Reduced Class Size and Other Alternatives for Improving Schools
An Economist's View
Reduced Class Size and Other Alternatives for Improving Schools: An Economist's View

DEAN T. JAMISON

The World Bank

It was a pleasure, but for me a double-edged one, to have been asked to prepare these comments on the research on the consequences of variations in class size. No other characteristic of a school system carries with it the economic consequences that the student-to-teacher ratio does; few other issues in school politics generate comparable public controversy in budget-conscious times; and no other area of educational research has reaped so bounteous a harvest of mutually contradictory results. It is a source of some pleasure, then, that one can now point to definitive integrations of the research on class size and cognitive achievement and of the research on class size, school ambience, and teacher and student attitudes\(^1\) (1979). However, Glass and Smith's clear findings that small classes \textit{are} better are unlikely to still the political controversy because, it seems, small classes improve achievement only slightly and scarcely at all in what for most school districts is the realm of economically feasible changes. Indeed, fully 40 percent of the class size comparisons that were examined failed to show an advantage for the smaller class. The search for ways to improve school quality must, then, for reasons of efficacy as well as cost, go beyond improving the student-to-teacher ratio. My comments here will address the question of how best to choose between reducing class size and
other alternatives that may be available for improving school quality.

In what follows I briefly recapitulate the principal findings of the research presented in this book, and then discuss methods for addressing the decision of whether reducing class size is, in any particular context, the optimal way to improve school quality. I close with two examples. One analyzes problems typical in low-income countries, where the simple absence of textbooks and school materials is a near-universal problem; the second examines the desirability of computer-assisted instruction for compensatory education in the United States.

The Findings

Glass and his colleagues draw their lessons from the class size literature by applying systematic and quantitative methods of combining the results of disparate studies. These methods go under the rubrics of "meta-analysis of research" or "research integration", and there is by now the beginnings of a literature on this subject—on how to write a survey paper. Glass has been one of the leaders in developing and applying quantitative methods of research integration, methods that have been mostly (though by no means exclusively) applied to the education literature. The approach to the class size literature Glass and his colleagues have taken is clearly the sensible one, and their reviews provide the definitive assessment of what the literature has to say. What do they find?

Concerning achievement, Glass and Smith (1979: 15) conclude as follows: "A clear and strong relationship between class size and achievement has emerged. The relationship seems slightly stronger at the secondary grades than the elementary grades, but it does not differ appreciably across different school subjects, levels of pupil IQ, or several other obvious demographic features of classrooms. The relationship is seen most clearly in well-controlled studies in which students were randomly assigned to classes of different sizes.... There is little
doubt that, other things equal, more is learned in smaller classes."

Glass and his colleagues summarize the achievement findings graphically with curves that show the expected median achievement of children in a class of size $C$ in terms of that achievement level's percentile rank in the distribution of scores expected from an otherwise similar class of size 40. Figure 6.1 reproduces these curves for elementary (upper frame) and secondary (lower frame) levels of schooling. The figure plots the curves only for class sizes below 40; variation in class size above that level was found to have virtually no effect, and the magnitude of the effect remains small down to class sizes around 20.

I have overlaid the class size effect curves with frequency distributions of class size for 97 countries around the world. Countries tend to have larger class sizes for elementary grades than for secondary, and this fact combines with a weaker class size effect at the elementary level to suggest that reducing class size will generally have greater impact at the secondary level. Still, even at the secondary level, the effect is relatively weak. The major mode of the frequency distribution for secondary class size is 25; the effect curve indicates that reducing class size from 25 to 20 would likely shift the distribution of achievement up by 2 percentile points.

Though it would appear that the practical significance of reducing class size across the board is limited (for improving achievement), there are at least two significant implications of the findings. First, because of the nonlinearity of the effects curve, increasing class size from an initial point will hurt achievement less than decreasing it from that point will help. Thus, for a fixed total number of students and teachers, having a few of the students in small classes and the rest in very large ones will result in higher mean scores than having all class sizes be the same. The policy implications are obvious, if slightly unpalatable, particularly when there is a concern for a special group (e.g., compensatory, gifted, females, and so forth).
Figure 6.1 The distribution of class sizes across countries and the class size and achievement relationship curve.
second implication of the finding is that research into what makes small classes better could yield insight into improving teaching at all class sizes; Cahen and Filby (1979) have initiated such a research program at the Far West Regional Laboratory in San Francisco.

