyzes all students by year of entry. Those entering in first- and second-grade seem to benefit considerably from more years in the program (Krueger, 1999).

The Nye, Hedges, and Konstantopoulus (1999) study also reports on estimates of cumulative advantages in Grades 4, 6, and 8 in math, reading, and science for students in small classes in one through four years of prior small classes. The effects are significant in all but Grade 8 for the first year only, and the effects increase with more years of small classes (Nye et al., 1999).

Finally, Hanushek reports on a study he did at the suggestion of Achilles that looked at the distribution of gains in small classes by school. The study was of kindergarten effects comparing all regular, regular with aide, and small classes in 79 schools. He found that smaller classes were superior to both other categories in only 40 schools. Although this result is better than what would be expected with equal probability across the three categories, it suggests that something in addition to small class size might be at work (Hanushek, 1999). This important point will be addressed in the discussion of difference in classroom behavior.

There are also difficulties in the Wisconsin and California programs, and the researchers involved in the SAGE and CSR studies are forthright about the problems in their research situations. By contrast, the STAR study may have less inferential and design problems than the other two major studies under way.

To begin, Wisconsin's SAGE program is not a random-assignment study. This situation is partially offset by the ability of the researchers to do comparative value-added models. However, there were also several problems with the comparison schools. First, there were only 17 comparison schools the first year, compared to 30 SAGE schools. The second year, two comparison schools withdrew and one converted to a SAGE school. Although on most student characteristics students appear similar in SAGE and comparison schools, in the second year there are considerably more white students from families ineligible for free lunch in the comparison schools (Molnar et al., 1999). These individual differences can be accounted for in multivariate analyses, but they might indicate differences in school characteristics that are not controlled. In addition, in the second year, with funding unclear, many SAGE schools did not reduce classes for first-graders until late in the fall or, in one case, the beginning of the second semester. This timing might have had an impact on the failure of achievement to increase further in the second year of the program.

As with the STAR study, there was high attrition from the SAGE program—approximately 30 percent during the first two years. As in the STAR program, attrition occurred more among underachieving students in both the small classes and in the comparison groups. Differences on pretests between those who left and those who remained in each group were very close, however, indicating that attrition would have little impact on the comparison between small classes and regular classes (Molnar et al., 1999). Finally, the

authors reported ceiling effects on 1996-97 first-grade tests—effects that should bias the small-class size advantages downward. The problem required switching the form of the test being used in 1997-98.

The California study presents even more potential problems. There was no experimental assignment. Study comparisons are between classrooms that were reported with smaller classes and those that were not. Reports emphasize that poorer, more heavily Hispanic districts were less able to implement small classes in the first two years. Crowded school districts were slow to implement the program, and this meant schools with high proportions of English language learning (ELL) students. Those schools in poor areas also did not have enough extra funds to implement the program, and therefore diverted money from other programs. If those programs affected achievement, a further unmeasured bias is introduced.

Additionally, students cannot be tracked over time, and hence value-added achievement measures cannot be used. These conditions create assorted problems and place heavy emphasis on controlling for student, parent, and school differences. And it is unclear how many of these controls can be instituted or appropriately linked to classroom type.

Perhaps the biggest problem may be yet to come. The CSR Research Report estimates that by 2000-01 almost all first- and second-graders will be in small classes, as will 90 percent of third-graders and 95 percent of kindergartners. The upshot is that comparisons in California largely will disappear by next year, and those used in the past might be questionable if the goal is to try to ascertain the pure effects of smaller classes on achievement.

Costs

The costs associated with smaller class sizes can be divided into monetary costs and quality-of-instruction costs. Both are difficult to determine and in the long term require many assumptions. Monetary costs include operating costs and fixed or facility costs. Quality of instruction costs include the effects of reduced-size classes on the supply of teachers and/or the substitution or addition of teacher aides and other support personnel.

With the exception of the CSR program in California, existing experiments provide little useful data for long-term cost estimates. That is because the STAR and SAGE programs were meant to be small-scale experiments or pilot programs. The STAR program cost about $12 million at the time; the SAGE program allocated up to $2,000 per pupil for participating schools and cost $4.59 million in the first year and $6.96 million in the second year.

The CSR program provides a better indication of costs. The state agreed to pay $650 per pupil for students in classes of 20 or fewer students in the first year and $800 per pupil in subsequent years. The state also gave each participating school a $25,000 facilities grant that increased to $40,000 in 1997-98. Total per-year program costs for 1997-98 were approximately $1.5 billion, and 1.6 million students were in kindergarten through third-

grade classes. Combining the facilities grants and cost-per-pupil for a 200-student K-3 school brings the costs to approximately $1,000 per pupil, or $20,000 per 20-student classroom in the California case. It should be noted that these costs were merely set by the California legislature, with little effort to relate them to actual costs of reaching the 20-student targets or needs (some schools already had classes with fewer than 20 students, but they still received state money).

National estimates are problematic and require a number of assumptions just to estimate new personnel costs. Because space inventories do not exist on a national basis, facilities costs cannot be estimated with any reliability. It is worth noting, however, that the CSR study found that space problems were listed as the number one problem by principals in schools that were unable to implement reduced-size classes in the first year (CSR, 1999).

Estimating personnel costs requires making assumptions on the class-size limit, which varies from 15 to 20. However, it also depends on how class size is measured and how flexible the measurement would be. An example of a flexible system would be one that relies on teacher-pupil ratios across a school or district, while an inflexible system (such as the California program) would require each classroom in a school to be below a specified size before any classes in the school would qualify. In addition, the grades to which small classes would apply, and whether the program is targeted to low-income students or all students, would also greatly affect estimates. Finally, labor costs and the dynamics of teacher supply will affect costs over time.

CSR researchers approach the estimates for operating cost increases by creating a "base policy" set of assumptions and then altering important assumptions to indicate the range of costs with different assumptions. The most important assumptions they make are to apply reduced classes to all students (no targeting) in "grouped" Grades 1-3 on a district level. Thus, a district average across these grades must meet the target classroom size, which varied from 15 to 18 to 20. They assumed that this system was "inflexible," because if the average were one student higher than needed, the district had to add a classroom. However, in comparison to the existing California policy and SAGE and STAR programs, grouping by grades and averaging across the system appears to be highly flexible. They also assumed that all grades would implement the policy at one time.

In the results for this base model, the first thing that is apparent is that the target-level class size is important. To reduce class size to an average of 15 students requires more than five times more classes than to reduce them to 20 students. For example, in 1997-98 there were actually about 510,000 classrooms for Grades 1 to 3 in the United States (Brewer et al., 1999). A class size of 15 in 1998-99 would require 226,910 new classrooms, or an increase of 44.5 percent.

How sensitive are these results to varying assumptions? That depends on the assumption. Working with the middle-size class of 18, it appears that the largest effect is created by targeting the program to low-income students. By setting the policy definition of an

eligible school as one in which 50 percent or more of students qualify for free or reduced-price lunch (approximately 180 percent of the poverty line), the costs of reducing classes to a grouped average of 18 lowers the annual cost by more than 60 percent, from $5.05 billion to approximately $1.8 billion. In contrast, eliminating the grouping and requiring each class to meet the average increases costs about 10 percent; setting the average on a school rather than a district basis adds approximately 20 percent to the base model costs (Brewer et al., 1999).

If one uses the base model with a class size of 18, the costs per classroom are about $10,000 per year for 1999-2000. That cost is considerably lower than what is being spent in California for a reduction to 20. The California policy is inflexible, however, requiring all K-3 classes in a school to be at or below the limit. This requirement could be much more costly. The other possibility is that California is providing too much support, and schools are gaining overall resources after they reduce classes. At any rate, somewhere between $10,000 and $20,000 per classroom per year might serve as personnel cost estimates of reasonable programs.

Although the study by Brewer, Krop, Gill, and Reichardt (1999) is clear, carefully thought out, and the best available, the authors indicate a number of limitations and issues. In addition to not being able to estimate fixed or facilities costs, they also do not take into account a number of dynamic aspects of teacher supply. For example, although they build cost-of-living increases into average salaries and benefits, they do not take into account aging of teachers or retirements. Aging is likely to add to out-year costs in that teachers move up in the salary grid; retirements will likely work in the opposite direction as new teachers at lower pay replace more highly paid retirees. Finally, their estimates do not include two possible savings: the reduced need for teacher aides and possible cost savings of educating students with disabilities. All of these factors might influence ultimate costs, and it seems impossible to determine even an assumed aggregate direction for these factors. Clearly, considerably more research is needed on these effects as states implement their programs. With even crude empirical measures of some of these changes, we will be able to assume parameter estimates and take these factors into account.

A final cost is the effect of class-size reduction on teacher quality. Evidence from the CSR program in California clearly indicates short-term problems in providing the 23,500 new teachers in the first two years of the California program. The most direct indicator of this was that the number of uncertified K-3 teachers rose from 1 percent before class-size reduction to 12 percent two years later. In addition, the number of uncertified teachers in schools varied dramatically by the income of the students. In schools in the lowest income quartile, more than 20 percent of the teachers were uncertified by 1997-98 (up from 2 percent in 1995-96) compared to 5 percent in the highest income quartile (up from less than 1 percent). (See CSR, 1999, Figures 6 and 7.)

Whether teacher quality will be affected adversely in the long term is unknown. Increased demand could increase teacher salaries and smaller class sizes could make the job of

teaching more attractive. Both factors could increase the quality of teachers. As Hanushek and others note, there are other important forces at work. For example, teaching—especially in the elementary grades—has traditionally been a woman's profession; as opportunities for women in other professions expand, the quality could be adversely affected. Also, markets for teachers vary dramatically across the country and across districts. That means that market shortages of crisis proportions could exist in one area while class-size reductions in other areas would be much less affected.

Thus, as with the benefits of class-size reduction, a number of research issues remain to be addressed before we can achieve an accurate estimate of the potential costs of this important policy intervention.

Pedagogical and Classroom Practices With Reduced Class Sizes

Most educators agree about what the small-size class research has concluded on classroom practices. All three of the central studies reviewed above analyzed pedagogy and classroom behavior using either surveys (usually of teachers and aides) and/or classroom observation by researchers in the classroom or by videotape. In all three studies and in several recently published nonexperimental studies, two conclusions seem to emerge.

The first is that radical changes in pedagogy do not result from smaller class sizes. Simply stated, teachers continue to do the same thing, but they seem to do it better. Specifically, the substance of lessons (what was taught) seemed to be similar in small and larger classrooms, and the approaches teachers took to teaching, such as large-group discussion, seat work, group exercises, and so forth, did not radically change. However, teachers in small classes reported, and it was observed, that more overall time was spent on instruction.

In addition, there were two important shifts in classroom behavior in small as compared to large classes. The first—highlighted in the STAR, SAGE, and CSR studies, and reinforced by other studies (Betts & Shkolnik, 1999; Rice, 1999)—was that more individualization occurred in small classes. This was reflected in increased time devoted to individuals as opposed to groups and to working closely with students who were having difficulty. A second and directly related result was that less time was spent on disciplining and other noninstructional activities. Thus it appears clear from a range of studies that class-size reduction beneficially increases time-on-task.

What is not known from the existing studies, but could be the subject of future experiments, is whether within small classes, different overall approaches to teaching and learning might provide superior achievement results. For example, one could compare an accelerated school, readiness to learn, and a Montessori program all using smaller classes. The point is that while teachers' pedagogy seemed to remain the same in smaller as in

regular-sized classes in the three most-studied programs, it is not evident that the gains from those approaches maximize the advantages of small classes. Thus future theories, trials, and empirical research are needed to think about and test the differential achievement results of various pedagogical approaches in reduced-size classes.

Class-Size Reduction Compared to Other Reforms

The issue of benefits and costs compared to other reforms and programs is a critical one. However, very little is known in detail about the costs or benefits of other reforms. Areas of study might include, for example, systemic reform efforts with increased use of standards and testing, the benefits and costs of choice programs and charter schools, or intensive staff development interventions. Costs often are not tracked on a program basis and benefits often are difficult to measure or to isolate from other changes occurring in school districts.

A more reasonable approach may be simply to calculate and debate the alternative uses of additional resources being devoted to class-size reduction. For example, if the costs fall between the $10,000 estimate offered by CSR researchers (for reduction to 18) and the $20,000 being spent in California, one could ask whether it would be better to reduce class sizes, increase teacher salaries, add technology, or improve professional development. This would consist of estimating costs without associated estimates on achievement for students, but the policy debate would at least have some substance with that approach. That minimalist approach assumes that at least those alternative costs can be accurately estimated.

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Making Policy Choices:
Is Class-Size Reduction the Best Alternative?

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Introduction

Everyone wants to improve student performance. The question is, how? States and school districts across the country have chosen class-size reduction as the answer. Anyone who has ever taught a class or read the available research knows that reducing class size does make a difference. Teachers have more time to give personal instruction to students and spend less time dealing with disciplinary issues.

Unfortunately, knowing that class-size reduction makes a difference is not very helpful for making school policy. Yes, lowering class size can help, but so can improving technology, providing better textbooks, expanding professional development opportunities for teachers, and increasing teacher salaries to attract and keep more able educators. All of these initiatives can improve student achievement. They also cost money. Information about the relative gains and costs of different policies should be accounted for in making the tough decisions about education spending.

How should these choices be made? In theory, all programs should be adopted if the benefits exceed the costs. In the real world, however, funding levels are fixed. Only some of the beneficial programs can be adopted. To get the most out of their limited resources, state and local policymakers must instead try to find the most cost-effective mix of programs—the biggest bang for the buck.

The problem that policymakers face is that they rarely have good information available to compare the costs and benefits of multiple programs. These comparisons are essential for sound decisionmaking, yet education research usually focuses on the benefits and only for individual programs. As a result, administrators and policymakers are forced to rely on instinct, intuition, the demands of key constituencies, and imitation of policies adopted in other districts or states. It is difficult to fault them for this approach, since they generally lack better information on which to base their choices.

In this paper we seek to promote the use of cost-effectiveness analysis to support more informed policy decisions. We illustrate the value of this approach by comparing policies aimed at increasing the *number of teachers* (decreasing class size) with those intended to

increase the *quality of teachers*. Our results call into question the conventional wisdom about class size. Analysis of the relative gains and costs of these two policies suggests that greater improvements in student performance could be achieved through sustained policies aimed at increasing teacher quality rather than through further class-size reductions. The remainder of this paper provides more detail about these conclusions.

National Trends

Policies affecting class size and teacher quality have changed dramatically in recent years. Table 1 below summarizes these changes from 1960 to 1990.

Table 1—Changes in School Resources (1960-1990)[1]

Year	Class Size	Teacher Daily Wage (1990 dollars)	Proportion of Total Spending		
			Teacher Salaries and Benefits	Other Instructional	Administration Other Costs
1960	25.8	$124	0.68	0.07	0.25
1970	22.3	$155	0.67	0.11	0.22
1980	18.7	$143	0.60	0.15	0.25
1990	17.2	$183	0.61[2]	0.12	0.27

Table 1 shows that teacher salaries (adjusted for inflation) have increased dramatically in recent years. What the table does not show is that the salaries of other college-educated workers have also increased. In fact, the relative salaries of teachers have gone down even as real salaries have increased.[3] This is especially true for women, who have gained much greater access to many professional jobs.

Table 1 also shows a significant downward trend in class sizes. Together with the increase in teacher salaries, these reforms have produced a large increase in total spending on education. Despite the increase in average teacher wages, however, the *proportion* of funds going to teachers decreased from 68 percent in 1960 to 61 percent in 1990. This decrease reflects even larger percentage increases in spending for special education and support services.

The Effectiveness of Class-Size Reductions

There are many ways to measure student performance. No single measurement will capture all of the things that parents and educators value. For our purposes, "effectiveness" refers to changes in two common measurements of student performance: test scores and future wages. Test scores might reflect student achievement in knowledge, verbal and quantitative ability, critical thinking, and other academic skills. Wages reflect many different aspects of performance after students leave school, such as the likelihood of graduating from high school, motivation and ability to finish college, people skills, and general work ability.

Experimental research consistently shows that class size affects how students perform on standardized tests. The Tennessee Student/Teacher Achievement Ratio (STAR) study of class-size reduction is the best-known piece of research in the field. STAR was a large-scale experiment that showed clear achievement gains from smaller classes in lower grade levels. The experiment took place in the 1980s and included random assignment of 12,000 students to small and large classes for kindergarten through Grade 3 (K-3). The average large class had 24 students, and the average small class had 15 students.[4]

A more recent experiment is Wisconsin's Student Achievement Guarantee in Education (SAGE) program, which included random assignment of 5,000 students to small and large classes with average sizes similar to the STAR program.[5] Many other smaller-scale experiments have been conducted. Glass and Smith studied 725 separate estimates of class-size effects based on studies completed before 1979. These studies used varying degrees of sample control and randomization.[6]

The results from these studies are summarized in Table 2. The numbers represent the percentile gains for students who start at the 50th percentile in student achievement and who experience an average class-size reduction of five students (e.g., from 25 to 20) over a period of six years (grades).[7] These findings assume a flexible reform in which class sizes can be reduced for any grades and student types—as long as the average decreases by five.[8] According to the Glass and Smith results, the effect of such a reform in elementary grades (1-6) would help a student at the 50th percentile to move to the 52nd percentile—an increase of approximately two percentage points.

The other class-size effects reported in Table 2, such as those for math and science, also assume that the change in average class size occurs over six years. This approach allows for direct comparisons across all of the grade levels, subject areas, and student characteristics listed. (A different number of years would imply a different length of treatment, making such comparisons more difficult.)

Table 2—Percentile Gains in Test Scores From Class-Size Reductions

(Base = 50th percentile. Treatment = reduce classes by 5 students over 6 grades.)

Study Characteristics	Study		
	STAR	SAGE	Glass & Smith
Elementary Grades	2.4	1.0	1.9
Secondary Grades	—	—	4.4
Black	—	1.7	—
White	—	0.8	—
Reading	2.0	0.8	—
Language	—	1.2	—
Math	3.4	2.0	—
Science	2.6	—	—

The most important idea to take away from Table 2 is that reduced class sizes do produce gains in students' academic achievement. The data in the table also suggest that the gains are larger in math than in other subjects. Black students appear to gain more than whites, which is consistent with other qualitative evidence showing that disadvantaged students gain more from class-size reductions. In addition, the table suggests that gains are larger for secondary students, which departs from the conventional wisdom about policies to reduce class size.

The Costs of Class-Size Reduction

In this section, we develop cost estimates for the simple class-size reduction policy described above. The main cost of reducing class size is the cost of hiring more teachers. If an individual school district seeks to reduce class sizes, teachers might move into the district from other school districts. Class-size reduction at the level of a single school district is unlikely to require much change in the total number of teachers in a county or state. State-level policies to reduce class size, however, almost certainly will require additional teachers to enter the workforce. The effects of class-size reduction therefore depend on the number of available candidates for new teaching positions and the qualifications of those teachers.

