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ABSTRACT

This policy brief is based on prior class size research and address the following issues of concern to policy makers: (1) the extent and reliability of class size impact on student achievement; (2) the mechanisms by which class size changes turn into student learning effects; and (3) the economic consequences of the reduction of class size. This synthesis of available research supported by a meta-analysis of achievement data shows that class size has a substantial and cumulative effect on student learning. Theoretically, the view that teachers represent a "fixed instructional resource" with their time and attention divided among the total number of students in the classroom best fits the research data. The conclusion is reached, however, that responding to this evidence is difficult because the cost of class size reduction is enormous. It is impossible to imagine public support for the level of funding needed to substantially reduce class size through expansion of school facilities and staff. Alternative strategies for reducing instructional group size can be implemented. The most promising strategy is the redeployment of existing school staff for part or all of the school day. (LL)

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How Changing Class Size Affects Classrooms and Students

Douglas E. Mitchell and Sara Ann Beach

Many state legislatures are taking action to mandate class size reductions in the public schools, and educators make class size a constant issue in labor contract negotiations. But are the beliefs held about the importance of small classes a matter of finely-honed professional judgement? Or do they reflect the biased and self-serving views of public employees seeking reduced work loads or ready-made excuses for poor school performance? This policy brief is based on a re-analysis of prior research on class size undertaken by the California Educational Research Cooperative.[1] The available evidence on the issue is examined from a policy perspective. The brief addresses issues policy makers are concerned about: 1) the extent and the reliability of class size impact on student achievement, 2) the mechanisms by which class size changes turn into student learning effects, and, 3) the economic consequences of the reduction of class size.

[1] *How Changing Class Size Affects Classrooms and Students* by Douglas Mitchell, Cristi Carson, and Gary Badarak. Copies may be ordered at a cost of $7.00 per copy by writing to CERC, School of Education, University of California, Riverside, CA 92521-0128.

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Historical Context

Research on class size has had an unfortunate history. The literature has often aimed more at convincing rather than *informing*. Among insupportable but frequently repeated assertions are 1) the presumption of a "threshold effect" i.e., little or no difference in achievement among larger classes and dramatic effects in very small ones, and 2) insistence that benefits are limited to the primary grades.

Class size research conducted prior to 1920 dealt primarily with effects of large classes on grade-to-grade promotion rates. As the 1920s unfolded, the newly developed standardized achievement and intelligence tests began to be employed in the research. The focus of study shifted from promotion rates to how class size affects individual student achievement. Findings were inconsistent. Interest in the issue waned during World War II, but became keen again as the postwar baby boomers entered school. During this period attention focused on whether increasing class size to accommodate expanding enrollment interfered with student achievement. By the late 1960s, emphasis in class size research shifted toward documenting the benefits of small group instruction and assessing the benefits for disadvantaged students. Evidence for the advantage of individual and small group tutorials is convincing; the question of benefits for disadvantaged students remains unresolved.

Systematic interpretation of the growing body of class size research took a giant leap forward in 1978 with the development of meta-analysis. Glass and Smith identified 77 studies containing 725 different comparisons of pupil achievement in classes of at least two different sizes. Using "Effect Size" (the difference between small and large class achievement scores divided by the standard deviation of the large class), **Glass and Smith found that achievement dropped off sharply when additional students were added to very small classes, but the marginal effects of each additional student decreased as classes got larger**. The relationship, then, was curvilinear. When the studies were regrouped into subgroups based on age, grade, length of time exposed to instruction within a class, etc., the curvilinear relationship showing the academic superiority of small classes remained.

The Glass and Smith study was sharply criticized in a report by the Educational Research Service (ERS) both for the research studies included and the meta-analysis technique used to analyze them. Using a box score review of 80 studies, the ERS report asserted that the principle benefits of small classes go to children in the early primary grades. The report is seriously flawed, however. Rather than looking at the results of all studies, ERS classified studies with measurable but not statistically significant differences in outcome as favoring neither large nor small classes. After discounting these studies they simply counted the number of studies favoring each condition without taking into account the magnitude or statistical reliability of each difference.

Scholarly disagreements about the magnitude of student achievement gains and the classroom processes by which they are produced

continues. In spite of the controversy, however, several state legislatures have recently mandated reductions in student/teacher ratios. Early results from these class size reduction policies in Indiana and Tennessee indicate that first and second grade achievement has increased.

A Policy Perspective

Class size is of vital concern to educational leaders at all levels. At the classroom teacher level, class size is a determinant of overall workload and influences teacher stress levels. At the managerial and executive levels, class size policy dramatically impacts budgets, facilities, and program planning. Among state and federal policy makers, class size is the single most important factor affecting overall cost.

How much, and how reliably, do class size reductions lead to *increased student achievement*? If student learning gains are slight or so unreliable that other factors completely overpower them, the only justification for investing in this expensive policy is a desire to make life easier for teachers and students. If, on the other hand, the effects are substantial and not easily produced by other means, failure to control class size would be a major stumbling block to overall school performance.