Concerning class size and its relation to attitudes and instructional practices, Smith and Glass (1980: 47) summarize their findings as follows:

Class size affects the quality of the classroom environment. In a smaller class there are more opportunities to adapt learning programs to the needs of individuals. Many teachers avail themselves of these opportunities; others would need training to do so. Chances are good that the climate is friendlier and more conducive to learning. Students are more directly and personally involved in learning.

Class size affects pupils' attitudes, either as a function of better performance or contributing to it. In smaller classes, pupils have more interest in learning. Perhaps there is less distraction. There seems to be less apathy, friction, frustration.

Class size affects teachers. In smaller classes their morale is better; they like their pupils better, have time to plan, diversify; are more satisfied with their performance. Does this mean that class size is merely a selfish, political issue for teachers? Or is the happier teacher the one who performs better? This we cannot unravel, except to cite the other evidence—that the smaller the class is the greater is the effect on the instructional process, on pupil affect, and on achievement."

These affective and instructional process outcomes are important both in themselves and as mechanisms through which class size may be affecting achievement; however, in the remainder of this discussion, I will deal only with issues relating directly to achievement.

The Trade-Off Between Reducing Class Size and Alternatives

This section presents the simple calculation of how much of an increase in class size there must be in order to compensate in
cost for the introduction of an alternative innovation designed to improve quality. The amount of teacher time required per child per year depends on average class size, average number of days per school year, and average number of hours per school day. For the purpose of this discussion we assume that the length of the school day and year are given and that, therefore, class size determines the variation in the amount of teacher resources going to each student. (Clearly, increasing the amount of school time is a plausible alternative for improving quality, and the trade-off between such increases and decreasing class size could be analyzed using the calculations presented below.)

Let the “instructional” cost per year for a class be the cost of its teacher’s salary plus the cost of introducing some other quality improving intervention. For concreteness, let us assume the alternative is to make an increased number of textbooks available in the classes of a low-income country where they are now scarce. The price of supplying the specified quantity of textbooks is, let us assume, $P per student per year. Let the teacher’s salary be $T per year, and assume that class size is initially $C_0$ students per teacher. To calculate the trade-off between textbook availability and class size that is possible at the initial per student allocation, we require that the cost per student with new textbooks be the same as the cost without by increasing the class size by an amount $\Delta C$. That is:

$$\frac{T}{C_0} = \frac{T + P (C_0 + \Delta C)}{C_0 + \Delta C}$$

Solving this equation for $\Delta C$ gives the expression for $\Delta C$, the class size increase required to keep per student costs constant, as a function of teachers’ salaries, initial class size, and the price (determined by the amount) of the textbooks supplied. The solution is:

$$\Delta C = P C_0^2 / (T - P C_0).$$
Figures 6.2 and 6.3 graph $\Delta C$ as a function of $P$ for several values of teacher salary ($T$) and initial class size ($C_0$). Figure 6.2 uses a range of values for $P$, $C_0$, and $T$ that might be expected in low-income countries; Figure 6.3 uses values that might be expected from high-income countries. For example, if the contemplated increase in textbook availability were to cost $4 per student per year, initial class size were 25, and teacher salaries were $2500 per year, then the middle income frame of Figure 6.2 shows that average class size would need to increase by one to keep per student costs constant. On the other hand, if teacher salaries were only $500 per year, the required increase in class size would be eight—far more pedagogically significant.