Research evidence on the supply of candidates for teaching jobs suggests that most districts face a surplus of candidates for teaching positions. The overall size of the pool is uncertain and there is great variation both within and across states.[9] In the cost model used here, we assume that the pool of candidates is 10 percent of the total number of

employed teachers. For example, if a district employs 1,000 teachers, we would assume a surplus of 100 teachers. We vary this assumption from 0 to 30 percent.

Regardless of the type of district, it is likely that new teachers hired in response to class-size reduction policies will be of lower quality than those already employed. This is almost certainly true if districts now are selecting the best available teachers in their hiring processes.[10] The benefits from reducing class sizes are therefore likely to be at least partially offset by a decrease in average teacher quality. One way to prevent this would be to offer starting salaries high enough to attract new teachers of higher ability who are now working in other professions or other districts. This change is likely to be costly, though, because most collective bargaining agreements would require that *all* salaries be increased, not just those of new teachers.[11]

To illustrate some of the trade-offs involved with these policies, consider California's recent program that provides $1 billion annually to reduce class sizes in the elementary grades. In many California districts, the evidence suggests that test score gains for students in smaller classes were offset by test score losses for students who ended up with less able teachers.[12] Wealthier districts were able to reduce class size by attracting the best teachers from low-income districts, while low-income districts were obliged to hire less qualified (and often unqualified) teachers. The net effect of the policy was to help some students at the expense of others.

Cost estimates require specific assumptions about the relationships between class-size reductions, the pool of candidates for teaching jobs, and average teacher quality. "Teacher supply elasticity" is the percentage change in the number of available teachers divided by the associated change in teacher salaries. The available research suggests that this elasticity ranges from 0 to 2.0, depending on the time frame.[13] A change in salaries today obviously will have little effect on the number of teachers applying tomorrow. So the short-term elasticity is essentially 0. As information spreads through the workforce, however, more teachers might enter the pool of candidates. The long-term elasticity might be as large as 2.0, meaning that a 1-percent increase in salaries will produce a 2-percent increase in the number of workers willing to teach.[14]

Our model also depends on how teacher salaries might affect the quality levels of teachers who apply. Manski (1987) concluded that a 10-percent increase in average teacher salary would increase the average teacher SAT score by 10 points. Ballou and Podgursky (1992, 1994) and Figlio (1997) obtained similar results.

Class-size reduction policies might also require capital expenditures if more classrooms are needed to accommodate students. Two facts suggest that the cost of classroom space is small compared to the cost of teachers, however. First, capital costs represent only 10 percent of total education expenditures. In addition, half of U.S. schools have extra space available that cannot easily be used for other purposes.[15] For these reasons, we initially excluded capital costs from the model.[16] If the results had shown that class-size reductions were more cost-effective, then it would have been necessary to include capital

costs in our calculations. However, the results presented below suggest just the opposite. Adding capital costs to the model would make class-size reductions compare even less favorably to increases in teacher salaries.

The cost model described in this section, combined with the effectiveness information in the previous section, suggests that it would cost $198 annually per student to move a student from the 50th to the 52nd percentile by reducing average class size by five students. These costs will vary depending on assumptions about labor supply elasticity, quality elasticity, and capital costs. Changes in these assumptions do not change the main conclusions of the paper, however.

The Cost-Effectiveness of Policies Designed to Increase Teacher Quality

So far, the term "teacher quality" has not been carefully defined. For our purposes, teacher quality refers to the ability of teachers to improve student outcomes. We make no claims about what these characteristics might be. Instead, we focus on research evidence showing the effects that teacher hiring policies have on students.[17]

There are two main ways to increase teacher quality. The first is to hire teachers who begin their jobs with high ability. The second is to develop teachers with high ability through training and professional development once teachers have been hired. The focus of attention here is on hiring better teachers, specifically through increases in teacher salaries. Although teacher salary increases could be implemented in many ways, the focus here is on across-the-board changes.[18]

The choices that potential applicants must make include whether to take formal teacher training (usually in college), whether to stay in a particular job or switch jobs after entering the profession, whether to stay in the teaching profession or change professions, and whether to continue working or to leave the labor force. Considerable research has been done about how prospective and current teachers make these decisions.[19] Not surprisingly, the reasons are complex and many are not under the control of school districts or state governments.

As suggested earlier, salary is certainly one important factor in determining who teaches. Unfortunately, in contrast to the research on class size, there is no experimental evidence regarding the effects of teacher salaries on student achievement. Instead, most studies on teacher salaries use a statistical tool called regression analysis that tries to imitate experimental conditions. This nonexperimental technique requires that the regressions include control variables that affect student performance, including class size and student characteristics. Regression estimates that exclude these variables suffer from omitted variable bias and can yield misleading estimates of the effects of the teacher salaries.[20]

Most nonexperimental studies find that salary matters, but the effects appear to be small.[21] Most of these studies suffer from the omitted variables problem, however, which means that their results might be misleading. To identify unbiased estimates of how teachers' salaries affect student achievement, we first selected regression estimates that included both class size and teacher salaries in the analysis. This is important because we do have experimental estimates of the class-size effect. We then restricted our attention to regression estimates in which the class-size effect was close to the experimental estimates found in STAR, SAGE, and other studies. If one of the effect estimates is unbiased, it is more likely that the other effect estimates are unbiased as well.[22]

Twenty regression estimates from seven different studies include both a class size and a teacher-salary variable. Eight of these estimates were left after restricting this sample based on the class-size evidence. Taking the average of these teacher salary effects suggests that a statewide increase of 10 percent in teacher salaries will raise a student from the 50th to the 52nd percentile on a norm-referenced test.

Multiplying the change in teacher salaries by the number of teachers yields the total costs of the reform. As with the class-size reduction policies discussed above, policies that seek to increase teacher quality by increasing salaries will affect the number of teachers available. The final cost will depend again on teacher supply elasticity, teacher quality elasticity, and other factors. We make the same assumptions here as we did regarding class sizes. Our results suggest that raising a student from the 50th to the 52nd percentile using teacher salary increases would cost about $100 per student per year.

Cost-Effectiveness and Simple Policy Reforms

Most research provides information about benefits *or* costs of *individual programs*. The purpose of analyzing cost effectiveness is to combine information on costs and benefits for *various programs* to obtain the highest possible level of student achievement. Policymakers need more than just information about benefits—they need to know how they can get the biggest bang for the buck.

The costs and benefits described above for class-size reductions and teacher salary changes are presented in a way that makes these comparisons easy. The cost of increasing student test scores from the 50th to the 52nd percentile is estimated to be $198 per student for class size, but only $100 per student for teacher salaries. These results vary somewhat based on assumptions about labor supply elasticity, labor quality elasticity, and other factors. We considered ranges of values for these factors, but even values at the extreme ends of these ranges did not alter the main conclusion.

The results above suggest that sustained teacher salary increases would be more cost-effective than class-size reduction in raising student achievement. The short-term effect of a change in class size

would almost certainly be greater, but the long-term effect would be smaller. As teachers leave the profession, higher salaries would attract better candidates for teaching positions. Over time these new teachers would have a greater impact on student performance at a lower cost.

The discussion thus far has focused on improving student test scores as the main goal of education. An additional purpose of education is to prepare students for their adult lives, including their careers. Different types of analysis are possible when the focus is on increasing student wages, since both costs and benefits are expressed in dollars. This contrasts with an analysis in which test scores were the outcome of interest. Test scores may be related to personal success in adult life, but they are also related to our general desire for knowledge and good citizenship. It is difficult to place a dollar value on these goals and values.

As with test scores, it is important to have precise estimates of the benefits that reducing class size or increasing teacher salaries provide for future student wages. Our review of the evidence suggests that a $100 increase in teacher salaries would increase students' future wages by 0.8 percent. A decrease in class size by one student in all grades would increase students' future wages by 1.6 percent.

Again, it is necessary to combine the above results about policy benefits with information about policy costs. One simple and useful way to approach the analysis with future wages is simply to ask, "At what point do the extra costs of education reforms exceed the extra future wages for students due to the reforms?"[23] The results of our analysis are similar to those in the earlier sections. The absolute size of the gain in student wages is larger when we reduce class size than when we increase teacher salaries, but the cost of the change is also higher. This suggests that it would be more cost-effective to raise teacher salaries than to reduce class size further.[24]

Cost Effectiveness: The Details Matter

Real-world policies are rarely as simple as those considered in the previous sections. Instead, policies almost always are filled with fine print, restrictions, and rules that add complexity. This section focuses on how the earlier results might change based on differences in policies and different cost assumptions.

Possible restrictions on class-size policies include maximum class sizes, restrictions by grade, and unique rules for special education and other student populations. All of these restrictions would add to the cost of reform. For instance, suppose a school imposed a maximum class size of 25. This would require splitting a class of 26 into two very small classes (13 and 13) and hiring an additional teacher, because a class of 26 would violate the rule.[25] Imposing this rule would make class-size reduction far more costly; more flexible reforms are generally cheaper.

Similarly, there are many different ways to increase teacher salaries, ranging from signing bonuses for new teachers to across-the-board increases for all teachers to merit pay based on professional development, experience, peer evaluations, or other factors. These different strategies can produce similar increases in average teacher salaries, while producing very different increases for particular teachers and very different consequences for the pool of candidates for teaching jobs. The details of policy design are therefore likely to make a big difference in how salary increases affect student achievement.

The available evidence suggests that increasing the average quality of teachers by increasing teacher salaries will improve student achievement, but our research does not provide guidance for choices among alternative strategies. As in the case of class-size reductions, however, complicating salary policies by adding rules might increase the cost of reform, sometimes in unforeseen ways. For example, offering signing bonuses or increased salaries for beginning teachers might be a good strategy for attracting talented young people to the teaching profession. Such policies might produce dissatisfaction or resentment among veteran teachers, however, leading to increased turnover or reduced retention. It clearly would be desirable to design policies that targeted salary increases in ways that would reward or retain more able or more talented teachers, but it is far from clear that administrators or policymakers are able to make the fine distinctions among teachers that would make such policies effective.

Policies to reduce class size or increase teachers' salaries could be implemented at various levels of the education system, from individual school districts to the federal government. In our analysis, we assume that these policies are part of state or federal reforms. Action by an individual district might make local students better off, without having much impact on the larger education system. Any single school district that reduces class sizes or increase salaries can probably attract the new teachers that it needs from nearby districts or private schools. State or federal policies that affect all school districts are likely to bring about major changes in the market for teachers, however. As the California experience suggests, these changes might benefit some schools and school districts at the expense of others unless policies are designed with care.

Conclusion

The results presented in this paper run against the grain of many recent policy initiatives in education, at both the state and federal level. Our research suggests that sustained increases in teacher salaries will be more cost-effective than class-size reductions in increasing student achievement. This is true regardless of whether we focus on academic achievement or students' future wages.

If research suggests that salary increases and increasing teacher quality are so cost-effective, why might actual policy decisions differ? One possible explanation is that class-size reductions have a much more immediate and identifiable impact on student perform-

ance. Teachers like class-size reduction because it has demonstrable effects on student achievement and allows them to focus more closely on each of their students. Parents like the reductions because they want their kids to have personal attention. This puts a great deal of pressure on school leaders to reduce class sizes, even if it is not the most cost-effective use of resources. In contrast, changes in teacher quality are hard to observe, and they might affect student achievement only over an extended period of time. Teachers might appreciate the importance of higher salaries, but making the case to parents and taxpayers is harder. Hiring fewer teachers and paying them more in order to raise teacher quality simply lacks the intuitive political appeal of hiring more teachers and reducing class size.

How can we improve student performance? Past research is useful, but it falls far short of providing a definitive answer to this question. Researchers and educators, devoted to finding a solution to pressing educational needs, search hard for programs that work. Through innovation and creativity, many successful programs have been developed in the process. These successes will remain meaningless if we cannot successfully choose among them, however. The best apple in the barrel is no better than the worst if we cannot find it. Instead of reaching out and picking the first good one we see, it is probably wise to dig deeper, compare several possibilities, and choose the best of the bunch. These choices are not merely a matter of economics—of mundane calculations of benefits and costs. Rather, the ability of educators to make these tough choices will determine how much we can contribute to the learning of our students.

Endnotes

1. Source: *Digest of Education Statistics* (1999).
2. This number is estimated because information about teacher benefits was not available for 1990.
3. See Hanushek and Rivkin (1996).
4. Nye, Hedges, and Konstantopoulos (1999) describe the study in greater detail. Other papers focus on the weaknesses of the project and previous interpretations of results, including attrition and some violations of random assignment.
5. The SAGE program, which started in 1996, also included staff development, after-school programs, and a new curriculum for kids in the treatment group. While this might appear to complicate the analysis, Molnar et al. (1999) found that these other programs had no significant effect after controlling for class size.
6. Hedges and Stock (1983) reanalyzed the Glass and Smith sample with some modifications, but found that these changes did not affect their results.
7. All calculations based on test scores assume that student performance is normally distributed.

8. More precisely, the policy experiment we propose assumes that schools will reduce class sizes in the same manner as those schools used in the studies. This approach ignores possible nonlinear effects. For instance, the effect of decreasing class sizes from 30 to 25 might be different from decreasing class sizes from 25 to 20.

9. See, for example, Ballou (1996).

10. Supporting evidence for this conclusion is presented below for California's recent class-size reduction. There are certainly some circumstances in which this would not be reasonable. For instance, the assumption might be false if the new teachers are expected to provide instruction on computers or other skills with which newer, younger teachers might be more familiar. Other reasons might also prevent this from being the case and these are discussed in later sections. However, these reasons do not appear to be strong enough to contradict the general conclusion that teachers on waiting lists are less able on average.

11. One way around this rule is the signing bonus, which provides one-time payments only to new teachers.

12. Class Size Reduction Research Consortium (2000) [Online]. Available: http://www.classize.org.

13. It is extremely difficult to estimate elasticity for particular time frames—e.g., short term versus long term. However, the distinction is important.

14. See Manski (1987), Currie (1991), Ballou and Podgursky (1994).

15. See *The Condition of America's Public School Facilities*: 1999 from the U.S. Department of Education. Also note that if extra space could be rented out, then the cost would include this rental value.

16. Excluding capital costs certainly does not affect the main conclusion of the paper. If capital costs were included, class-size reductions would fare even worse when compared with teacher salary increases.

17. There is substantial evidence that certain teacher characteristics are associated with student success, including teacher test scores and years of experience. Again, no assumptions are made about these characteristics in this paper.

18. This is an important assumption given the substantial evidence that the way in which salaries are now paid is far from cost-effective. See Manski (1987).

19. These exams may also exclude teachers who lack verbal and quantitative skills, but who have other valuable abilities.

20. Some econometric estimates are based on "panel data," which can produce unbiased estimates of effect sizes. Unfortunately, such data are rare, especially regarding the effects of school resources, such as class size and teacher salaries.

21. See, for example, Hanushek and Pace (1997), Ballou (1992), Ballou and Podgursky (1994).

22. To check the validity of these estimates, we also estimated the effect that teacher salaries have on average teacher test scores (e.g., SAT scores from college or certification exams). We then reviewed the evidence regarding the effect of teacher quality on student outcomes, where teacher quality is measured by teacher test scores. The results were similar to those obtained using the procedure described in the text. See Harris (2000) for details.

23. Economists use the terminology, "marginal costs and marginal benefits." The point at which these are equal is called the "optimal" level.

24. This approach requires a discount rate that reflects the common assumption that future benefits and costs should receive less weight than current benefits and costs. The base discount rate in this model is 3 percent with a range of 0 to 6 percent. In addition, this is a partial equilibrium model in which the interrelationships between some markets (e.g., the teacher labor market and the market for other workers) are ignored.

25. The costs of class-size reductions are interrelated with two other polices of many schools and states. First, schools-of-choice policies make it increasingly difficult for schools to shift student populations across schools to avoid these class splits. In middle and high schools, an additional problem is that students request specific classes, and teachers specialize in ways that prevent splitting classes.

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Smaller Classes, Lower Salaries?

The Effects of Class Size on Teacher Labor Markets

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In recent years, the effects of changes in class size have been the focus of intense discussions among education policymakers. Much of the debate has centered on the relationship between class size and student performance, as researchers attempt to study the effects of reducing class sizes and to interpret the results from a policy perspective.

Though controversy about the costs and effects of change remains, the range of differences is narrowing and the options are becoming clearer.[1] However, the existing research generally neglects the overall effects of smaller class sizes on teachers. Current literature tends to concentrate on teaching techniques, such as classroom management and time on-task, to which achievement gains can largely be attributed. But how does class size affect overall teacher satisfaction? Do teachers simply enjoy their jobs more when their classes are smaller? If so, how does that affect teacher salaries and the labor market?

Most experts agree that smaller classes reduce the teacher's workload. Fewer students means fewer papers to correct, fewer tests to grade, and fewer discipline problems. Smaller classes indeed might provide teachers with increased personal satisfaction in their jobs. There is some survey evidence that says teachers prefer smaller class sizes, though it is not the most important issue for the majority of teachers.[2]

To understand the policy implications of teachers' preferences about the teaching environment in general and class sizes in particular, we must explore which characteristics teachers value in their workplace and how much compensation they require to accept something different. Preferences and compensation directly affect the decision to become a teacher and, once in the teaching profession, to change jobs among schools and school districts or to leave the teaching profession altogether. For example, many people have suggested that teachers move from inner-city schools to suburban settings because they prefer the location, achievement levels, or economic background of students in those areas. But class size also is a characteristic that might affect a teacher's level of satisfaction with the workplace.

Some research has been done on class-size policy as it relates to employment (e.g., Hanushek, Kain, & Rivkin, 1999), but little effort has been made to measure its importance—a measurement that could be critical for policymakers. For example, if it is found that teachers are willing to accept lower salaries in exchange for smaller classes and better working conditions, this information could reduce significantly the costs of lowering class sizes.[3] On the other hand, if research shows a weak relationship between class

size/working conditions and salary demands, then these factors would not enter into the policy debate.

This chapter explores the ways in which class size, among other working conditions, affects the teacher's salary. To produce accurate cost estimates for policy changes, it is essential to understand the effects of working conditions on the salaries and retention of teachers. This analysis will identify the magnitude of these effects.

The Study: How Does Class Size Affect Teacher Salaries and Job Turnover?

This study found that an increase of one student generally increases teacher salaries between 0.9 and 1.2 percent.[4] This effect is found to be statistically significant in *some*, but not all, of the empirical specifications and for *some*, but not all, points on the salary schedule. At the same time, other factors have a stronger influence on district salaries. For example, we find that teachers with a higher number of minority students within their school district are compensated positively.