The answer is complicated. The link between class size and student achievement is analogous to the link between cigarette smoking and cancer. Statistically speaking, the evidence is substantial and convincing, but that does not mean that every small class produces greater learning. Just as surely as many smokers escape lung cancer and many non-smokers are struck by cancer, many small classes fail to teach materials that can be effectively taught to much larger student groups. The meta-analysis produced by Glass and his colleagues is widely interpreted as documenting rather small gains for children exposed to typical classes, while identifying much larger effects as class size approaches one-to-one tutorial. Reduction in class size from 40 to about 20 students per teacher produces about a six percentile point increase on a typical achievement test. This small gain becomes substantial if class reductions are maintained over a child's entire 13 year career in the public schools.

Figure 1
The Impact of Class Size on Achievement

In sum achievement gains are reliable and cumulatively substantial. Whenever class size is allowed to rise to release resources for other purposes, it is appropriate to ask whether the funds used for those purposes meet the test of improving student learning at least as much as would result from maintaining lower student/teacher ratios.

Exactly how does changing the student/teacher ratio *influence student learning*? Simply changing the number of students in a classroom cannot, by itself, be expected to change learning outcomes. Evidence indicates that other changes in classroom operations are necessary to produce the achievement gains that accompany class size reductions. Research on this issue is particularly confusing, however, because researchers have presented no theory of how altering class size produces these changes in classroom operations. Researchers have instead concentrated on the use of statistical methods to fit the data. Armed with theory, policy makers could inquire into specific strategies for improving instructional effectiveness. Available data can be used to evaluate four competing theories of how class size affects student learning. Named for their assumption regarding the most important mechanism affecting achievement, the theories are: (A) Classroom Overhead, (B) Student Interaction Costs, (C) Adjustment to Student Ability, and (D) Fixed Instructional Resource.

A. *The Classroom Overhead* theory assumes that the primary source of declining achievement is the expansion of non-instructional activities that accompany each class size increase. No doubt, smaller classes spend less time in activities such as taking attendance, collecting and passing out papers, checking on student understanding, and disciplining misbehaving students. If this theory is the source of reduced learning, achievement will decline as a *linear* function of class size.

B. *Student Interaction Time* is a second possible explanation for higher achievement in smaller classes. This theory assumes that the extra time needed for each additional student to interact with the teacher and other students in the class detracts from overall learning. This additional interaction time makes it increasingly difficult to bring closure to class discussion or to reach consensus among students on important ideas. With the addition of each new student to the class, this theory posits an exponential increase in possible interactions and thus, an exponential loss of effectiveness.

C. *Teacher Adjustment to Student Ability* theory was applied to class size data by Preece in 1987. This theory asserts that achievement in large classes declines because teachers adjust their teaching strategies to reach the least able students in a class. If students are randomly assigned, larger classes will tend to have somewhat lower ability students because larger classes have a statistically greater chance of being assigned

students with the full range of abilities; smaller classes will be less heterogeneous. Hence, with lower ability students in their classes, teachers of large classes will slow the pace of instruction for everyone.

D. *Fixed Instructional Resource* theory, developed by the California Educational Research Cooperative researchers, posits that each teacher's total capacity is limited and must be divided among all of the students in any given class. Therefore, as class size increases, each child gets a smaller portion of the teacher's time and attention. Thus, for example, in a class of ten students, each student would receive 1/10th of the teacher's instructional attention. In a class of 25 stu-dents, each would receive only 1/25th of the teacher's attention. The loss incurred by adding one student to a class of ten is therefore much larger than the loss incurred by adding one student to a class of 25. The rate of decline becomes less with each new student because the teaching effort is spread more thinly.

By clearly specifying what each theory predicts regarding the relationship between achievement and class size and then matching the predictions to the data, each of the four theories can be tested using the data from the Glass and Smith study. The *Fixed Instructional Resource* theory best fits the data, accounting for 41 percent of the variance. It was slightly better than the *Teacher Adjustment to Student Ability* theory which accounted for 38 percent of the variance. The *Classroom Overhead* and *Student Interaction Time* theories did not fit the data at all well (accounting for 7 percent and 32 percent of the variance respectively) and were completely absorbed by the *Fixed Instructional Resource* theory.

The most likely explanation for the achievement gains found in small classes, then, is that teachers must divide their attention among the students they face, and they must adjust instructional strategies to fit the needs of all students in the class. Since the data document *how* smaller classes tend to get better results, it is possible to investigate whether these results might be produced in other ways.

Changes in Classroom Processes

A meta-analysis of studies measuring student attitudes toward school and teacher feelings of efficacy and satisfaction show that class size reductions improve attitudes and encourage the use of effective teaching techniques. Observational studies comparing the cognitive, affective, and management differences between large and small classes found that teachers interact more frequently with individual students and make substantive changes in classroom layout, student evaluation, and classroom management. In Tennessee, teachers in small classes report less noise and misbehavior, more use of learning centers, more enrichment activities, more cooperation among students, and a better ability to evaluate student work effectively.