Textbooks and Educational Radio in Nicaragua

My first example draws on results from a large-scale development effort and experiment involving the use of radio for elementary mathematics instruction in Nicaragua, and on the results of a smaller-scale experiment (imbedded in the larger one) that involved providing every child in an experimental group with a mathematics workbook. To simplify a bit, the experiment consisted of random assignment of something over sixty first-grade classrooms (all in different schools) into three groups of about twenty. Classes in one group received daily radio mathematics lessons that had already been carefully developed, pretested, and revised; these lessons, accompanying printed material (less than one page per day) and specified teacher support activities, replaced the standard methods for mathematics instruction. The second group of classes received enough mathematics workbooks for every child to have his or her own and the teachers received some instruction on how the workbooks might be used. (This increased greatly the number of texts and workbooks available to these classes.) The third group served as a control. Data were gathered at a student level on pre- and posttests, and at the classroom level on teacher and
Figure 6.2 Class size increase required to pay for educational innovations while holding per-pupil costs constant: low-income countries
Figure 6.3 Class size increase required to pay for educational innovations while holding per-pupil costs constant: high-income countries.
school characteristics. Treatment effects were calculated by regressing posttest scores against pretest scores and indicator variables for the treatment conditions. The results were as follows (Galda et al., 1980):

1. the radio group scored 1.21 standard deviations above the controls; and
2. the workbook group scored .22 standard deviations above the controls.

These differences are significant at standard levels.

The improvement of .22 standard deviations for the introduction of textbooks corresponds, assuming a normal distribution of achievement test scores, to having the mean of the distribution of scores in the textbook group be at about the 58th percentile of the control group. From Figure 6.1 it can be seen that this effect is about the same as would be expected to result from decreasing class size from its present level of about 40 to perhaps 10—a totally unrealistic possibility if it were to be done for all subjects, although it could conceivably be done for one or two subjects. From a slightly different perspective, one can use the iso-cost trade-offs of the preceding section to estimate the increase in class size that would be required to "pay" for the additional workbooks holding per-student costs constant. With a teacher cost of about $2500 per year, an initial class size of about 40, and a book cost of, say, about $2 per student per year, Figure 6.2 suggests that $\Delta C$ would be about 2.5. Since Figure 6.1 indicates that there would likely be almost no drop in student achievement in consequence of slight increases in class size from an initial size of 40, by the criterion of achievement maximization, buying textbooks with increased class sizes would clearly be a reasonable approach to take.

The impact of radio on achievement is far more dramatic, at least at the first-grade level. (There is some indication that the effects are less pronounced at higher grades.) Though radio might cost almost twice as much as workbooks, implying a $\Delta C$ of perhaps 4, its impact on achievement is such that its introduction instead of textbooks would clearly be desirable if the cost were in terms of class size and the criterion in terms of achievement. If, however, class size were for some reason to be
held constant, then it would simply be a matter of policy judgment whether to pay more for radio than for workbooks in order to realize the substantially higher achievement gains, or indeed, whether any improvement in achievement would be worth the price that would have to be paid.

Computer-Assisted Instruction for Compensatory Education in Los Angeles

Perhaps the most pressing problem of educational quality improvement within the United States is that of improving the cognitive performance of the 10 to 20 percent of children who are achieving at low levels for reasons, at least in part, of social and economic deprivation. Title 1 of the Elementary and Secondary Education Act of 1965 has authorized the expenditure of about $2 billion per year for "compensatory" education for these children, and a great deal of research effort has sought to ascertain what does and does not work. These research efforts have included a longitudinal, experimental study (in Los Angeles) of the effectiveness of computer-assisted instruction (CAI) for compensatory education in mathematics, reading, and language arts. CAI's costs fall well within per-student, title I allocations,6 and experience has suggested it to be easily implemented in elementary schools. Because of CAI's cost and replicability, it was judged important to undertake a thorough evaluation of its long-term impact on achievement, and this was the rationale for the Los Angeles study.7

Preliminary results of the Los Angeles study (Ragosta et al., 1979) are available for children who began receiving CAI about two-thirds of the way through the fourth grade and who have now completed sixth grade. These results suggest that CAI in reading and language arts is ineffective in improving these children's performance on standardized achievement tests in those subjects, although it does improve performance on tests specifically geared to the CAI curriculum. In mathematics, on the other hand, the results are impressive: 10 minutes per day of math CAI resulted in a standardized achievement test gain of .2 standard deviations against controls, and 20 minutes per day resulted in a gain of .35 standard deviations. Thus, the mean of the 10-minute group would be at about the 58th percentile of
the control group; the mean of the 20-minute group would be at about the 64th percentile.