The available data allow investigation into how effects might differ across relevant policy dimensions. Specifically, one might think that the reactions to differences in class size are strongest in urban areas, where the alternative employment opportunities for teachers are larger. However, the results show stronger effects of class size on teachers' salaries in suburban and rural areas.

The way in which teacher salaries adjust to local wages seems muted, though the adjustment is stronger as we move up in the teacher salary schedule. A 10-percent increase in local salaries for people with bachelor's or master's degrees is associated with 1.6- to 2.1-percent increases in teacher salaries.

The data also allow us to observe other dimensions of the relationship between teacher labor market decisions and school environment. Specifically, labor market determinants of teacher turnover and the tendency of districts to have difficulties finding qualified teachers were examined.

Teacher turnover at least partially reflects the degree of satisfaction of teachers with their jobs and work environment. Low turnover should reflect teachers' satisfaction with their decisions to teach in a particular school against opportunities in other schools, or in the nonteacher labor market. We find that higher teacher salaries, lower minority enrollment, and lower outside salaries are associated with lower teacher turnover. One intriguing feature of the data is that bigger class sizes *do not* prompt higher turnover.

The study also sheds some light on districts that reported problems hiring new teachers. These problems are reflected in the districts' responses to vacant or temporarily filled

teaching positions and whether they had to close teaching positions due to difficulties in finding suitable personnel. The presence of bigger class sizes and higher concentrations of minority students are good predictors of these difficulties. However, teacher salaries do not seem to have a strong predictive power. On the other hand, larger class sizes do seem to have some impact on making hiring more difficult. But if a district has difficulty hiring, it might need to have larger class sizes simply because it has too few teachers. The question remains, though: which causes which?

The Study's Approach and Methodology

The study followed a process of standard economic analysis of a labor market. In simplest theoretical terms, workers choose jobs from a number of opportunities available to them. A worker generally will choose a job that gives the most satisfaction, even if it is not the highest paying job. In comparing jobs, workers consider not just compensation, but factors such as working conditions, satisfaction of the work, friends/coworkers, and workplace location.

The implication of this analysis is simple: If two teaching jobs have equal pay, the same general location, and other factors, teachers will choose the job with the better working conditions.

In other words, if a job has inferior, less desirable working conditions, such as dangerous or unpleasant surroundings, the employer must pay a premium to attract workers. Thus, nominal salaries will be higher. This framework, which labor economics literature refers to as the theory of compensating differentials, is applied directly to salary decisions made by teachers with respect to class size and other school attributes.

Of course, this assumes that labor markets involve the free flow of individuals, so that the relationships can be interpreted as the marginal effect of salaries on various factors. Significant rigidities in labor markets—caused, for example, by geographic constraints on teachers or union restrictions—could distort the wage impact. Two things are important for this study, however. First, although imperfections in the labor market might affect the interpretation of differences, these are the conditions faced by districts. Second, as shown below, there is significant turnover of teachers across the country and across different geographical areas. Thus, there is an obvious case for clear labor market adjustments.

To analyze the relationship between teacher salaries and job satisfaction, we use the same principles employed by the Bureau of Labor Statistics in the development of the consumer price index. The basic concept is to regress the costs of an item based on its characteristics in order to determine and understand how consumers value different features. The concept can be applied to labor markets by regressing individual salaries based on the worker's characteristics plus the characteristics of the job.

These methods also have been proposed as one way of dealing with the adjustment of teacher salaries for inflation (Hanushek, 1999; Goldhaber, 1999). Although they are not

easily applied to disentangle overall salary inflation, they can provide direct evidence on district-to-district effects of different working conditions.

In this study, each school comprises a set of characteristics for which we must determine a value according to teacher preferences. Characteristics include the following:

- Salary schedule
- Fringe benefits
- Location
- Physical attributes of the school and surroundings
- Student demographics
- Expectations/teaching load
  - Number of classes to be taught
  - Length of the school day
  - Class size

In the first stage of the analysis, we focus on how teachers are compensated for changes in their teaching environment. For example, how much must a teacher be compensated when he or she is asked to teach larger classes?

This approach presents an inherent challenge. It is difficult to account adequately for other job characteristics and for differences in the skills of individuals. In many occupations, the more desirable, attractive jobs are often occupied by people with higher skills. Since highly skilled workers generally are paid more, an inaccurate conclusion could be drawn suggesting that these desirable jobs pay higher wages. Therefore, it is imperative to attain an accurate estimate of other attributes that affect earnings in order to obtain estimates of any compensating differentials.

We view the issue as a district characteristic, in part because teachers seldom are hired for specific schools and seldom expect to spend their career in a single school. On the other hand, this is clearly a simplification, because most teachers know the schools where they are likely to teach and where they are willing to teach. Unfortunately, given our approach and the structure of available data, we are unable to go into the details of any district.

Data

To complete this study, teacher salary data was collected, along with information about school and teacher attributes and teacher recruitment and retention.

The School and Staffing Survey (SASS), conducted by the National Center for Education Statistics (NCES), includes a representative sampling of U.S. schools, both public and private. Data were gathered by interviewing school officials, teachers, and district administrators. SASS databases provide excellent information on district, school, and teacher characteristics and allow the investigation of the relationship between teachers and schools over time.

This study used the 1993-94 SASS, which provides data on 4,993 school districts.[5] Relevant information from the survey included the following:

- Geographic location
- Socioeconomic status of the area
- Grade levels offered in each school
- Student enrollment
- Minority student enrollment
- Number of students eligible for free or reduced-price lunch
- Number of full-time equivalent (FTE) teachers and support personnel
- Number of minority teachers
- Wage schedule

The SASS also asked teachers about the number of students and classes they were teaching. We aggregate this information to determine an average class size in each district.

It must be stated that teachers are not isolated from the general labor market—they have employment opportunities outside of the school. These employment opportunities will vary by region. Some areas boast higher wages, while others have better overall opportunities. Information about local labor market conditions was used to allow for variations in the conditions facing individual school districts. To do so, census data were used to construct a wage index and an unemployment index for each metropolitan statistical area (MSA). For school districts not aligned with a specific MSA, information corresponding to labor market conditions in non-MSA locations in each state was used.

It is no surprise that the general pattern revealed by the data is that teacher salaries are higher on average in urban areas than in rural areas. (See Table 1.) The relative salaries in central cities versus the suburban rings of metropolitan areas are generally close across all levels of teacher experience and education, although teachers in central cities tend to have slightly higher average salaries than do those in suburban districts.

Table 1
Basic Descriptive Statistics by Region and Geographic Location

	Northeast Central City	Suburban	Outside MSA	Midwest Central City	Suburban	Outside MSA	South Central City	Suburban	Outside MSA	West Central City	Suburban	Outside MSA
Salaries by Category												
Bachelor's Degree and No Experience	26,278	26,608	22,057	23,066	22,697	19,853	21,918	21,432	20,446	23,758.88	23,022	21,161
Master's Degree and No Experience	28,316	28,937	23,891	25,361	25,115	21,929	23,324	23,075	22,068	25,912	25,561	23,688
Master's Degree + 30 Credits and No Experience	29,835	30,775	25,254	27,108	26,775	23,307	24,058	24,088	22,988	27,506	26,775	25,059
Master's Degree and 20 Years of Experience	46,686	49,143	38,364	41,920	42,203	32,484	34,738	33,128	30,633	40,282	39,920	36,056
Highest Salary in District	51,311	54,377	41,944	47,042	46,034	34,869	38,831	32,789	33,955	46,219	45,452	39,509
Other Characteristics												
Class Size	21.019	20.42	18.63	22.03	22.524	19.65	21.88	21.85	20.247	26.42	25.85	19.93
% Minority	39.37	13.36	3.36	28.97	11.157	7.57	52.98	26.17	31.32	47.7	33.65	26.33
% Free or Reduced-Price Lunch	49.78	25.41	39.83	41.66	29.317	49.96	52.39	44.64	60.67	50.53	38.62	50.89
Area Wage With Bachelor's or Master's Degree	24,873	25,646	19,103	21,796	23,614	17,279	21,611	22,393	18,638	23,376	23,173	17,456
Unemployment Rate	0.021	0.023	0.029	0.022	0.020	0.025	0.023	0.022	0.023	0.029	0.027	0.043
Turnover Rate	0.051	0.068	0.070	0.054	0.067	0.078	0.105	0.099	0.085	0.076	0.090	0.10
Districts With Hiring Difficulties	25	101	34	46	62	87	60	119	199	45	117	89

Northeast: Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, and Vermont.

Midwest: Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Ohio, South Dakota, and Wisconsin.

South: Alabama, Arkansas, Delaware, District of Columbia, Florida, Georgia, Kentucky, Louisiana, Maryland, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, Virginia, and West Virginia.

West: Alaska, Arizona, Colorado, Hawaii, Idaho, Montana, Nevada, Oregon, Utah, and Washington.

The range of average class sizes across regions tells a slightly different story. In the rural Northeast, classes average fewer than 19 students per class, while classes in the central cities of the West average more than 26 students. Again, the differences between rural and urban districts are larger than those between central cities and suburban districts.

The characteristics of student bodies also differ significantly by region and geographic location. As is well known, central city districts typically have larger minority populations than either suburban or rural districts. Eligibility for free and reduced-price lunch, however, does not follow the same pattern. Rural areas are generally identified as having higher concentrations of students eligible for free and reduced-price lunches, although a portion of that might reflect an inaccurate measurement of poverty rates by geographic location.

Finally, average wages of those in competing industries vary by geographic area and region. These wages, calculated as the average earnings of individuals with a bachelor's degree in each metropolitan area or rural areas in a state, indicate how competitive wages vary. The earning opportunities tend to be highest in the Northeast and lowest in the South.

In the second stage of our analysis, we constructed teacher turnover ratios. These ratios correspond to the number of newly hired full-time equivalent (FTE) teachers, over the number of total FTE teachers in the district. In Table 1, we present the mean of these variables according to region and geographic location. The turnover rate ranges from 5 percent in the central city districts of the Northeast to 10 percent in the rural West. (The level of teacher mobility suggests enough movement for wages to adjust to varying supplies of teachers.)

In the final part of the analysis, we measured the difficulty of hiring suitable teachers. A district that had to reduce the number of FTE positions because of a lack of suitable candidates or a district that had vacant or temporarily filled positions was considered to have difficulties in hiring suitable teachers. In Table 1, we present the number of districts reporting these problems by region and geographic location. Such hiring problems are consistently more prevalent in central cities and in the fast-growing districts of the West.

Empirical Strategy

Teacher compensation

Though the primary objective was to determine how teacher compensation adjusts for varying class sizes, it is necessary to consider other factors that affect compensation and to determine a suitable formula for calculating teacher salaries.

The primary set of factors considered were the following:

- Average class size in the district (CS)

- Average number of classes taught (NUMCL)
- Time spent at school (TIME)
- Minority population inside the district (PMIN)
- Proportion of students eligible for free or reduced-price lunch (PLUNCH)
- Average wage of workers with bachelor's degrees, specific to MSA (WAGE)
- Unemployment among workers with bachelor's degrees, specific to MSA (UNEM)

Additionally, we control for the specific state and whether or not the district is located in an MSA.

We begin by using a basic salary determination model that shows how these factors influence teacher salaries. (See Figure 1.)

Figure 1
Salary Determination Equation

$$salary = a_0 + a_1CS + a_2NUMCL + a_3TIME + a_4PMIN + a_5PLUNCH + a_6wage + a_7UNEM + a_8STATE + a_9METRO + e_1$$

Notes on the equation:

The error term in the equation, e, indicates unexplained differences in salaries.

Lower case for the variable corresponding to teacher salary (*salary*) and average local income (*wage*) indicate that they have been transformed into logarithms.

The coefficients to be estimated ($a_0, \ldots a_9$) indicate how teacher salaries adjust to each of the explanatory variables. Specifically, the coefficient representing class size (a_1) is the increase in teachers' salary associated with an increase in one student in the class size. This interpretation—the percentage increase in salaries from a one-unit change in the variable—applies to all variables except area wages. The coefficient on wages indicates how percentage changes in area wages translate in percentage changes in salary.

In this salary determination model, class size, number of classes, and time spent at school are all included to measure characteristics of the job structure that teachers might value.

Other work has shown that teachers are sensitive to the demographic characteristics of the students they teach. For this reason, we include both a measure of socioeconomic status (eligibility for free or reduced-price lunch) and the minority composition of the school.

The wage for other college-educated workers in the area serves two purposes. First, it measures the job opportunities in the area, and second, it indicates whether the area is a high- or low-wage area that would partially reflect cost-of-living differences.

The unemployment rate also is designed to indicate the underlying employment structure in the area.

The geographic measures are meant to incorporate the amount of potential mobility, in particular, the limitations that might occur in rural areas.

Finally, individual state differences in teacher certification, regulations, and the like are incorporated as a fixed state factor.

Flies in the Ointment: Alternative Models

Estimating these relationships requires some care, and alternative approaches were pursued. The basic estimation employs standard regression techniques but corrects for any differences across states in the variance of the errors.[6] Note, however, that in order to obtain unbiased estimators of the different influences, we have to assume no relationship between the error term (e) and the other variables on the right-hand side of equation (1).

This assumption could be flawed in a variety of ways. Perhaps the simplest would arise from important factors being left out of the modeling. If important factors are not considered, the estimate generally misstates the true relationship.[7] An alternative source of problems can arise through the way in which the class sizes are set inside the district. For example, there could be general preferences toward education that imply both smaller class sizes and higher teacher salaries, leading to an artificial relationship between the two.

To overcome these possible problems, we directly consider the possibility that class sizes are determined simultaneously with teacher salaries. We estimate the system in Figure 2.

Figure 2
An Alternative Salary Determination System

$$salary = a_0 + a_1\text{CS} + a_2\text{NUMCL} + a_3\text{TIME} + a_4\text{PMIN} + a_5\text{PLUNCH} + a_6 wage + a_7\text{UNEM} + a_8\text{STATE} + a_9\text{METRO} + e_1$$

$$\text{CS} = b_0 + b_1\text{SALARY} + b_2\text{KCS} + b_3\ \text{POPGROW} + b_4\text{STATE} + b_5\text{METRO} + e_2$$

Note:

POPGROW is the growth in student population described above, and KCS is the average class size for kindergartens in the district.[8] These two equations provide the basis for a different way to estimate the coefficient on class size, the parameter of interest.

In order to estimate the separate equations in Figure 2, it is necessary to find factors that affect class size but have no effect on teacher salaries. These factors, called instruments in the statistical literature, allow us to distinguish causation from the observed correlation. We use two such possible factors.

The first, POPGROW, is the rate of student population growth, measured as the ratio of the number of students in Grade 12 to those in Grade 1 within the district. The faster the growth rate in students, the more teachers a district will need, and the harder for districts to keep constant teacher-student ratios. If there is a time lag between student population growth and teacher hiring, this will constitute an additional valid instrument.

The second instrument, KCS, is the class size of kindergarten classes in the district. The importance of small classes in the early years has been cited in many studies. This instrument would be valid if kindergarten class size—because of its independently perceived educational value—did not directly enter into the district's perceived financial constraints, or if it did so but had a smaller effect than on regular classes.

Salary Determination Results

The basic results of the salary determination estimation, using the alternative approaches described in Figures 1 and 2, are summarized in Table 2. For discussion purposes, we concentrate on Model 3. These allow for simultaneous determination of class size and salaries and are estimated with the full set of instruments for class size (POPGROW and KCS). These estimates are the most straightforward of the set.

In Table 2, teachers are divided by their place on the salary schedule as noted by degree level and years of teaching experience. There is some variation in the estimated effects of class size on salary across the different teacher categories, but the effect on entry teachers is instructive. By the first set of instrumental variable estimates, increasing class size by one student is associated with a 0.9-percent increase in salaries for entry teachers. This estimate is significant at the 1-percent level, indicating considerable confidence that it is not 0. This estimate indicates that there would be some salary offset to any class-size reductions. The largest relationship between salary and class size actually occurs for teachers with the highest salaries in the district. The estimate for this group is twice as large as that for new teachers.

The results tend to be somewhat sensitive to the precise estimation strategy, and many of the separate estimates are not significantly different from 0. As a general statement, however, there tends to be a small positive effect on salary as a result of larger classes.

Teacher Turnover

In addition to the consideration of wage determination, we must look at staffing issues and consider how labor market and school factors might affect those issues. We considered how factors similar to those that affect salaries also affect teacher turnover. Again, we use an equation to predict the district's teacher turnover ratios. (See Figure 3.)

Table 2
Estimated Effect of Selected Variables by Teacher Characteristics 1/

	Model 1 2/		Model 2 3/		Model 3 4/	
Variable	Coefficient	P>|t|	Coefficient	P>|t|	Coefficient	P>|t|
Bachelor's Degree and No Experience						
Class Size	0.001166	**	0.00618		0.008829	***
Local Wage	0.1898	***	0.16599	***	0.15912	***
Minorities	0.000573	***	0.0005458	***	0.000516	***
Free Lunch	-0.00026	***	-0.0002494		-0.00024	***
Master's Degree and No Experience						
Class Size	0.0016	***	-0.0013643		0.01098	***
Local Wage	0.2057	***	0.20158	***	0.16789	***
Minorities	0.000638	***	0.000664	***	0.000542	***
Free Lunch	-0.00028	***	-0.0003		-0.00025	***
Master's Degree + 30 Credits and No Experience						
Class Size	0.00196	***	0.00216		0.011666	***
Local Wage	0.20797	***	0.19833	***	0.17465	**
Minorities	0.000766	***	0.0006785	***	0.000578	***
Free Lunch	-0.00035	***	-0.0003863	*	-0.00033	***
Master's Degree and 20 Years of Experience						
Class Size	0.00303	***	0.0680947		0.012141	**
Local Wage	0.2436	***	0.0289178		0.18218	**
Minorities	0.000718	***	0.0000898		0.000625	***
Free Lunch	-0.00047	***	-0.0000814		-0.00042	***

1/ Other independent variables were the number of classes taught, hours spent at school, unemployment rate, metropolitan status and state.

2/ OLS estimation corrected by heteroscedasticity at the state level

3/ Three-stage estimation of system presented in text. Class size does not include preschool teacher ratio.

4/ Three-stage estimation of system presented in text. Class size includes preschool teacher ratio.

*, **, *** denote significance levels smaller than the 10%, 5%, or 1%.

Figure 3

Teacher Turnover Determination Equation

$$TURNOVER = a_0 + a_1CS + a_2INCG + a_3SALARY + a_4WAGE + a_5QUA + a_6PMIN + a_7PLUNCH + a_8WAGE + a_9UNEM + a_{10}STATE + a_{11}METRO + e_1$$

Among the determinants of turnover are the district's class size, the expected income growth (INCG), the teacher salary, the local wage, a measure of the degree of certification inside the district (QUA),[9] the unemployment index, and indicators of state and metropolitan areas.