The evidence indicates that small class achievement gains are produced through specific changes in the behavior of both teachers and students. Where changed teaching and learning behaviors do not accompany reduced class size, achievement gains do not result. The questions of whether these behavior changes are *necessarily* linked to class size reduction are speculative, however. Careful analysis of the classroom and learning process variables associated with small classes suggests that policy makers could profitably shift their attention from simply distributing students among a larger number of classrooms to examining ways of reducing effective *instructional group size* within existing classrooms. Policy makers should examine how instruction is *organized* as well as how classrooms and schools are *staffed*.

What are the organizational and fiscal implications of the documented link between class size and student achievement? A frontal attack on class size reduction is enormously expensive. Two important ingredients of educational cost, teacher salaries and school facilities, are dramatically impacted when class size reduction is approached as a matter of dispensing students to more and more classrooms. Careful consideration of optional ways of handling the multifaceted organizational and fiscal aspects of the problem suggest that some important alternatives exist.

Estimating the overall cost of class size reduction is a sobering experience. In California, for example, it costs an average of $93,000 to maintain, staff, and operate an average classroom serving about 28 students. If costs remain constant, class size reduction can be calculated by determining how many more classes are needed and multiplying that number by $93,000. To reduce the California average 28 students per classroom by 5 students would cost $3.13 billion. To reduce the class size to 17 would cost $9.32 billion. This estimate is probably somewhat high, because smaller classes need fewer books and supplies.

A lower estimate is produced if we include only building construction, maintenance, and teacher salary costs. These costs would sum to about $90,000 for the initial year when a portable classroom is purchased and about $50,000 in succeeding years. To reduce class size to 23, then, would cost $2.09 billion and to 17 would cost $6.22 billion. Under current conditions there is very little chance that overall education expenditures will rise 15 percent to 60 percent to pay for class size reduction alone.

Other approaches can be developed if policy makers are willing to reconsider long established patterns of organization and administration. Scheduling and staffing substantially influence instructional group size. If schools were willing to make schedules more complex and to use staff members more flexibly, much can be done to reduce instructional group size for part or all of the school day. This observation leads to the fourth policy question.

What alternatives to direct increases in the number of teachers and classrooms in today's schools might produce the desired achievement gains? Ultimately, policy analysis involves looking at the extent to which desired goals can be reached using the most economical means. The traditional assumptions about schools with single schedules and uniform-sized, self-contained classrooms may need to

be substantially altered in order to incorporate the best findings from class size research into day-to-day school operations.

Within reasonable resource constraints, at least three distinct strategies can be found for reducing class size: 1) redeploying critical staff members, 2) redistributing students, and 3) incorporating small class instructional strategies into existing classrooms. Little is known about the relative costs of these alternatives.

Redeploying staff. Large reductions in effective class size can be generated for various parts of the school day if existing staff resources are creatively managed. One elementary school, for example, divides the school day to devote a three-hour block of uninterrupted time exclusively to instruction in the core academic subjects. During this period, all certificated staff take a class of about 15 students. Instruction is protected from all interruptions. Assemblies, office announcements, children changing classes occurs only during the remainder of the day when class size is allowed to rise to about 30 students. During the period organized for large class size, specialist teachers provide help to special needs children and all teachers get planning time. A review of typical schedule and staffing arrangements in California schools indicates that language and math instructional groups of 18 or fewer students could be produced through this or a similar process.

Redistributing students. Less sweeping changes can be made by individual teachers within their own classrooms. Some of the benefits of class size reduction can be produced by better use of appropriate student grouping strategies. Enhanced teacher handling of the three factors which control the effectiveness of instructional grouping: the method of student assignment, the tasks set for group members, and the access of students to needed resources can be encouraged through staff development and clinical supervision. Peer tutoring and team teaching can also be used to multiply teaching resources, though there are time costs associated with these strategies.

Incorporating small class instructional strategies. Especially effective teaching practices found most often in small classes include better utilization of space, more individual interactions, and enhanced teacher "with-it-ness." Also found in small classes are lower noise levels, fewer discipline problems, more one-on-one instructional time, and more response by teachers to diverse student interests and abilities. Although many of these attributes are facilitated by the lower workload and more spacious environment, some of these features might be profitably incorporated into larger classes. To date, research has shed little light on the extent to which these techniques are necessarily linked to small classes and which can be effectively incorporated into larger classes. These techniques could include a better use of learning centers geared to student interests and abilities as well as expanded use of cooperative learning groups.

Conclusion

Although class size research has had an unfortunate history, careful synthesis of available research, supported by a meta-analysis of achievement data, shows that class size has a substantial and cumulative effect on student learning. Theoretically, the view that teachers represent a *Fixed Instructional Resource* with their time and attention divided among the total number of students in the classroom best fits the research data. Responding to this evidence is difficult, however, because the cost of class size reduction is enormous. It is impossible to imagine public support for the level of funding needed to substantially reduce class size through simple expansion of school facilities and staff. Alternative strategies for reducing instructional group size can be implemented. The most promising strategy is the redeployment of existing school staff for part or all of the school day.

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