As with the previous textbook example, it is possible to examine either the reduction in class size that would be required to replicate the CAI math gains, or to ascertain the increase in class size that would be required to introduce CAI while keeping per-student costs constant.

Figure 6.1 shows that, assuming an initial class size of 30, class size would need to be reduced to about 8 to expect the same mathematics achievement gains found in the 10-minute CAI group; they would need to be reduced to 2 students per teacher to equal the gain of the 20-minute group. While it is (barely) conceivable that all mathematics instruction take place in very small groups, it is impossible, of course, to reduce overall average class sizes by anything like this amount. Algebra similar to that above indicates that class size could be reduced by about 5, to 25, for the expenditure required to support 10 minutes per day of CAI. This would result, according to Figure 6.1, in about a 2 percentile increase in achievement, but for all subjects.

Alternatively, if one wishes to hold per-student costs constant, the increase in class size required to pay for 10 minutes per day of CAI (costing $130 per year) will be about 8 (interpolating between the $C_0 = 25$ and $C_0 = 35$ curves). This would result in less than a 1 percentile loss in achievement in all subjects for about an 8 percentile gain in mathematics.

Here again we see the effects of the nonlinearity in the relation between achievement gain and class size. If additional resources are available with which one can reduce class size or buy CAI, lowering class size appears relatively more attractive than it does when the comparison is made holding per-student expenditures constant. Yet, ironically, the political realities indicate that CAI is far more likely to be chosen when there are incremental resources available (e.g., Title I).
Conclusion

This discussion has dealt with only a few alternatives to reducing class size as a means of improving school achievement. Its principal purpose has been to illustrate methods by which empirical research results concerning cost and effectiveness can be combined to assist in making choices on how to improve school quality. A secondary purpose has been to refer to a few well-documented examples of how school quality can be improved without decreasing class size. I suspect, however, that the findings of my specific examples from low and higher income countries would probably be generally true. In particular, provision of instructional media (like textbooks or radio) would, I predict, usually be far more cost-effective in low-income countries than would reducing class size. In high income countries, the call will tend to be much closer, although, if the cost of, say, CAI continues to fall relative to teacher salaries, the decision will increasingly tilt away from class size reductions.

NOTES

1. The edge on this otherwise satisfactory summation of research findings was that the conclusion—that reducing class size is likely to improve achievement, albeit slightly—contradicted that of a review on which I had worked some time ago (Jamison et al., 1974). Our review, which was a good deal less systematic, concluded that available evidence on class size and achievement was so mixed that there was no particular reason to think achievement was much influenced by class size.

2. This same nonlinearity of effects also implies, of course, that even if each child has the same student-to-teacher ratio, it would be possible to raise achievement averages by having very large class sizes for some subjects and very small ones for others.

3. The discussion here is drawn from Jamison et al. (1976: 236-237).

4. This example only illustrates the obvious—that is, that the attractiveness of books depends very much on the price relative to teachers. In the Middle Ages, when a tutor could be hired for several years for the price of a book, it is perhaps not surprising that the elites frequently provided individual tutors for their children, but few books.

5. Note that this increase to a class size of 42 is for all subjects, not just mathematics.
6. Levin and Woo (1979) estimate the cost of this type of "drill-and-practice" CAI to be about $130 per student per year for one 10-minute CAI session per day (a standard amount).

7. The National Institute of Education contracted this study, which will run from 1976 to 1981, to the Educational Testing Service; Dean T. Jamison and Marjorie Ragosta are Co-Principal Investigators.

8. The decrease in size will be \( C_o^2 P / (T+C_o P) \).
REFERENCES


Smith, M. L. & Glass, G. V. Unpublished, 1980. Now available as Chapter 3 of this book; quotation is on pages 64-65.