Prediction of the district's difficulties in recruiting teachers was done using a dichotomous variable model, where the dependent variable (PROB) could only be one of two values: yes if the district reported problems, and no. The model to be estimated is:

$$PROB = a_0 + a_1CS + a_2INCG + a_3SALARY + a_4WAGE + a_5QUA + a_6PMIN + a_7PLUNCH + a_8UNEM + a_9STATE + a_{10}METRO + e_1$$

As determinants of hiring problems, we include the class size, the expected income growth (INCG), the teacher salary, the local wage, a measurement of the degree of certification inside the district (QUA), the unemployment index, and indicators of state and metropolitan areas.

Interpretation

Teacher Compensation

A reduction in class size tends to be very expensive. For example, reducing class size from 20 to 19 students is a reduction of 5 percent. If no other inputs changed, it would be appropriate to compare the increased demand for teachers and the reduction in salaries—suggesting that the salary offset from class-size reduction could cover perhaps 10 to 20 percent of the added costs. It seems unlikely that no other costs would rise with smaller classes. In fact, a common estimate is that total per-pupil expenditures will rise proportionately with a reduction in class size. If this were the case and if only teacher salaries were affected by lower class size, the percentage of salary offset would be cut roughly in half.

The effect of other factors on teacher salary, such as the concentration of minorities, was found to be significant. An increase of a single percentage point in the minority population of a school district was directly related to a salary increase of 0.05 percent for teachers with bachelor's degrees and no experience.

This implies that one district with 50 percent more minority students will exhibit higher teacher salaries by almost 3 percent.[10] At the same time, salaries do not appear to rise with more disadvantaged students. In fact, it is just the opposite. This juxtaposition of

the salary effects of minority and of disadvantaged students is puzzling, because previous analysis (e.g., Hanushek, Kain, & Rivkin, 1998) suggest that teacher preferences and mobility related to these populations parallel each other.

The elasticity between teacher salaries and local salaries was found to be 0.16. This implies a relatively small adjustment of teacher salaries to local market conditions. For example, 10 percent higher average salaries among college graduates in an area would push up teacher salaries by only 1.6 percent.

It is not clear how to interpret these estimates. It could be that schools tend to be rather insulated from local labor market conditions, perhaps because people who want to teach are relatively insensitive to salary. Alternatively, schools in expensive markets simply might tend to hire lower-quality teachers.

By disaggregating the data by region, we can investigate the source of the positive salary effects of class size. The South and the Midwest show the most significant effects—1.5- and 0.8-percent increase in teacher salary per additional student, respectively. These estimates are balanced against positive, but statistically insignificant, effects in the remainder of the country.

Regarding the effects of class size on salaries in metropolitan areas, we find different coefficients on the class-size effect among metropolitan areas and the surrounding areas. We observe a larger effect in suburban areas than in central cities. The effect in suburban areas is significant. Rural areas also present a positive effect, but smaller than that in suburban areas.

Teacher Turnover and Hiring Problems

Salaries are not the only place where labor market factors and working conditions wield their influence. They can also affect the ability of districts to hire and retain teachers.

An analysis of teacher turnover in districts shows, not surprisingly, that higher teacher salaries decrease the turnover ratio. At the same time, higher local salaries increase turnover rates, but by a lower quantitative amount. This implies that these labor markets are not separated, but it also reinforces the previous finding: Teachers are not too sensitive to variations in outside wages.

A higher percentage of minorities in the student population is also associated with higher turnover.

Higher ratios of certified teachers are related to less turnover, although the exact explanation for this is unclear.

The only surprising part of the models is that class size has a negative impact on turnover. In other words, it appears that turnover is reduced when a district has larger class sizes. This perhaps reflects the fact that teachers choosing districts with larger aver-

age class sizes are happy with the wage differential they receive and are, on average, not dissatisfied.

The final aspect of the analysis is to consider what causes districts to have difficulty in hiring teachers. The basic results suggest that difficulties in finding teachers are related to larger class sizes.[11] Nonetheless, the interpretation is difficult. If a district cannot find teachers for its vacancies, class sizes could rise because there are insufficient teachers. In other words, the direction of causation is in doubt.

Within these models, it is difficult to sort out the separate effects. Districts with higher minority student populations have more difficulties hiring teachers, but salaries do not seem to play a major role.

Conclusion

Class-size policies have many facets—from educational to political. In addition, however, there are a series of fiscal implications. This work concentrates on just one of these—whether differences in class size affect the appeal of districts sufficiently to have impacts on the labor markets that the districts face. This aspect ignores a number of other important issues, including the direct costs of hiring more teachers to accommodate a smaller class size and the necessity of having additional classroom space. It is nonetheless important, because teacher quality is a key ingredient to better performance of schools.

Historically, little has been known about the salary or hiring implications of reduced class sizes. Some have even speculated that teachers so value small classes that the reduced salaries they would be willing to accept would offset the costs of class-size reduction. Nonetheless, it is clear that some salary effects could help recoup some of the additional costs.

This analysis suggests that class size has a small but noticeable effect on the salaries paid by school districts. All things being equal, a decrease of class size by one student is associated with teachers' salaries that are 1 to 2 percent lower. Thus, for example, a class-size reduction policy of three to four students across the board could lower the necessary payments for teacher salaries by some 5 percent. If teacher salaries are half of the cost of a district's operations, this could amount to a 10- to 15-percent offset to the class-size reduction policy.[12] This study, however, suggests that this effect may differ across regions of the country and across geographic locations within states (i.e., central city, urban, suburban, and rural). The latter estimates are, however, prone to considerable uncertainty.

This analysis also has provided insight into a variety of other aspects of teacher salaries and teacher labor markets. One of the most interesting findings is that teacher salaries do not move very closely with the salaries of other college graduates in an area. If other salaries are 10 percent above the national average in an area, teacher salaries tend to be

only about 1.6 percent higher than teacher salaries elsewhere. What is unknown is whether the quality of teachers also adjusts with these different opportunities.

In addition, we have found that characteristics of the student body also affect salaries. In particular, it appears that teachers require higher salaries to teach in districts with higher concentrations of minority students. On the other hand, just the opposite appears to be true for disadvantaged students. Thus, it is difficult to make consistent conclusions about the preferences of teachers for specific types of students.

The turnover of a district's teachers, which we take to be an indication of the employment appeal of a district (after allowing for population growth), has the expected relationship with salary. Higher teacher salaries reduce turnover, while higher outside salaries in the area increase turnover. Again, however, these are not as precisely related as one might expect. Turnover is much more dependent upon district salaries than on other market opportunities.

This study is best viewed as a preliminary investigation of factors of the teacher labor market. Most notably, we have no measures of the quality of teachers, with perhaps the exception of the certification rate. We can observe flows of teachers into and out of districts and we can observe the salaries associated with districts' filling their teaching requirements, but we cannot observe the effects on student outcomes. Any full policy consideration should certainly pursue the issue of quality results, but this study did not attempt to do so.

Endnotes

1. Some sense of the range of discussion and the current state of the debate can be found in a special issue of *Educational Evaluation and Policy Analysis*, Summer 1999.
2. For example, the recent Public Agenda survey, Farkas et al. (2000).
3. Indeed, some people have argued that these effects are large enough to justify reduced class size, even if the effect of class size on student performance is zero. These arguments in the past have not been based on any evidence, however.
4. The estimates depend on the level on the salary schedule considered. See Table 1.
5. The SASS was conducted by the NCES during the years 1987-88, 1990-1991 and 1993-1994.
6. Because different mechanisms inside the states can affect the dispersion in educational expenditures, we correct for heteroscedasticity. States not only control an important part of educational funding but also face differing court and legislative pressures to achieve local revenue equalization.
7. Intuitively, the estimated coefficients are biased because the measured factors will partially reflect unmeasured influences that are correlated with variables in the estimation. The degree of bias is related to how important the omitted factors are and how closely correlated these omitted factors are with the included factors.
8. This corresponds to Model 3 in Table 3. A previous model with population growth as the sole instrument for class size is presented as Model 2.
9. It has been argued that certification represents a sunk cost for teachers.
10. Results were similar for the other salary schedules.
11. Because the dependent variable is binary (there are either problems or not), these models are estimated using probit techniques. The coefficients can be evaluated as indicating the effect that each of the factors has on the probability of that the district faces problems.
12. The exact mechanism for achieving these savings is, of course, unclear, because it is doubtful that such a salary roll-back would be negotiated immediately. Instead it would probably reflect lower wage growth over a number of years.

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Smaller Classes, Better Teaching?
Effective Teaching in Reduced-Size Classes

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One of the fundamental questions surrounding the issue of class-size reduction is whether or not smaller class sizes help teachers teach more effectively. A close look at a study conducted by the Student Achievement Guarantee in Education (SAGE) program in Wisconsin helps illuminate the effects of class size on the efficacy of the teacher.[1]

SAGE studied the results of reducing class size to 15 students in approximately 300 first-grade classrooms across the state. Though the study will continue through the 2001-02 school year, early results indicate that reducing class size improves student academic performance. The study has observed achievement gains in reduced-size classes in reading, language arts, and mathematics that are significantly higher than gains in larger first-grade classes.

The study also found specific effects in the classroom associated with reducing class size. The most obvious result is that teachers are more apt to individualize their instruction to fit the needs of their students (see Figure 1). Through one-on-one tutoring, small-group learning, and total class teaching, individual student understanding and input are elicited, critiqued, and corrected or extended. The content taught is largely the same, but the teaching techniques vary for each student.

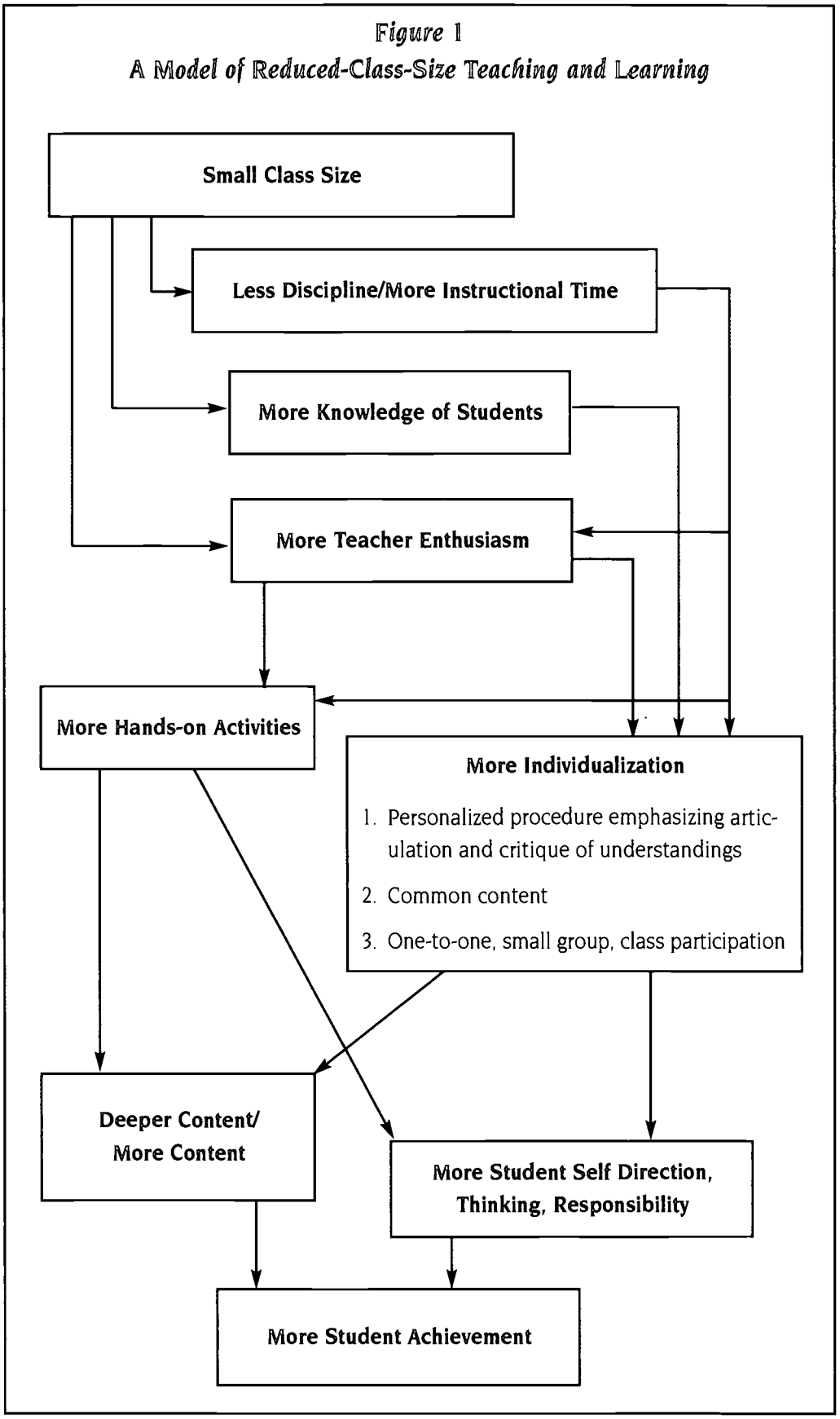
This increased use of individualization in reduced-size classes is possible because teachers can spend more time on students and less on disciplinary issues, have greater knowledge of their students, and feel more enthusiastic about their work. In turn, individualized instruction and more hands-on activities result in more in-depth instructional content, more student self-direction, and, ultimately, greater student achievement as reflected by higher achievement scores.

Still, although first-grade students in the SAGE program generally out-performed students from comparable schools outside of the program, test score gains varied among the SAGE schools. Clearly, some SAGE first-grade teachers are having more success than others. This study strives to find out why.

The Study

The study focused on 76 first-grade teachers or teacher teams who had participated in the SAGE program for a minimum of two years. They were teachers or teacher teams who had shown comparatively higher-than-expected achievement gains for each of the two years, as well as teachers or teacher teams who had shown comparatively lower-than-expected achievement gains for the same time period.

Figure 1
A Model of Reduced-Class-Size Teaching and Learning



To determine the type of teaching used by highly effective teachers in reduced-size classes, two analyses were carried out over a six-month period:

1. Using qualitative research procedures, comparisons were made between the teaching behaviors observed among a group of highly effective first-grade teachers in reduced-size classes and those observed among groups of less effective first-grade teachers in reduced-size classes.

2. Questionnaires were distributed to all first-grade teachers participating in the SAGE program to determine their self-reported behavior and techniques. The results were then analyzed against gains in student achievement test scores using quantitative research procedures.

1. The Qualitative Analysis

Based on geographic accessibility, 13 of the SAGE teachers were selected for a qualitative study of their teaching techniques and behaviors. Nine of them were higher-achieving teachers (representing seven classrooms, since two were team-taught) and four were lower-achieving teachers.[2] All of them were teaching classes of 15 students, except for the team-taught classes, which had 30 students—maintaining the 15-to-1 ratio.

	Higher-Achieving (9)	Lower-Achieving (4)
Sex	7 female, 2 male	4 female, 0 male
Average Years of Teaching Experience	14 years	23 years
Education	2 with Master's degrees	1 with a Master's degree

The following are other relevant characteristics of the groups:

Data were collected over a six-month period using classroom observations, teacher interviews, and a teacher self-reports.

Classroom Observations

Each teacher was observed a minimum of four times. Two of the observations were conducted as the teachers taught reading, and two were conducted as they taught mathematics. Observers focused on general aspects of teaching, such as objectives, learning activities, student behavior, classroom organization, and teacher behaviors found to be related to reduced class-size teaching in previous research (e.g., individualization, discipline, hands-on activities, and instructional time). Observers took notes, which were used to prepare expanded descriptive accounts of the classroom events.

Teacher Interviews

Introductory interviews were conducted with each teacher, followed by two additional interviews—one focusing on teaching reading and one on teaching mathematics.

The introductory interview obtained teacher background information, information about typical teaching characteristics, class composition, recent changes in teaching, and descriptions of normal testing procedures.

The reading and mathematics interviews asked teachers to describe their instructional philosophies regarding these areas, to describe a typical lesson in each of these areas, and to discuss perceived ways to improve their teaching in each of these areas.

All interviews, which lasted from 30 minutes to more than an hour, were tape-recorded and transcribed.

Teacher Self-Reports

Teachers also were asked to complete self-reports regarding their instructional techniques. The self-report focused on those teaching behaviors and the effects perceived to be related to smaller classes.

Results

The general pattern of teaching found to be associated with smaller classes was evident to varying degrees in both the higher-achieving and lower-achieving classrooms. All of the teachers emphasized individualized instruction to some degree. They attended to the needs of individual students in several ways, including the following:

- Monitoring learning
- Eliciting understanding
- Requiring students to display skills
- Providing feedback and critiques
- Reteaching when necessary

Discipline and management were less important than they might have been in a larger class. Teachers also expressed greater enthusiasm for teaching, although some teachers indicated that their enthusiasm was down from prior years in the SAGE program. However, data regarding enthusiasm were collected in February—rather than in May, as in prior years—which might have been a factor in the morale level of teachers.

It was also found that teachers had greater knowledge of each student and used more hands-on activities, although still not as often as they would have preferred. There was also evidence that students were willing to learn more content in greater depth in a smaller classroom environment.

This pattern of teaching and learning was not uniform across the two types of classrooms, however. There were marked differences in instructional orientation, classroom management, and individualization between higher-achieving and lower-achieving classrooms.

Instructional Orientation

Instructional orientation refers to the "ends" and "means" preferred by the teacher. The goals or outcomes sought by the teacher are referred to as the desired ends. The means are the teaching methods or techniques the teacher uses to reach that outcome.

Data revealed that lower-achieving teachers emphasized personal development as the end goal. These teachers wanted to help students improve problem-solving skills, develop critical-thinking ability, gain deep understanding, enjoy learning, and generally become self-motivated, independent learners. Acquiring basic skills and fundamental concepts was not ignored, but it was secondary for these teachers.

The teaching methods preferred by teachers of lower-achieving classes were hands-on activities, cooperative group work, problem-solving tasks, and generally child-centered, experiential learning in which the teacher serves as a facilitator. The instructional orientation of each of the teachers in the lower-achieving classrooms revealed one or more aspects of these kinds of goals and methods:

Teacher L3[3]**:** "I *try* [*to*] *be hands-on. I try* [*to*] *explain things in a way so that everybody has the opportunity and understands.... So, I think the most dominant* [*characteristic*] *is my hands-on style.... I like to get the kids problem-solving. I like to not give them too much information. They're mainly having to come up with ideas themselves.... I tend to not do skill-and-drill type things, but to do small group problem-solving type of problems.*"

L1's emphasis on problem-solving and hands-on activities was evident in both her reading and mathematics instruction. Her room, which is organized into "interest centers," provides many opportunities for students—individually and in small groups—to engage in experiential learning on their own. Furthermore, the group activities she uses in mathematics often consist of solving problems, and the activities she uses in reading stress comprehension.

Both teachers L2 and L3 saw fun and enjoyment as major goals in their teaching:

Teacher L2: "*One of the reasons I went into teaching is that I want kids to like reading. I'm not a reader... [but I believe] students will read more if they enjoy it..., so that is one of my main goals also....*

Regarding mathematics:

Teacher L2: "*I think that is a real important part of math that it should be a discovery part for them. It should be interesting, and it should be fun even though there are certain things that you have to do ... it is important to get the interest level ... I'm a real believer in having students feel comfortable and be able to express their feelings ... I have a lot of hands-on things ... [that] give them experience. That's one of the biggest things, I think.*"

Teacher L3, although not neglecting the need to memorize basic facts and acquire basic information, values creative teaching that produces student interest.

Teacher L3: *"I'm creative. I don't know ... how creative 'creative' is, but I'm sure that is one thing ... that [colleagues] would say is pretty visible in my teaching .... I can look past the typical type activities that you would do. For example ... [we] do something using everyday materials that you wouldn't really think of, but [the materials] just happen to be there, and it's something that would be fun and it sparks the interest of kids."*

Teacher L4 is dissimilar to the other teachers who had lower achievement, having goals that emphasize thinking and other personal qualities or methods that emphasize hands-on activities and experiential learning. However, she is similar in that basic skills and concepts are not a primary goal for her. Her main goal appears to be coverage:

Teacher L4: *"Well, I try to get to the designated grade level at the end of the year, get through the book .... They give us the [math] book and then [tell us] this is what we have to take.... We have to read and figure out what we're going to do. It's a lot of running off and a lot of preparation for everybody. [In] our math program, we have six of these books to go through."*

This focus on coverage is coupled with an elaborate system for recording coverage progress and issuing grades. For Teacher L4, recording student progress often substitutes for helping students see errors and reteaching.

For the teachers of higher-achieving classes, instructional orientation included personal goals and experiential methods, but to a somewhat lesser degree than the lower-achieving teachers. The higher-achieving teachers have goals that are comprehensive, but that emphasize basic skills and processes in general and in relation to the needs of individual students.

Their reading programs focus on word attack skills and sight words along with comprehension. Their mathematics programs are based on problem solving, but they add an emphasis on basic facts and computational skills. This balanced set of goals is matched by a balanced set of instructional methods.

The higher-achieving teachers have a variety of methods, including experiential methods; however, they give more attention to drill and practice than do lower-achieving teachers. When they do use discovery, problem solving, and other student-centered techniques, they use them in a teacher-centered way. The teacher directs and controls the activity to reach predetermined objectives.

This balanced instructional orientation, with special attention given to the acquisition and practice of basic skills, is characteristic of the teaching of each higher-achieving teacher.

Teacher H3: *"You need to have a balanced reading program where you have phonics, you have some whole language ... you need to have a lot of writing and reading, [so] that [the students] have a lot of practice .... [Reading] is a combination of phonics, picture clues, and comprehension.... I believe in [phonics] very strongly.... There [are] so many words that [the students] are going to come across that if you were teaching [just] sight vocabulary, they would have no skills to break down words.... My strengths, I think, are teaching basics and the structure."*

Teacher H7: *"I think it's great when we do [hands-on activities], but I also do the skills. They still have to know two plus two equals four in my room, and my students do know.... I know [teachers] complain their series doesn't have a lot of skill work, but I give [the students] skill work ... on my own ... So, as you can see, I still do some skills too, because I think it's important."*

Teacher H6T: *"We do a lot of supplementing because we don't feel that the kids are getting what they need from their series. In fact, they're missing a lot. A lot of stories don't reinforce the basic sight words and that's what we feel they need."*

Most higher-achieving teachers stressed the need for both teacher-centered instruction and learner-centered instruction. Students need variety, but the variety must include drill and practice as well as explicit explanation and modeling.

Teacher H2: *"In order to teach them how to read, you're going to have to use a lot of different methods because children have different ways of learning."*

Teacher H5T: *"You know you want to try to hit things from as many different angles as possible so that kids who need different angles pick up on things.... [W]e have to have a variety of ways to approach things."*

Comments by the teacher team H6T and teacher H7 exemplify the views of higher-achieving teachers about drill and practice. Teacher team H6T said their teaching is game-oriented and they use lots of projects:

Teacher team H6T: *"We still like the rote-type activity because that's what math is all about."*

Teacher H7 regarding reading: *"I could see at a glance who was catching on and who wasn't. And you know we'll go over it again and again."*

In relation to explicit teaching, teacher H7 said, *"I think it's better if they see a teacher model first.... I know you're supposed to let them create and see what they come up with, but I think it just works better if the teacher models first, and that's what I like to do."*

Teacher H3: *"I do some direct instruction because I think they need that modeling. They need to be guided sometimes. They need that modeling and the redirection and checking for understanding."*

Classroom Management

The second aspect of teaching on which higher- and lower-achieving teachers differ is student and lesson management. Student management refers to classroom discipline polices and practices. Lesson management refers to the structuring, directing, and pacing of learning activities.

Interviews and observations revealed that teachers in lower-achieving classrooms differed from higher-achieving teachers in student management, lesson management, or both—in several ways.

Student management typical of the lower-achieving teachers can be characterized as permissive and inconsistent. The lesson management of lower-achieving teachers revealed a tendency for the lessons to have unclear goals, lack logical sequence, and pursue tangential ideas, and the teachers tended to have lengthy exchanges with one or two students. The outcome of both of these sets of traits was student inattention and reduced engagement in learning tasks.

Of the four lower-achieving teachers, teachers L2 and L3 had difficulty in both student management and lesson management. Teacher L1's student management was effective, but her lesson management led to student confusion. Teacher L4's management style, although different from that of the others, had a similar effect on students.

Teacher L3's management style was evident in the opening-day activities and a reading lesson that she taught. The day began as Teacher L3 called the class of 14 students to the rug area. All of the students sat on the rug, except for two who continued to walk around the main section of the room or over to the reading "cubby hole," a section of the room enclosed by bookcase dividers four feet high. The teacher did not require these two students to join the group. She generally ignored them and possibly lost track of them, because once in the cubby area they were not visible.

The activities consisted of previewing the day's events by having students place pictures and times on a chart at her direction (e.g., Gym 12:30), discussing the date using a large calendar, and reading a story aloud to the class.

During the events and calendar activities, many if not all of the students had opportunities to make contributions. Some students shouted out their comments, which were accepted by the teacher, while a few students waited for the teacher's recognition. The pace of both activities was slow and deliberate. She dwelled on topics with individual students for long periods of time, while the rest of the class fidgeted, talked, and distracted one another.

The discipline techniques teacher L3 used were positive and humane, (e.g. "James, when I hear you talking, I can't hear Michael."), but they were mostly ineffective in bringing about desired results.

After a story had been read to the class and a brief discussion had taken place, the class was asked to return to their desks. The teacher and class engaged in another activity, this time about the weather. Again, many students chatted amongst themselves. Some roamed about the room and generally ignored the teacher, or the teacher interacted with one student at length. As some students continued to misbehave, the teacher began to write their names on the board, but compliance remained elusive.

The last activity was to write a story based on the story that had been read aloud. The teacher modeled what she intended students to do, monitored the activity, and provided assistance when needed. In general, students settled into the activity, although a few still walked around the room or escaped to the "cubby hole."

The actual activities and methods that teacher L3 used were sound, and the stories that many of the students wrote were imaginative and detailed, but the effectiveness of the opening-day activities was undoubtedly reduced by the teacher's acceptance and, in some cases, facilitation of student inattention. Her discipline procedures, lesson pacing, sequence of activities, and even room arrangement resulted in taking time and focus away from instruction.

Teacher L2's classroom management resembled that of Teacher L3. She pursued individual students' comments that were only marginally related to the objectives of the lesson and discussed them at great length, while the class began to unravel. She was inconsistent in enforcing her policy of raising hands to seek permission to speak, and she dwelt on topics beyond the students' ability to understand.

The lesson-management problems of teacher L1 consisted of vague goals for some of her lessons, a sequence of activities of tasks that lacked logic, and a slow pace. The slow pace and poor clarity of the lessons often resulted in interruptions—as students sought clarification—and inattention, leading to incomplete or poorly completed tasks.

Teacher L4, as seen in relation to instructional orientation, had a teacher-centered and teacher-controlled classroom. She had a discipline policy that she followed consistently, and her lessons were carefully organized and sequenced. Her management, however, appeared to be excessive. Lessons seemed to progress regardless of whether students understood them. Misbehavior was dealt with instantly and sometimes harshly. She said to one student, "I don't want you to touch my stapler any more this year. Don't put your hand on my stapler again this year. If I had wanted you to staple them, I would have told you." In teacher L4's classroom, student learning and attention appeared to be secondary to classroom efficiency and order.

By contrast, the higher-achieving teachers are considerably more able to manage students and manage lessons so that students are engaged in the intended academic pursuits. Many see their ability to structure and organize as one of their most important teaching characteristics.

Teacher H4: "[*Other people*] *would say I have a structured classroom. I try to maintain a routine because the children really need to have a routine. They need to know what to expect.*"

Teacher H1 (when asked what her colleagues might say about her techniques)**:** "*They'd say, 'Oh, she's structured,' and I feel our kids ... need some structure. I try to keep a daily routine ... so that it isn't always changing, because the behaviors are such that they can't handle that.*"

Teacher H3: *"Another thing is I'm pretty organized; I have to be organized or it would drive me nuts."*

This ability of higher-achieving teachers to organize and manage is illustrated in a reading lesson taught by Teacher H1. The lesson began with Teacher H1 calling the class of 15 students together to listen to directions for the day's seatwork. As she waited for them to assemble, she reviewed the class rules for sharpening pencils. In response to a child's request to get a drink, the teacher gently reminded him that students are not permitted to get drinks while the teacher is talking.

The seatwork consisted of four activities. The first, a multipart task involving vocabulary related to animals was carefully explained and demonstrated by the teacher. After each part was explained step-by-step and the students began that part, the teacher and classroom aide circulated and offered help where needed. The other three tasks were routine activities involving an addition sheet, a word recognition sheet, and a story to be written in the students' journals. These tasks also were explained in detail.

Following the explanation of seatwork, the teacher explained and assigned "interest centers" where students could go after completing their seatwork. The centers included a computer center, library-reading center, listen-to-a-taped-story center, and board-activity center. The centers were located in various sections of the room, but the children in the centers were visible from any area in the room. None of the bookcases and other dividers were tall enough to create hidden "cubby holes."

As the students began the seatwork, the teacher called the first of five reading groups to the front reading table. The groups, formed on the basis of reading ability, used different reading and instructional material, but followed a similar routine. Each included vocabulary work; relating the story to students' experiences; predicting story events; oral reading either to the group, to the teacher, or in pairs; discussion of the story; and assigning of story-specific skill or comprehension exercises.

During the reading group sessions, the teacher continually surveyed the room and issued quick, decisive, but kindly commands if students were becoming disruptive. For example, "Bruce, I shouldn't be able to hear your voice." As one group left the reading area and another group came to it, the teacher circulated around the room making sure each student was on task. When the last reading group returned to their desks, the teacher turned off the lights, signaling the end of the reading period and time to put away or turn in their work.

Throughout this reading lesson, all of the students were engaged and on task. The teacher gave clear directions, the tasks were appropriate and followed a logical progression, and the pace was brisk. In her management of the students, teacher H1 was positive and nurturing, but she was also firm and decisive.

Although the management of all of the higher-achieving teachers results in a high degree of student engagement and production, teacher teams H5T and H6T have especially effective management. Student management is accomplished in a novel way in the

teamed classrooms. One teacher is almost always available to oversee student attention and give help while the other presents a lesson. Furthermore, because teamed teachers share their views of individual children, they are able to develop an in-depth understanding of each child and target responses to student inattention. In addition, however, each team has an elaborate student management system.

Teachers in team H5T have developed a ticket/sticker system in which tickets are placed in a student's envelope for good behavior and removed for poor behavior. One of the teachers said, "Three, two, one, we're done. Everyone freeze. I'll take a ticket from anyone not quiet."

Implementation of the system was neither rigid nor harsh. At another time, the teacher said, "Now direct your attention up here. Please. Pretty please. Pretty please with sugar on top. Cherries?"

The other team's approach is based on self-control. The following comment was characteristic of their classroom: "Someone in back is being disrespectful. Being disrespectful is making poor choices. It is important to always...," and the class chimes in, in unison, "Make good choices."

The teacher collaboration that produced these systems and their implementation also influences lesson management. Because lessons are planned together and are discussed and critiqued at length, they are usually well organized and efficiently presented. Unproductive tangents, ambiguous deviations, and slow pace rarely occur.

Individualization

In the reduced-size classroom, the direct effect of an instructional orientation that emphasizes academic development and management that enables it to flourish is increased use of individualization. Individualization means meeting the needs of individual students by providing opportunities for them to reveal their understandings and abilities and offering critique and assistance in all settings. It occurs in both lower-achieving and higher-achieving classrooms almost automatically as a result of having a reduced-size class. But it occurs more often in higher-achieving classrooms than in lower-achieving classrooms.

The teachers in lower-achieving classrooms are not necessarily less inclined to focus on individuals, but their focus is less teacher-directed and they have less time available to attend to teaching in general and to individuals in particular, because of their management problems.

Teacher L3, for example, uses a variety of methods, elicits student understandings, has one-on-one sessions with students, and shows concern for individuals, but her individualization is not productive. In fact, in some cases, it is counterproductive. Her opposition to drill and practice and her inability to control the class negate any benefits of individualization. As we have shown, when she does seek students' understanding or offers help

to an individual student, she does it for an extended period of time, which causes misbehavior on the part of other students.

This same problem affects Teacher L1's teaching, because her explanations are often confusing, and Teacher L2's teaching, because of her concern for students' emotional well-being. In one instance, Teacher L2, in discussing a story during a reading lesson, asked the class to name possible enemies of the city. One student said it was the car. Another, however, remarked that he did not like birds and began to tell the class why he did not like birds. The teacher encouraged the student to share his thoughts about birds at great length, even though it was unrelated to the story and caused the class to become disruptive.

The higher-achieving teachers mention—and their teaching reflects—a high degree of individualization. They diagnose present levels of achievement, elicit students' thoughts, offer feedback, reteach when necessary, and give periodic reviews. Their lessons are characterized by a variety of types of activities in an attempt to facilitate various learning styles, by much sharing and oral reading, and by monitored practice.

Teacher H2: *"You're going to have to use a lot of different methods because the children have different ways of learning.... I do some individual reading with every child. With this small class I can get around and listen to every child read individually every day."*

Teacher H3 has regular writing conferences with her students individually, which require students to read their work to the teacher, edit their work with the teacher, answer questions about the finished stories, share their interpretations, and read the finished stories to the teacher and eventually to the class. Her goal is *"that each child grows throughout the year.... I just need to meet their needs."*

Teacher H4 holds conferences with students individually about their books, discusses any questions they might have, and asks them to reread their favorite parts aloud to her.

Teacher H5T: *"You want to hit things from as many different angles as possible so that the kids who need different angles pick up on things. If you're forced to throw it down their throats in one way, it would be like eating pudding all of the time. You know some kids can't eat pudding.... [W]e need to have a variety of ways to approach things."*

Models of Less Effective and More Effective Teaching

The models depicted in Figures 2 and 3 represent two types of teaching that result from using the same techniques differently. Teachers in both higher-achieving and lower-achieving classes use all of the elements identified in both figures, but the higher-achieving teachers use the elements in Figure 3 more often than the lower-achieving teachers, and the reverse is true in Figure 2.

Figure 2 does not represent all of the lower-achieving teachers from whom data were collected. Teacher L4, as we have seen, is an exception with her different teaching characteristics; however, the effects of her teaching match those of the other lower-achieving teachers.

Figure 2
A Model of Less Effective Teaching in Reduced-Size Classes

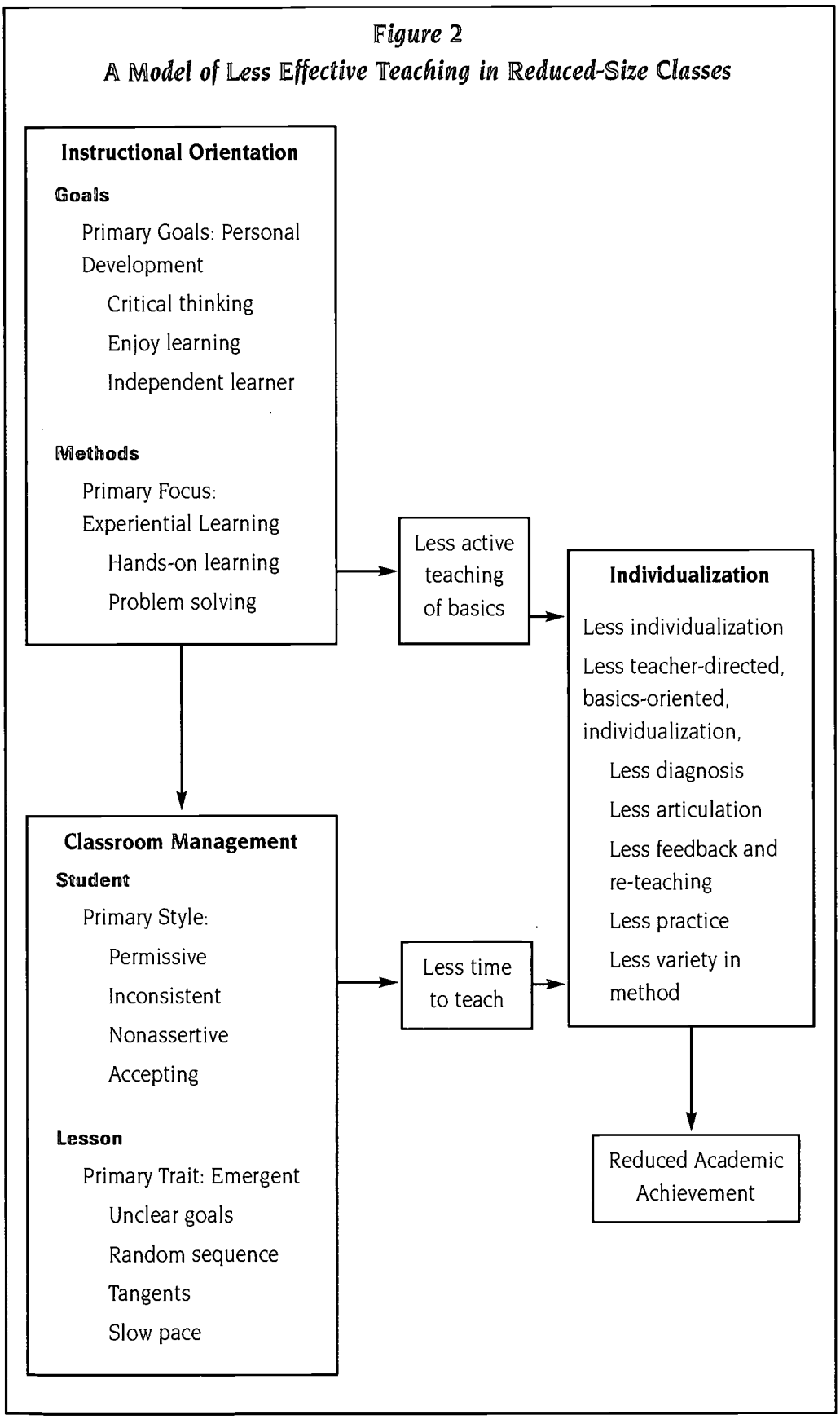
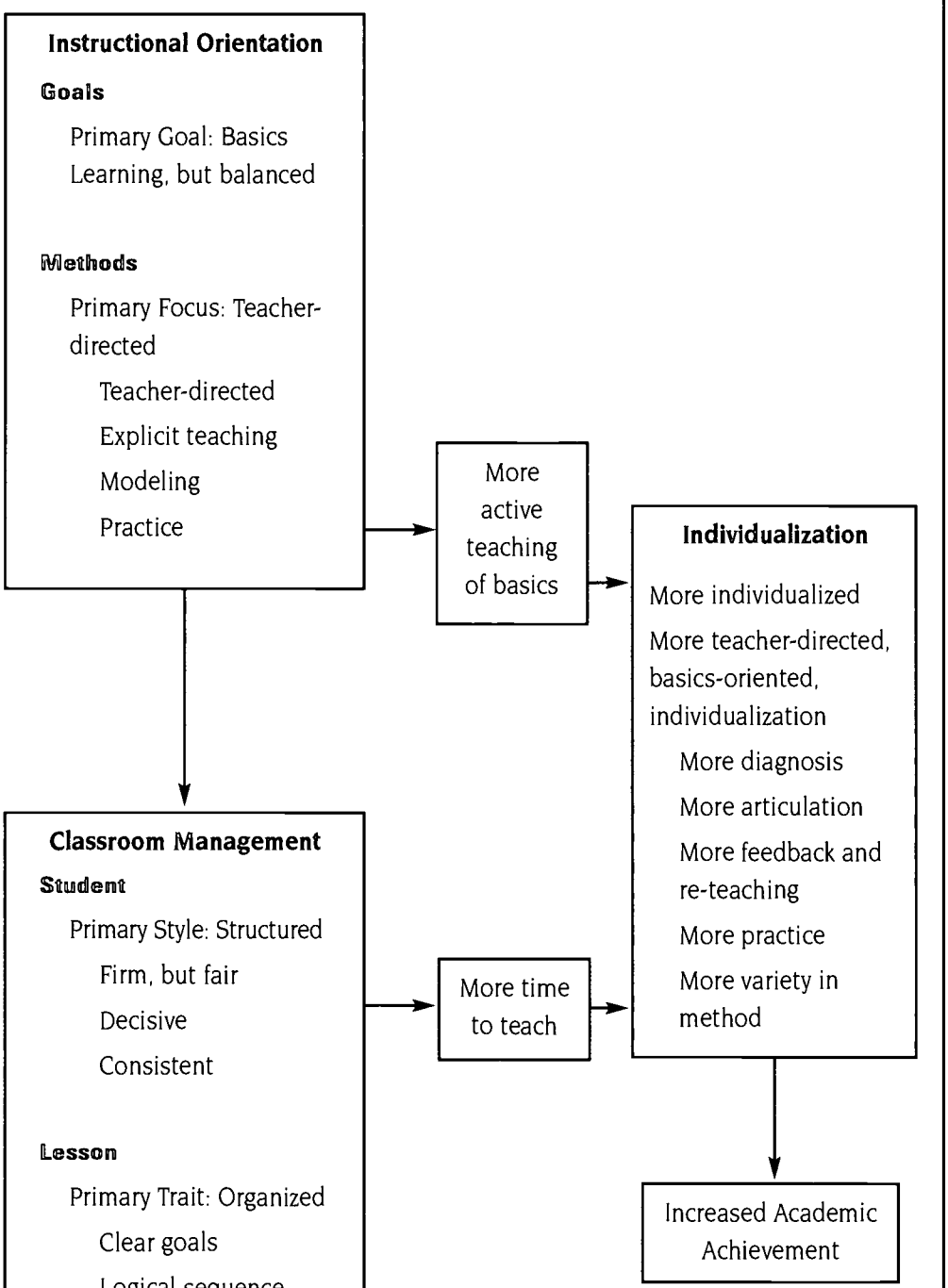


Figure 3

A Model of More Effective Teaching in Reduced-Size Classes



Less-Effective Teaching in Reduced-Size Classes

Figure 2 shows the following characteristics of teachers in lower-achieving classrooms:

- Teachers in lower-achieving classes have goals that emphasize the personal development of students and stress methods that facilitate independent, experiential learning. These preferences result in a de-emphasis of the teacher's role and a reduced focus on the basic skills and concepts of reading and mathematics in comparison to teachers in higher-achieving classrooms.
- Teachers in lower-achieving classes have student management procedures that are tolerant and permissive and lesson management practices that evolve and develop. These methods are time-consuming and result in less time for academic, goal-directed instruction in comparison to higher-achieving teachers.
- Lower-achieving teachers use individualization in their reduced-size classes. However, because of their attitude toward the active teaching of basics and the limited time available for instruction in their classrooms, the individualization is less teacher-directed and basics-oriented than in higher-achieving classes. The result, it is hypothesized, is reduced academic achievement.

More Effective Teaching in Reduced-Size Classes

Figure 3 shows the following characteristics of teachers in higher-achieving classrooms:

- Teachers in higher-achieving classes have more balanced goals that include attention to personal development, but they emphasize basic skills and concepts. The methods they prefer are those associated with explicit teaching, such as explaining, modeling, checking, and evaluating. These goals and methods result in more active teaching of the basics compared to lower-achieving teachers.
- Higher-achieving teachers are more structured and organized in their management of the classroom. Students are treated in a positive but consistent and firm manner. Lessons are aimed at important goals and proceed in a systematic, efficient way. Together, these student management techniques increase academic learning time while decreasing distractions.
- Because of the inclination to focus on the active teaching of basics and the increased amount of time available for instruction, the individualization of higher-achieving teachers is more teacher-oriented and basics-oriented than in lower-achieving classrooms. The result, again hypothesized, is increased student achievement.

It should be noted that although the teaching goals and methods of lower-achieving teachers jeopardize achievement as measured by standardized tests, they may not be harmful over time and might indeed be helpful. If the goals of teaching students to think about and solve problems are realized, students will be served in the future even though the attainment of basics is delayed.

Other Possible Factors Affecting Student Achievement

This analysis is based on the assumption that teacher behavior is the critical factor in separating higher- and lower-achieving reduced-size classrooms. However, several other factors could be responsible in whole or in part for the achievement differences. Three of the most plausible factors are students, aides, and testing.

Student ability and behavior could cause achievement differences between the two sets of classrooms, but differences between these classrooms regarding these variables did not exist. Since pre-test achievement data—rather than post-test achievement data—were used to identify higher- and lower-achievement teachers, student ability differences in reading and mathematics were controlled. In each of the 11 schools, the school used a stratified random procedure based on student behavior to form classes. Students likely to misbehave and disrupt the class were equally distributed across classes. This procedure served to reduce or eliminate behavioral problem differences across classes and between the two sets of classes.

A related student factor that could possibly explain achievement differences is the number of exceptional education students in each classroom. Here, too, however, students classified or likely to be classified as having exceptional education needs were equally distributed across classrooms rather than placed in one classroom. An exception was Teacher L3, who had special-education certification and was assigned a greater number of exceptional education students than other first-grade teachers in her school.

A classroom with many teacher aides or assistants could be thought to have an advantage over a classroom in which the teacher is the only adult providing instruction to students. The range of assistance varied from 0 to 16 hours per week in the 11 classrooms. However, between the two sets of classrooms, differences in the amount of aide time were minimal. The roles and responsibilities of the aides also could have an impact on achievement, but these data were beyond the scope of this analysis.

Substantive and procedural preparation for the achievement test obviously could affect the test scores. Every teacher in both sets of classrooms reported that he or she prepared students for the test by practicing filling in circles and other format features of the test and by trying to relax the students to prepare them to do their best. With only one exception, the teachers said that they did not specifically identify and teach content that would be tested. The exception, Teacher H1, said, "*I'm always thinking back to the testing when I am teaching. What things need to be stressed? What do they need to do to learn?.... I've always looked at the state Terra Nova, and ... am I hitting all those points?*"

None of these factors were found to be a major cause of achievement differences in this study.

2. The Quantitative Analysis

The SAGE database was used to provide quantitative data regarding achievement test scores, teacher questionnaire responses, and student profile reports.

Student Achievement

Mean achievement gain scores were obtained for each class taught by the 76 SAGE teachers for two successive years using the Terra Nova Comprehensive Test of Basic Skills (CTBS). Tests were administered in October and again in May. The mean gains for each of the two years were combined to arrive at a group mean achievement gain score for each teacher.

Teacher Questionnaire

Each spring, SAGE administered a teacher questionnaire to all participating teachers. Of the 76 teachers, 59 teachers or teacher teams completed the questionnaires in at least one of the two years.

The questionnaire asked teachers to rate and rank their use of 12 teaching behaviors that could be expected to be the result of smaller classes (see Appendix). Teacher scores for each of the two years were averaged to provide a total teacher score for each item.

Student Profile

The student profile is administered in the fall and spring in each SAGE classroom. The profiles provide descriptive class information regarding size, enrollment, gender, race/ethnicity, socioeconomic status, and dominant language. These data also were combined for the two-year period.

Results

The correlation between the ratings of each of the 12 questionnaire items and class achievement is positive (see Table 1). Since most teachers perceived themselves as using almost all of the behaviors to a high degree, this finding is not surprising.

The rankings, where teachers were required to discriminate among the 12 items by identifying the three most important behaviors, reveal a different result. The following six teacher behaviors correlate negatively with student achievement:

- Covered more content
- Covered more content in depth
- Involved students in more hands-on activities

Table 1

Correlations of Ranking and Rating of Teacher Behaviors with Mean Classroom Achievement in Reduced-Size Classes at the First-Grade Level

	Ratings[1]	Rankings[2]
1. Spent more time teaching rather than managing the classroom	.220	.218
2. Covered more content	.017	-.195
3. Integrated content from several subjects	.162	.159
4. Covered content in more depth	.089	-.289*
5. Spent more time individualizing instruction, assessing learning, providing learning activities, and giving help	.164	.172
6. Spent more time engaging students in discussion, encouraging them to share their ideas, and answering their questions	.101	.065
7. Involved students in more hands-on activities	.251	-.201
8. Based activities on students' prior knowledge, understandings, and skills	.271*	.096
9. More often involved students in problem solving, creating, and experimenting	.207	-.036
10. More often organized the class into cooperative groups	.126	.033
11. Offered more opportunities to choose among learning activities and materials	.076	-.112
12. Am more enthusiastic about my teaching	.159	-.185

Notes:

[1]Ratings of teaching behaviors were obtained using a 5-point Likert scale.

[2]Rankings consist of the three most important teaching behaviors teachers used.

* $P < .05$

- More often involved students in problem solving, creating, and experimenting
- Offered more opportunities to choose among learning activities and materials
- More enthusiastic about teaching

The six teacher behaviors that correlate positively with student achievement are as follows:

- Spent more time teaching than managing the classroom
- Integrated subjects
- Spent more time individualizing
- Spent more time in discussion
- Based activities on students' prior knowledge
- More often used cooperative groups

These two sets of correlations are generally consistent with the findings from the qualitative analysis regarding teaching behavior and serve to support and confirm those findings, particularly with regard to negative correlations and instructional orientation and amount of individualization.

Since the teacher questionnaire did not contain items related to specific forms of student management, characteristics of lesson management, and elements of teacher-directed methods, comparisons between qualitative and quantitative data cannot be made in these areas. Concerning methods, however, the opposite of hands-on activities, problem solving, and opportunity to choose is likely to be presenting, modeling, checking, and similar behaviors, which would be consistent with the behaviors used by the more effective teachers of reduced-size classes examined in the qualitative analysis.

Discussion and Implications

These findings, although limited in scope by the size of the sample and the examination of only one grade level, have possible implications for staff development in schools with reduced-size classes.

Improved teaching and learning seems to occur in most first-grade classrooms when class size is reduced to about 15 students. It is not unreasonable to speculate that even the teaching of less-effective teachers improves in a smaller class. The results of this study suggest that all teachers of reduced-size classes could affect students' learning to a much greater degree if they employed particular kinds of instruction and management.

Although smaller classes result in fewer student management problems and increased one-on-one time, the policy does not ensure that students will benefit. As we have seen, some teachers might use the increased time to sit back and relax. The time saved by fewer discipline problems and a more manageable class might cause some teachers to become less assertive, ill-prepared, and less focused. A smaller class seems to permit these behaviors without the danger of the class getting out of control.

Experiential learning and a clear focus on what is best for the students are of the utmost importance and should be present in every classroom. Teachers of reduced-size classes need to recognize the unusual opportunity they have to advance the achievement of the individual students in their classrooms. They should be encouraged to increase their emphasis on academic learning, not decrease it. They should spend more time, not less, on teacher-directed, basics-oriented individualization—with a special emphasis on student articulation of understandings, teacher critique, and reteaching.

Staff development programs emphasizing the teacher behaviors used by the more-effective teachers of reduced-size classes can conceivably strengthen the positive results found to be associated with the policy. Reducing class size alone will not increase student achievement, but helping teachers become more effective in those smaller classes will.

Endnotes

1. For more detailed background information about the SAGE program, please see Chapter 1, Reducing Class Size in Public Schools: Cost-Benefit Issues and Implications, by John Witte.

2. Originally, ten higher-achieving and five lower-achieving teachers/teacher teams were selected. One from each group was later dropped from the study due to insufficient data.

3. Teacher comments and remarks are used to illustrate the findings of the study. Attribution will be made as follows: Teachers from the high-performing classes will be indicated by H1-7 (Teacher teams indicated with a T). Lower-achieving teachers will be L1-4.

Implementing a Class-Size Reduction Policy:
Barriers and Opportunities

Ray Legler
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As the earlier chapters have shown, the decision to implement a class-size reduction policy is based on many factors, including funding, the availability of space and teachers, and the need to weigh the relative costs and benefits of reducing class sizes against other approaches to improving the academic achievement of students. However, once the decision has been made to reduce the number of students in classrooms, several practical issues may arise. For example, where will one find the additional classrooms that will be needed since there will be fewer students per classroom? What if there are no additional classrooms available? Should more buildings be built? Where will one find the additional teachers who will be needed to teach the increased number of classes? This chapter attempts to move from the theoretical and research issues presented earlier to consider practical, real-world matters.

In order to gain insight into these issues, we spoke with several educators in Milwaukee, Wisconsin, who have direct experience implementing a class-size reduction policy. The Milwaukee Public School (MPS) system, which employs more than 7,000 staff to instruct and assist more than 100,000 students in grades pre-K through 8, has 88 schools currently participating in the SAGE program. As described in earlier chapters, the SAGE program started in 1996 in Wisconsin and emphasizes a rigorous curriculum, school-community collaboration, professional development, and reducing K-3 class sizes to 15 students per teacher. During 1999-2000, Wisconsin funded the SAGE program with $17 million in order to assist 78 schools in 46 districts. In 2000-2001, an additional $37 million will enable another 400 schools to join the program.

The superintendent of MPS, Dr. Spence Korté, and two of his staff members, Jackie Patterson and Doreen Britton-Lange, were gracious enough to share with us some of their perspectives on and experiences with MPS's efforts to reduce class sizes. In addition, an MPS elementary school principal, Lorraine Applewhite, provided us with additional perspectives.

Critical issues

Teacher availability

One issue the Milwaukee districts has had to address is the problem of teacher availability. "Just like in any other district, there's a teacher shortage," noted MPS Deputy Superintendent Jackie Patterson, who has worked for MPS since 1970 as a teacher, principal, and administrator. As the district reduces class size to 15 students, Ms. Patterson said, MPS is "constantly" looking for teachers in order to fill all its classrooms.

MPS has several strategies for dealing with the teacher shortage, including an internship program and an alternative certification program. "We've got a variety of programs, working with universities to just come up with creative ways of getting our teachers," Ms. Patterson said. "We have programs that will allow educational assistants to go back to school and work directly in our schools, and we're recruiting nationally, like everyone else."

MPS found an untapped resource from which to draw new teachers in its pool of support-staff workers already employed in schools. "If we have someone who wants to go through a program and pick up their bachelor's degree, we're working directly through the universities to have that happen. We've found that the people who have worked in our schools before seem to be more committed to stay in our schools," Ms. Patterson said.

Space

Another serious problem for Milwaukee schools has been a lack of space the new classes, said Superintendent Spence Korté, who has been an educator in the MPS system for 28 years, including serving as principal from 1985-1999 of Hi-Mount Community School, where his emphasis on technology use in the classroom led to a 2-to-1 ratio of students to computers. Dr. Korté holds a doctorate in educational administration from Southern Illinois University.

Dr. Korté described a paradoxical situation in Milwaukee regarding the availability of classroom space: In some areas, there are too many students for the available classrooms, while in other areas, there are more classrooms than students need. "There's been an overall birth decline in the city, and there's also been a fairly serious migration of people to the suburbs," Dr. Korté explained. As in many large urban school districts, some Milwaukee schools are serving the maximum number of students that they were built to house, or more. Meanwhile, in other areas, declining student populations have left schools with extra space.

One way that MPS deals with this disparity is to bus children from heavily populated areas to neighborhoods where schools have extra space: Every day, MPS buses 70,000 of its 103,000 students. Busing has relieved the space problem in part, but at a substantial cost. Dr. Korté noted that MPS spent more than $60 million on busing during the 2000-2001 school year—a figure that is likely to escalate with the rising cost of fuel. One solution might be to reduce busing by opening new schools in the overcrowded neighborhoods, Dr. Korté said.

The Wisconsin state legislature just approved a plan called the Neighborhood School Initiative, which will fund the building of new schools and enable MPS to accommodate 11,000 more children in overcrowded neighborhoods, reducing the need for busing. Yet this initiative might introduce new problems. "Where there is no natural student population, some of those schools over the next three years will experience a nice opening up of the classroom space and the only abiding question for us is: Can we afford the overhead to keep them open?" Dr. Korté explained. "If we could figure out how to handle the overhead and reduce our cost, at least on paper, we should end up with a surplus of classrooms for the first time in the 28 years I've been in the district ... We may end up actually having enough space [but] not being able to afford the overhead of keeping the building open."

MPS also has addressed the problem of insufficient space by "doubling up" teachers—putting two teachers in one classroom with 30 students, Dr. Korté said. "It's not that bad, but it depends on the teachers' relationship and how well they are able to work together," he said. "That has been our main approach so far."

Addressing the issues

Team teaching

As might be expected, team teaching presents both potential problems and benefits. Differences in personalities and teaching styles can lead to disharmony and conflict. "Putting two teachers in one classroom sounds like a fairly good alternative to space problems, but if those folks don't have the same educational philosophy, then it isn't any kind of panacea at all," Dr. Korté said.

From a principal's perspective, this issue is particularly salient. "Personalitywise, it is just trying to get teachers to get along with each other. It is very strange to say, but that is my only issue with that. The two people working together have to want to work together," said Lorraine Applewhite, who taught at Milwaukee's Maryland Avenue Elementary for

nine years before becoming its principal three years ago. She holds a master's degree in educational administration.

At Maryland Avenue Elementary, teachers work well together in some instances while in others, they simply choose to co-exist, Ms. Applewhite said. "We have four classes out of nine that share. Of those four, there is one class where the teachers don't necessarily teach together—they wanted a wall, and they wanted to teach separately. They might do a few things together, but they are totally responsible for their own kids. In the other classrooms where they share, they actually do team-teaching activities. The two teachers feed off each other, and they work totally together to make sure the children get it."

Ideally, paired teachers should be compatible both interpersonally and professionally. In light of this, schools in the MPS system make efforts to find compatible matches when hiring new teachers. While interviewing potential new teachers, school administrators bring in the staff teacher who would share the room with the new hire. That way, the question of compatibility can be addressed at the onset.

"[Schools] are looking for a good match," said Doreen Britton-Lange, who has been with the Milwaukee school system for 31 years as both a teacher and a principal. Currently the district's elementary leadership specialist, Ms. Britton-Lange provides evaluation and support for elementary school principals.

Ideally, paired teachers can complement each other in the classroom. "Most people teach to their own strength," Dr. Korté pointed out. "One person might really like to teach mathematics and feel comfortable with it, while the other person may be sort of a language arts and reading whiz. But to the extent that you can play off people's strengths, kids get a better exposure.

"One of the other hidden benefits in my mind is, if we could do this a little more scientifically, we could actually try to match up teachers in terms of their expressed interest," Dr. Korté added. "And so an elementary teacher, rather than having five or six preps, might be able to do three. And they would move the kids to the teachers' strength. If I'm a really good reading teacher, I would teach reading to all the kids, while the other teacher was doing another subject—math or science or something."

Supporting and retaining new teachers

Combining classrooms brings both potential problems and potential benefits. Because teachers need guidance to learn how to survive in a classroom, the MPS system is looking at ways to bring new teachers on board a little more gently than typically happens in a large urban school district, Dr. Korté said. Ideally, an experienced primary-level teacher could help ease a new teacher into the job. Having a veteran teacher with as many as 20 years of experience working alongside a green teacher is a "major side benefit" of team-teaching as a means of reducing class size, Dr. Korté said.

Such a program might complement the district's mentor program, in which mentor teachers work with first-year teachers. "We certainly don't have enough to go around to work with all of the first-year teachers," Ms. Patterson said, "but many of the first-year teachers will have a mentor working with them."

Providing support for new teachers is particularly important in a district that is struggling to increase its total number of teachers. Once new teachers are hired, the issue becomes one of retention: It does not help a school system to hire a large number of teachers only to see many of them resign after a year or two.

Dr. Korté explained that the issue of retention might require cooperation with the teacher's union. "I'm thinking this may be a fertile area for us to sit down with them and say: 'Look, we have a teacher shortage. We're losing a lot of teachers. Let's try to work out something in the teacher assignment process that intentionally takes a young, fragile teacher and puts him or her in proximity to a veteran, hoping to improve our retention,'" Dr. Korté said. "That would make some sense, and I think that it could be structured in a way that the teachers' union would see that as a win-win."

Professional development for teachers

MPS has started to tailor professional development to the particular issues raised by the reduced class-size program. The large number of new teachers and the need to have some teachers work together highlight the need for strong professional development. Since the class-size reduction component of the SAGE program in Wisconsin targets grades K-3, the district's professional development emphasizes early childhood issues, Ms. Patterson said. "We have a lot of new teachers coming on board," she emphasized. "So not only do we want to make sure they're able to work as a team member, we also want to make sure that they understand the social issues and the physical things going on with our children at that age and the curriculum."

Some of the MPS's professional development efforts focus on collaborative team teaching strategies, striving toward "the best way to team in the classroom so that one teacher isn't teaching all 30 and the other isn't, you know, just sitting back," Ms. Britton-Lange said. "The other one could be [working] individually throughout the classroom." Teachers also can explore ideas on how to break students into workable groups. Rather than simply split the students—one teacher's 15 and the other teacher's 15—the teachers may choose to group students according to their needs and the needs of the subject material, Ms. Britton-Lange said.

At Maryland Avenue School, Principal Applewhite decided that implementing the class-size reduction program presented a good opportunity to institute a rigorous, inquiry-based curriculum. She found that after some initial enthusiasm about having fewer students, her teachers instructed 15 students the same way they had taught 30. Ms. Applewhite noted that there's no sense in reducing class size if teachers don't adjust their approach to instruction. "I've had to really let my teachers understand that with SAGE ... children should really advance," Ms. Applewhite said. "It doesn't matter if they're low [in terms of achievement] when they come to you. There should be some strides made in the year. And sometimes it's difficult for teachers to understand that they have to change. They have to teach more rigorously."

The professional development process at Maryland Avenue School focuses its curriculum and instruction on theories of multiple intelligences and engaging students in the learning process. Teachers must integrate several activities into what they do in the classroom, following five basic principles, Ms. Applewhite explained. First, they must ensure the lesson is continuous and that children relate what they've done in the past to what they need to do with the present subject—seeing how the current lesson relates to math or social studies or across curricula, for example. Second, teachers must ensure that lessons are inclusive, that they're structured to engage all students and not just lower-level students. Teachers need to find ways to challenge the students who are achieving at an above-average level, as well as those in the middle and those who are below-average. Third, teachers must ensure that their teaching is learner-centered, so that the students have the opportunity to do exploration and discovery activities and not simply be told the material. Fourth, teachers must ensure their teaching is interactive, that it's fostering participation from the students and is not just dictatorial. Finally, the teaching must be authentic. Ms. Applewhite believes that combining the reduced class-size program with an inquiry-based approach enables her teachers and students to take maximum advantage of the lower student-teacher ratio in the early grades.

Other benefits of class-size reduction

One of the most commonly held beliefs about small class sizes is that it enables teachers to better control their classrooms, which leads to fewer discipline problems and more time for teaching and learning. Although no systematic approach has been taken in Milwaukee to confirm this theory, staff at the district and school levels report that a reduction in discipline problems in classes with fewer students. Ms. Patterson stated that, "[Teachers] have more time to sit down, listen to children, and actually begin to build relationships, and that in itself cuts down on the discipline problem."

Another, somewhat unanticipated, benefit from reducing class sizes is the increased opportunity for teachers to work with special-needs students. "When you add in two or three children who are handicapped to the classroom of 30, [it's very different] than when those three children are part of the smaller group of 15. It isn't a perfect solution, but it gives the teacher a reasonable opportunity to respond to the special-needs kid and also the kids who come to the school a little bit behind," Dr. Korté said.

A reduced class-size also means fewer parents that teachers must update on a child's progress. "They're pleased also with the parent contacts that they're able to make," Ms. Patterson noted of the teachers. She added that this has increased both the quantity and quality of teacher-parent communication, which research has shown can contribute to improved student attendance, performance, and reduced discipline problems (Epstein et al., 1997).

Barriers and opportunities

The potential barriers to the effective implementation of a class-size reduction policy can also present unexpected opportunities to address significant educational issues. Class-size reduction may require a school or district to find and hire new teachers, but it also might force schools to become creative and identify previously untapped sources of potential instructors. Although a lack of space may prevent each class from having its own room, the silver lining could be the opportunity to implement a team-teaching approach that helps support and retain new teachers.

Conflicts of personality or pedagogy within teaching dyads might be barriers to effective instruction, but teaching in pairs may allow teachers to learn new approaches to instruction and present opportunities to assist students with special needs. Smaller classes might require professional development that specifically addresses the issues associated

with a smaller student-teacher ratio. However, this also provides an opportunity for teachers to implement new techniques in a more controlled setting and to fundamentally shift their approaches to instruction. Implementing a class-size reduction policy may present many hurdles, but the opportunities for more one-on-one interaction between teachers and students and improved communication between teachers and parents helps reduce discipline problems and improve student learning.

Recommendations

Based on their experiences with implementing a class-size reduction policy, the educators with whom we spoke suggested several points that others implementing such a policy might wish to consider. Certainly, planning in regard to the issues that have been discussed above is one obvious recommendation. This includes advance examination of and planning around issues such as the availability of classroom space and need for additional teachers. If space limitations require that teachers and classes share classrooms, advance consideration should be given to how teachers will work together.

The administrators and principal we interviewed recommended significant planning for professional development. Ms. Applewhite suggested that long-term professional development planning should begin well in advance of a class-size reduction policy implementation. This approach will ensure that teachers receive the support that they need to take full advantage of smaller classes, she said, and help good teachers become excellent teachers. Principals and administrators cannot expect that simply reducing the number of students will result automatically in student achievement gains.

Ms. Britton-Lange emphasized addressing the specific needs of the teachers. For example, if teachers are expected to work together in a shared classroom, professional development should address the issues of team-teaching in a way that deals with the concerns and anxieties that might accompany such an arrangement. This is particularly true if the teachers involved have been teaching in a classroom by themselves for a long time.

Dr. Korté suggested that advance efforts be made to work with collective bargaining units on issues arising from a class-size reduction policy. Early negotiation with teachers' unions could enable districts and schools to systematize the assignment of new teachers to dyads that include a veteran teacher, helping ensure the retention of new teachers.

Dr. Korté also stressed the importance of evaluating outcomes, not only to assess the effect of the class-size reduction policy but also to answer political challenges. He suggested that

educators who plan to implement a class-size reduction policy should first determine how to document student achievement improvement, as that documentation will provide evidence that the program is working and strengthen arguments for continued or increased funding.

Finally, Ms. Patterson stressed the importance of maintaining a focus on the "big picture." Districts reducing class sizes need to stay focused on the main goal—improving student achievement—and not get caught up in the minutia that can accompany new policy implementation. Teachers, principals, and administrators need to remain flexible and spend time discussing how smaller classes and improved instruction can improve student learning.

Conclusion

This chapter explored several practical matters regarding the implementation of a class-size reduction policy. The relative importance of these issues will vary across schools and districts, and other issues exist that may be of greater significance in particular areas. Although teacher availability varies across regions and states, it likely will be a factor for many schools that attempt to reduce the number of students in their classrooms. Schools and districts will need to plan strategies for recruiting new teachers: They may need creative approaches to working with local education schools, and they may need to find untapped pools of potential teachers.

The availability of space in which to conduct a larger number of smaller classes is another issue. This issue may include consideration about building new schools, transporting students to schools with more space, and assisting teachers who must team-teach in shared classrooms. A planned approach to professional development helps address this issue: Working in concert with teachers unions may help a school system implement its class-size reduction policy by addressing potential problems like team-teaching and teacher retention in productive ways. Determining how to evaluate the program in advance allows school systems to document the benefits of smaller class sizes in a way that is politically beneficial. Finally, reminding both administrators and teachers that the ultimate goal is improving academic outcomes for students can help build flexibility into the policy's implementation and keep the focus on student achievement.

References

Epstein, J., Cortes, L., Salinas, K. C., Sanders, M., & Simon, B. (1997). *School, Family and Community Partnerships*. Thousand Oaks, CA: Corwin.

Implications of Class-Size Reduction Research for Practice and Policy

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Much has been written about the effects of reduced class size on student performance and on the implications for the operations of schools. The chapters in this volume discuss many of the issues important for educational practice and policy and shed new light on the topic. The question for educational practitioners and policymakers is, what does all this mean? How can I use this information to make decisions I feel I need to make? The purpose of this chapter is to explore the implications for practice and policy of the research presented here and provide some practical guidance to improve schools.

The first part of this chapter synthesizes what we know about class-size reduction, pulling together findings from earlier chapters and offering some conclusions. The second part of this chapter uses these conclusions to offer specific guidance to superintendents and principals interested in implementing class-size reduction and to policymakers considering class-size reduction legislation or state initiatives.

Some Conclusions About Class-Size Reduction

The chapters included in this volume provide some conclusions about class-size reduction: Reductions in class size produce increases in student achievement, class-size reduction is costly, class-size reduction affects teacher labor markets, class-size reduction cannot be implemented alone, and class-size reduction raises equity concerns.

Reductions in class size produce increases in student achievement

The results from research on programs such as STAR and SAGE provide convincing evidence that reductions in class sizes produce statistically and educationally significant increases in student achievement. However, many questions remain unanswered. How much are the achievement gains and at what level do they seem to be the most signifi-

cant? Questions remain about whether the gains occur at the earliest level or at all levels. Are reduced class sizes necessary for the retention of student achievement gains, and do the gains disappear if class sizes are increased again? While these kinds of questions remain, additional longitudinal studies, which will look at student achievement gains over time in relation to class sizes, will help provide new information from which to offer guidance. The inescapable fact remains that student test scores increase with fewer students in the class.

Class-size reduction is costly

Reductions in class sizes require an increase in funding. The most obvious cost of class-size reduction is the increase in the number of teachers. Costs vary for teachers depending on salary schedules, fringe benefits provided, the cost of leaves, professional development costs, and whether the new teachers are beginning teachers or veteran teachers. The calculations are rather simple: If you have 100 students at a grade level and class size of 25, then four teachers will be required. If you reduce class sizes to 20 students, then five teachers are necessary; six teachers will be necessary if class sizes are reduced to 17 students. Likewise, the number of classrooms will need to increase. Some schools and school districts have excess capacity of classrooms, but most do not. At the very least, class-size reductions may require the acquisition of temporary classrooms and, more likely, they mean engaging in capital facility expansion.

Class-size reduction affects teacher labor markets

A very important question is that when a district decides to engage in a systematic program of class-size reduction, where will the new teachers come from? How good will they be? In many subject areas and in many areas of the country, there is a shortage of good teachers. Teacher labor market projections indicate that this shortage likely will become more acute during the next decade. How will we attract and retain a sufficient number of good teachers? Will class-size reduction be effective if it dilutes the talent pool of teachers? How will this affect costs? One chapter in this volume suggests that by reducing class size, schools will increase the attractiveness of teaching by providing more satisfying working conditions and thus allow for a reduction in teacher salaries. Other evidence suggests that the only way we will be able to attract and retain more high-quality teachers will be by providing higher salaries. The effects of class-size reduction on teacher labor markets also depend on whether class size is implemented in one district or whether it is implemented in all districts. If only one district initiates a class-size reduction program, it may be able to entice teachers from neighboring districts at minimal excess costs above

normal teacher salary levels. If a program is implemented statewide, it may produce widespread teacher shortages and sharply increased teacher costs.

Class-size reduction cannot be implemented alone

The evidence seems very clear from both the research studies included here and the experiences of administrators described in this volume that class-size reduction with an extensive professional development program is much more effective than class-size reduction alone. According to a teacher in a class-size reduction program in Hammond, Indiana,[1] "Having the smaller classes made learning new instructional strategies very easy to do compared to going into a classroom of 20 to 22 and trying to use this. You had a lot more time to deal with issues or to think about what you were doing or to make plans" (NCREL, p. 3). Significantly reducing the number of students in a class requires different instructional approaches. Some of the research suggests that for class-size reduction to be effective, there needs to be more individualized instruction and more hands-on teaching. However, simply placing teachers in smaller classes in no way guarantees that they will change their instructional approach. In fact, the Zahorik et al. found that in some cases, "The time saved by fewer discipline problems and a more manageable class may cause some teachers to become less assertive, ill-prepared and less focused" (see Chapter 4). Teachers need coordinated programs of professional development related to school improvement plans in order to do this.

Class-size reduction raises equity concerns

Implicit in the Harris and Plank chapter (Chapter 2) is that if class-size reduction occurs on a district or a school basis, rather than as part of a statewide policy change, the costs involved increase the likelihood that it will be more affluent districts with more resources that will be able to effectuate class-size reduction. As a result, the achievement gains more likely will be experienced by students who already are doing well, and the benefits of class-size reduction will not accrue to lower-income students who may be performing at below-average levels to begin with. Two years ago, the Michigan legislature passed a class-size reduction pilot program in 106 schools to reduce class size in grades K-3. One of the goals of Michigan's program is to improve student achievement in schools with smaller classes, and a four-year evaluation[2] of the initiative is examining how different groups of students are affected by class-size reduction and why. These equity concerns suggest that provisions need to be made to ensure that schools of all income levels and funding levels have access to adequate resources for class-size reduction.

Implementation of Class-Size Reduction

These conclusions are mostly consistent with the ever-growing knowledge base on class-size reduction, but they also raise some new implications for the implementation of class-size reduction in states, schools, and districts. Implications are provided both for policymakers at the state and federal level and for local school administrators. In addition, each set of implications is followed by a list of questions policymakers and local school and district administrators may want to ask and answer before embarking on reducing class size.

Implications for state and federal policymakers

A number of factors discussed above suggest that class-size reduction might best be implemented through some kind of systematic and uniform state or federal program. Such a program could alleviate the equity concerns raised above. In fact, a state or federal program of class-size reduction might focus on poor school districts, poor schools, and schools with high concentrations of children in poverty. The research from the earlier chapters suggests that class-size reduction might be particularly effective with low-achieving children, and a state or federal policy initiative might provide resources for a program focusing on such children. Also, a comprehensive state or federal policy on class-size reduction could address such issues as how to enable districts to have access to a larger pool of highly qualified teachers and how to provide resources for capital facility expansion to meet class-size reduction needs.

The questions Harris and Plank raise in Chapter 2 also need to be addressed at the state or federal level. To what extent should policymakers focus on class-size reduction and to what extent on the teacher-quality issue? Also, that chapter raised the issue of how to increase teacher salaries to provide an incentive to increase the number of highly qualified teachers available to schools. This is an issue that best would be solved by state or federal action rather than a hodgepodge of local incentive programs.

Additional questions for state and federal policymakers

- What are the goals and priorities of school reform in a state that will be addressed through a policy of reducing class size?
- What competing education policy priorities might address the state's reform goals in lieu of implementing a class-size reduction initiative?

- What is the existing picture of teacher supply in the state, and how will state policies address issues of teacher quality and quantity in case a class-size reduction initiative induces a teacher shortage?
- What types of additional programmatic and policy incentives need to be in place to ensure the successful implementation of a class-size reduction initiative?
- How can class-size reduction policies be used in conjunction with such statewide education policies as reading readiness and comprehensive school reform?

Implications for local administrators

These chapters and the conclusions drawn from them raise a number of critical implications for local school administrators.

Expected outcomes of class-size reduction

Any district planning to enter into a comprehensive program of class-size reduction needs to be clear about its goals. There should be clear and explicit statements of the student achievement gains that are expected from class-size reduction and the period of time needed to achieve those goals after introducing the reform. School board members, administrators, teachers, parents, and students should not be given any false expectations about what likely will happen. The research reported in this volume shows the possible effects of class-size reduction, but it also shows that it may take time for tangible results to emerge and also that the sustainability of the achievement gains can be an issue.

Costs of class-size reduction

Before embarking on a program of class-size reduction, a careful and detailed cost plan should be developed. Major elements in this plan will be increases in teaching staff, increased cost of classroom space, and professional development costs. These need to be developed for both the first year of the program and for future years. The initial start-up costs may be high, and the recurring costs of sustaining the program also will be sizeable. The cost plan should be accompanied by a plan of projected revenues to support the policy.

The cost-effectiveness calculus

A plan for any large expenditure of funds also should consider alternative means of achieving the same outcomes and a cost comparison of the options available. As suggested in Chapter 2, a program for improving teacher quality may be more effective at a lower cost in raising student achievement. A district or a school first should look carefully at its needs and select the most cost-effective measure for meeting those needs.

The Personnel Factor

As discussed, class-size reduction requires more teachers. In the current teacher labor market, it's necessary to address the question of whether sufficient numbers of new teachers can be found to implement the program, and what the source and cost of those teachers will be. Also, consider that hiring new teachers not only incurs a new cost to the district, it represents an investment in human capital. If, at some point, the district changes priorities and discontinues its class-size reduction program, it still will have a staff about which to be concerned.

Professional development plan

Before engaging in a program of class-size reduction, the district needs to have a clearly articulated program of professional development that connects the improvement in teacher quality to class-size reduction and the school improvement plan. This plan should be clear about the changes in teaching and learning that are expected and how teachers might improve their approaches to instruction.

Additional questions for local administrators

- What are the expected outcomes of a districtwide class-size reduction initiative, and how will those outcomes be measured?
- What are the range of facility and fixed costs associated with implementing a class-size reduction program?
- What are the short- and long-term implications of the number of new teachers needed to implement a class-size reduction initiative?
- What pedagogical approaches and classroom organization and management techniques will maximize the advantages of small classes?

Some Concluding Comments

Class-size reduction has proven valuable in improving student achievement; however, other reforms may provide equal or greater value. Class-size reduction comes with a significant cost to the school district, and those costs are not confined only to the costs of more teachers. Also, class-size reduction can be connected to other issues, such as the quality of the teaching pool available and the fair distribution of teaching talent. Class-size reduction is not a simple issue, but it is one that schools need to consider. This chapter has tried to provide some clear guidance from the literature on the issue and some considerations for the implementation of a class-size reduction policy.

Endnotes

1. The city of Hammond received class-size reduction funding from the Indiana Department of Education in 1999. The project is focusing on reducing class size in first- and second-grade classrooms in three elementary schools. NCREL is the external evaluator on this project.
2. NCREL and the Indiana Center for Evaluation at Indiana University are conducting the evaluation for the Michigan Department of Education.

Resources and Annotated Studies

Achilles, C. M. & Price, W. J. (1999). Can your district afford smaller classes in grades K-3? *School Business Affairs*, 65 (1), 10-16.

Achilles and Price provide an overview of the issue by discussing class-size initiatives in Indiana, Tennessee, and Texas. The authors distinguish between pupil-teacher ratio (PTR) and the actual number of students taught in a classroom by one teacher. The second half of the article discusses potential cost savings brought about by the class-size reduction. Achilles and Price suggest reflecting on the following cost savings: (1) reduced grade retention; (2) reduced costs incurred for behavior problems such as vandalism and detention; (3) fewer remediation projects; (4) early identification of each learner's special needs; and (5) increased teacher attendance and reduced substitute costs resulting from improved teacher morale.

Brewer, D. J., Krop, C., Gill, B. P., & Reichardt, R. (1999). Estimating the cost of national class size reductions under different policy alternatives. *Educational Evaluation and Policy Analysis*, 21(2), 179-192.

In this article, the authors offer cost estimates for introducing reduced class sizes nationwide. Specifically, Brewer et al. estimate that class-size reduction would cost between $2 billion and $11 billion annually. Costs of reducing class size can be broken into both operational and facilities costs. Operational (noncapital expenditure) costs include money needed to supply the necessary number of teachers, aides and resources to meet the class-size reduction policy of each state. Facilities (capital expenditure) costs includes the money needed to build more classrooms or classroom space. The focus of this article is operational costs.

According to the authors, several factors present difficulties in producing an accurate cost estimate for class-size reduction. First, each state has a different target number for class-size reduction (e.g., 15, 18, or 20 students to each teacher). Further complicating the issue of estimating costs is how class-size reduction is defined. For example, some states define class size by average pupil-to-teacher ratios while other states view actual students in a classroom. The authors suggest that relevant areas affecting costs are: what grade levels are affected by class reduction, eligibility of schools and districts, implementation period or how long change is expected to occur, and the level of class-size reduction.

Brewer et al. developed an estimate for the number of new classes needed for class-size reduction from 1998-99 to 2007-2008. Their estimate is based on the total number of students attending school in each state in addition to assuming that a new class would be created for each student above the minimum class-size level

within that state. Assuming a "middle-ground" set of teacher salaries and benefits, the cost of class-size reduction would be $2.127 billion for 20 students per teacher, $5.049 billion for 18 students per teacher, or $11.047 billion for 15 students per teacher for the 1998-99 school year.

According to the authors, the following assumptions were made in the calculation of these cost estimates. Brewer et al. did not consider teacher aging, or that significant retirement would occur during the next decade. The authors assume that as classes are added, additional aides and support staff would be added as well. In addition, the authors assume that teachers can be added without an increase in their price or a reduction in the quality of teachers. A fifth and final assumption was grounded in a belief that a federal class-size reduction program would be fully funded.

Finn, J. D., & Achilles, C. M. (1999). Tennessee class size study: Findings, implications, misconceptions. *Educational Evaluation and Policy Analysis*, 21(2), 97-109.

Finn and Achilles revisit the results of the Tennessee Student/Teacher Achievement Ratio (STAR) study that indicated statistically significant achievement gains in academic achievement for students who participated in smaller class sizes in all subjects areas and at every level (K-3). The authors also present evidence that a carry-over effect exists in all subject areas through seventh grade for those who participated. Furthermore, the authors contend that these achievement differences were most profound for minority students.

The authors raise the fundamental issue of defining class size and class-size reduction. For example, there are distinct differences between class-size reduction and changing student-to-teacher ratios. As the authors acknowledge, the research shows reducing student-to-teacher ratios has little to no effect on student learning. Since these ratios most frequently are identified as the number of students divided by the number of professional educational staff in a school or district, these studies don't necessarily illustrate the immediate classroom interactions between teacher and student. Class-size reduction, as illustrated in the STAR and in other studies, influenced classroom practices when teachers taught fewer children in the classroom. As the authors write on page 103:

When class sizes are reduced, the pressure is increased for each student to participate in learning, and every student becomes more salient to the teacher. As a result, there is more instructional contact, and student learning behaviors are improved. Further research is needed to collaborate these conclusions.

Hanushek, E. A. (1999). *The evidence on class size.* (Occasional Paper No. 98-1.) Rochester, NY: University of Rochester, W. Allen Wallis Institute of Political Economy. [Online.] Available: http://www.edexcellence.net/library/size.html

In this report, Hanushek notes that research has yet to validate any connection between class size and higher academic achievement.

Hanushek, E. A. (1999). Some findings from an independent investigation of the Tennessee STAR experiment and from other investigations of class size effects. *Educational Evaluation and Policy Analysis*, 21(2), 143-163.

Hanushek discusses the range of evidence available on the effect of class size on student performance with special attention to Project STAR. Although assignment experimentation has considerable conceptual appeal, the methodological and implementation problems associated with the STAR study introduce large uncertainty about any policy implications. "It is difficult to assess with any precision the impact of the various sampling and selection issues that arise in STAR," the author writes. Project STAR combined with other evidence does not provide a persuasive case for the widescale class-size reductions currently being debated.

Hedges, L. V., Laine, R. D. & Greenwald, R. (1994). Does money matter? A meta-analysis of studies of the effects of differential school inputs on student outcomes. *Educational Researcher*, 23(3), 5-14.

This analysis is a replication of an earlier study conducted by Eric Hanushek. The authors discuss education production functions and present an analysis of the effect of a variety of inputs, including teacher-pupil ratios, per-pupil expenditure, teacher experience, teacher education, teacher salary, administrative inputs, and facilities. In contradiction of Hanushek's earlier findings, Hedges et al. conclude that for each increase in the input variable, there is a slight positive improvement in student achievement.

Mississippi Department of Education. (1998). *Reducing Class Size: Strategies and Implications for Mississippi.* Jackson, MS: Office of Academic Education.

This pamphlet produced by the state discusses five strategies for reducing class size, including: (1) hiring more teachers and building more space; (2) reducing the scope of class-size reduction; (3) rearranging scheduling priorities; (4) rearranging staff priorities; (5) increasing the benefits of reduced class size through effective professional development. Each strategy includes a comparison of costs (including financial and time factors of costs) between two hypothetical districts.

Molnar, A., Smith, P., Zahorik, J., Palmer, A., Halbach, A., & Ehrle, K. (1999). *Educational Evaluation and Policy Analysis*, 21(2), 165-177.

The authors explore the Wisconsin Student Achievement Guarantee in Education (SAGE) program. Project SAGE, mandated by law, began as a five-year K-3 project in the 1996-97 school year reducing the pupil-teacher ratio within a classroom to 15 to 1. SAGE was targeted toward schools that have at least 30 percent of students living below the poverty line.

Classrooms in the SAGE project have been single classes of 15 student to one teacher, classes of 30 students with two teachers, and, in some cases, classes of 45 students with three teachers working collaboratively. As the authors note, there were no significant differences between first-grade classes of 15 students with one teacher or 30-student classes with two teachers. If this finding is supported by further research, then reduced class size may be achievable without the capital costs of building additional classrooms.

Results from the authors' analysis found that attendance at a SAGE school was a significant predictor of student achievement. As was found in the STAR study, minority students benefited from reduced class size (i.e., African American students scored significantly higher on post-tests than their counterparts in non-SAGE schools).

In addition to examining learning gains through a pre-test/post-test design, the SAGE analysis examined teacher perceptions through surveys and interviews. From the results, teachers mentioned several areas of the teaching/learning process that were most affected by reduced class size: knowledge of students, discipline, instruction, individualization, and learning activities.

Due to class-size reduction, teachers were more aware of students' individual personalities as well as their unique learning abilities. Having fewer students in a class meant that class discipline was easier to manage. Reduced discipline problems allowed for more instructional time for students. In addition, as a consequence of knowing each child's strengths and weaknesses, teachers were more able to individualize teaching and learning. Finally, teachers mentioned an increased ability to introduce student-centered activities.

Full and summary reports of SAGE are available at http://www.uwm.edu/SOE/centersprojects/sage/

Nye, B., Hedges, L. V. & Konstantopoulos, S. The long-term effects of small classes: A five-year follow-up of the Tennessee class size experiment. *Educational Evaluation and Policy Analysis*, 21(2), 127-142.

The authors present the findings of the Lasting Benefits Study (LBS), a follow-up longitudinal study of students who participated in the Tennessee STAR study. According to the LBS analysis, there exists a lasting positive benefit in regard to reading, mathematics, and science achievement for those children who participated in STAR class-size reduction in the early grades of K-3. Researchers found that the benefit lasts through eighth grade. In addition, those students who dropped out of the K-3 program actually achieved higher levels of achievement than those who remained in STAR, suggesting that the measured achievement differences between those in smaller class size and those in larger classes was not due to attrition.

Stecher, B. M., & Bohrnstedt, G. W. (Eds.) (1999). *Class size reduction in California: Early evaluation findings*, 1996-98. (CSR Research Consortium, Year 1 Evaluation Report.) Palo Alto, CA: American Institutes for Research. [Online]. Available: http://www.classize.org/summary/summaryrpt.pdf

This research summary provides an overview of the positive gains and potential concerns brought about by California's multibillion-dollar class-size reduction initiative ($1 billion initially in 1996 followed by $1.5 billion annually). From the evaluation, the issue of teacher-quality emerged. For example, due to the need for more teachers (an increase of 38%), half of the teachers who were hired had little experience in the classroom. In addition, issues of equity were raised. For example, the evaluation found that the most ethically diverse and poverty-stricken schools had the most difficulty moving quickly to implement smaller class sizes. In fact, between 1995 and 1997, the difference between all schools and those in the bottom economic quartile in regard to the number of teachers without full state-certified credentials increased approximately ten-fold.

Stecher, B. M., & Bohrnstedt, G. W. (Eds.) (2000). *Class size reduction in California: The 1998-99 evaluation findings*. Sacramento, CA: California Department of Education. [Online]. Available: http://www.classize.org/summary/summaryrpt.pdf

This report indicates that CSR efforts are approaching full implementation, with preliminary results indicating small improvements in third-grade student achievement persisting into fourth grade, but a decline in teacher-qualification levels, especially in the elementary grades. More individualized instruction was noted, but the curriculum did not change. The report emphasizes that findings are preliminary and cautions that conclusions on cost-effectiveness and benefits cannot be made yet on the largest-scale class-size reduction program in the United States.

Online Resources and Summaries

California Legislative Analyst's Office: *Class Size Reduction*. [Online]. Available: http://www.lao.ca.gov/class_size_297.html

Provides background to California Class Size Reduction program initiated in 1996-1997 Budget Act, offers analysis of costs versus benefits, and sets forth recommendations for refinements to the program.

California Legislative Analyst's Office: *Class Size Reduction*. [Online]. Available: http://www.middleweb.com/ClassSize.html

Explores links and issues to relating to smaller class size from the middle-school perspective.

WestEd. (August 1998). *Class Size Reduction: Lessons Learned from Experience*. [Online]. Available: http://www.wested.org/policy/pubs/full_text/pb_ft_csr23.htm

Analyzes the experiences of class-size reduction programs across the country.

Education Week: *Class Size* (2000). [Online]. Available: http://www.edweek.org/context/topics/issuespage.cfm?id=44

Provides a brief overview on the issue of class-size reduction and provides links to other resources on the Web.

National Conference of State Legislators. (1998). *Class size reduction*. [Online]. Available: http://www.ncsl.org/programs/educ/class.htm

An overview publication provides information on class-size reduction research as well as costs. In reviewing the research literature, this document discusses the results of Project STAR in Tennessee as well as SAGE in Wisconsin. In addition, the paper provides an overview of costs incurred in California and Michigan, with more extensive data on Nevada and Indiana. Analysis of cost in the article is exclusive of capital expenditure or other local costs.

National PTA Background Brief: *Class Size Reduction*. [Online]. Available: http://www.pta.org/programs/bbclass.htm

Gives background on federal support of class-size reduction initiatives providing support to the PTA's position that such initiatives ought to be supported.

Oregon School Boards Association: *Class size reduction*: Is *less really more*? Available: http://www.osba.org/hotopics/classize/states.htm

This site summarizes class-size reduction efforts in 12 states.

U.S. Department of Education: *Reducing Class Size: What Do We Know?* (1998, May 8; revised 1999, March). [Online]. Available: www.ed.gov/pubs/ReducingClass

The authors examine research on class-size reduction, specifically from California's CSR program and Tennessee's Project STAR. They conclude: "Overall, the pattern of research findings points more and more clearly toward the beneficial effects of reducing class size."

Federal and State Class-Size Reduction Web Sites

Federal

http://www.ed.gov/PressReleases/07-1999/wh-0720a.html

http://www.ed.gov/PressReleases/11-1999/wh-1108a.html

http://165.224.220.253/MailingLists/EDInfo/msg00400.html

http://www.ed.gov/databases/ERIC_Digests/ed259454.html

http://www.ed.gov/offices/OESE/ClassSize/

http://www.ed.gov/offices/OESE/ClassSize/research.html

http://www.ed.gov/offices/OESE/ESEA/themes/cc-title-vi.html

http://www.ed.gov/offices/OESE/ClassSize/Guidance/A.html#effective

http://www.ed.gov/offices/OESE/ClassSize/Guidance/A.html#progress

http://www.ed.gov/offices/OESE/ClassSize/Guidance/H.html

Alabama

http://www.us.net/mccpta/classize.html

California

http://www.cde.ca.gov/classsize/

http://www.classize.org/techreport/index-00.htm

http://pace.berkeley.edu/california_class_size_redu.htm

Iowa

http://www.state.ia.us/educate/fed_class_size/

Nebraska

http://www.nde.state.ne.us/EEO/CSR/welcome.htm

New York

http://www.nysed.gov/nycscs/early.htm

Oklahoma

http://region7.ou.edu/powerpoints/Money/sld001.htm

Oregon

http://www.osba.org/hotopics/classize/states.htm

Policy

http://www.policy.com/issuewk/1999/0830_90/detail650.html

Electronic data collection

http://csr.westat.com/

Other Class-Size Reduction Publications and Resources

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

Hanushek, E. (1996). A more complete picture of school resource policies. *Review of Educational Research*, 66(3),397-409.

Johnston, J., & Davis, T. (1989). *Inside the black box: The effects of class size on quality of work life for teachers and children*. Paper presented at the annual meeting of the American Educational Research Association, San Francisco, CA.

Maier, P., Molnar, A., Smith, P., & Zahorik, J. (1997). *First year results of the Student Achievement Guarantee in Education program*. Milwaukee, WI: Center for Urban Initiatives and Research, University of Wisconsin-Milwaukee.

Molnar, A., Smith, P., & Zahorik, J. (1998). 1997-98 *results of the Student Achievement Guarantee in Education* (SAGE) *program evaluation*. Milwaukee, WI: School of Education, University of Wisconsin-Milwaukee.

Robinson, G., & Wittebols, J. (1986). *Class size research: A related cluster analysis for decision making*. (Research Brief). Arlington, VA: Educational Research Service.

Slavin, R. (1989). Class size and student achievement: Small effects of small classes. *Educational Psychologist*, 24, 99-110.

Word, E., Johnston, J., Bain, H., Folton, B., Zaharias. J., Achilles, C., Lintz, M., Folger, J., & Breda, C. (1994). *The state of Tennessee's Student/Teacher Achievement Ratio* (STAR) *project: Technical report* 1985-1990. Nashville, TN: Tennessee Department of Education.

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