CLASS SIZE REDUCTION: EFFECTS AND RELATIVE COSTS

Technical Paper

Final Report

By
Lawrence O. Picus
Center for Research in Education Finance
USC Rossier School of Education

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EXECUTIVE SUMMARY

Perhaps the hottest state educational policy initiative in the nation today is reducing class size, particularly in the primary (K-3) grades. In recent years, a number of states have passed legislation either mandating smaller classes in elementary grades, or establishing incentive programs to finance smaller classes. Washington has been a leader in this effort using both a mandate and incentives to reduce class size in grades K-3. Between the 1987-89 biennium and the 1991-93 biennium, the state reduced the effective pupil-teacher ratio in grades K-3 from 21.7 pupils per certificated instructional staff to 18.4 for a total reduction of just over 3 pupils per certificated instructional staff.

Research on class size strongly favors smaller classes. However, lowering average class size by three students per classroom may not be a large enough decrease to have a large impact on student achievement. Washington distributes funds on the basis of certificated staff positions per 1,000 students, but there is no requirement or guarantee that the reductions in staffing ratio will actually result in smaller classes.

Making dramatic reductions in class size is expensive. California has spent over $4 billion in three years to reduce the average class size in grades K-3 from 29 to no more than 20. Maintaining that ratio over time will continue to cost in excess of $1.5 billion a year. As class sizes become increasingly smaller, costs increase more rapidly.

There may be more cost-effective ways to improve student outcomes. Research on student learning has shown that teacher knowledge and skills are more important to improving student learning than simply reducing class size. Investment in teacher training and professional development has shown greater gains in student achievement per dollar spent than class-size reduction. In addition, schools that have restructured the way they use the resources available to them have also seen substantial gains in test scores.

The question state policymakers face is whether to make the substantial investments in smaller classes or do something else to try to improve student learning. Research suggests that such investments will lead to improved student outcomes. However, the research also shows that attention to teacher training and expertise may have a bigger payoff per dollar spent. Moreover, states that jump into a major class size reduction program quickly may find they have a shortage of qualified teachers, as California's experience shows. Given the importance of high quality teaching to student learning, investment in the quality of the teaching force before reducing class size might be a better way to maximize the potential of the dollars that are used to reduce class size.

In short, few appear to oppose class size reduction. However, there are a number of things states and school districts can do to insure that the substantial investment made in teachers and classrooms pays off. Virtually all of them revolve around insuring that the state has the highest quality teaching force possible.

CLASS SIZE REDUCTION: EFFECTS AND RELATIVE COSTS

Perhaps the hottest state educational policy initiative in the nation today is reducing class size, particularly in the primary (K-3) grades. In recent years, a number of states have passed legislation either mandating smaller classes in elementary grades, or establishing incentive programs to finance smaller classes. There are few public policy proposals more popular than class size reduction. In March 1997, a *Wall Street Journal* poll found that 70 percent of adults believe reducing class size would lead to big improvements for public schools. A 1997 *Education Week* survey found that 83 percent of teachers and 60 percent of principals believed classes should not exceed 17 students (Bell, 1998). Parents say their children are happier and learn more in smaller classes. Teachers report they have fewer discipline problems, are able to give students more individual help and can cover material faster.

Many states have enacted class size reduction measures in recent years. Perhaps best known is California's effort to reduce the size of all K-3 classrooms to no more than 20 students. Tennessee has had a program in place since 1990 to reduce class size, while Texas mandates that all K-4 classrooms in a school average no more than 22 students. Most states that implement class size reduction seem to set average K-3 class size at around 20 students. Nevada has the lowest mandated size, requiring no more than 15 students per class.

Washington was a leader in this effort. Beginning in 1987-88 the State Legislature increased the number of certificated instructional staff per 1,000 students funded through the state basic aid distribution formula. Specifically, the state changed the allocation of resources for K-3 students. Prior to the change, each 1,000 students in a school district generated 46 certificated instructional staff (1 per 21.74 students). In 1987-88 this was increased to 48 per 1,000 for grades K-3 and the next year to 49 staff per 1,000 students (1 per 20.41). In addition beginning with 1989-91 the state provided districts the opportunity to increase the ratio to as much as 52.3 certificated instructional staff per 1,000 students (1 per 19.12) provided they are able to document that the funds were spent on K-3 programs. This incentive for smaller classes was improved in the 1991-93 biennium when the ratio was increased to 54.3 certificated instructional staff per 1,000 students (a ratio of 1 per 18.42).

The continued and growing popularity of this reform was evident in 1998 when President Clinton called for hiring 100,000 new teachers to reduce class size to an average of 18 students in grades 1-3. He also proposed a construction tax to help build and modernize schools to help pay for the estimated $12 billion it would cost to provide enough classrooms.

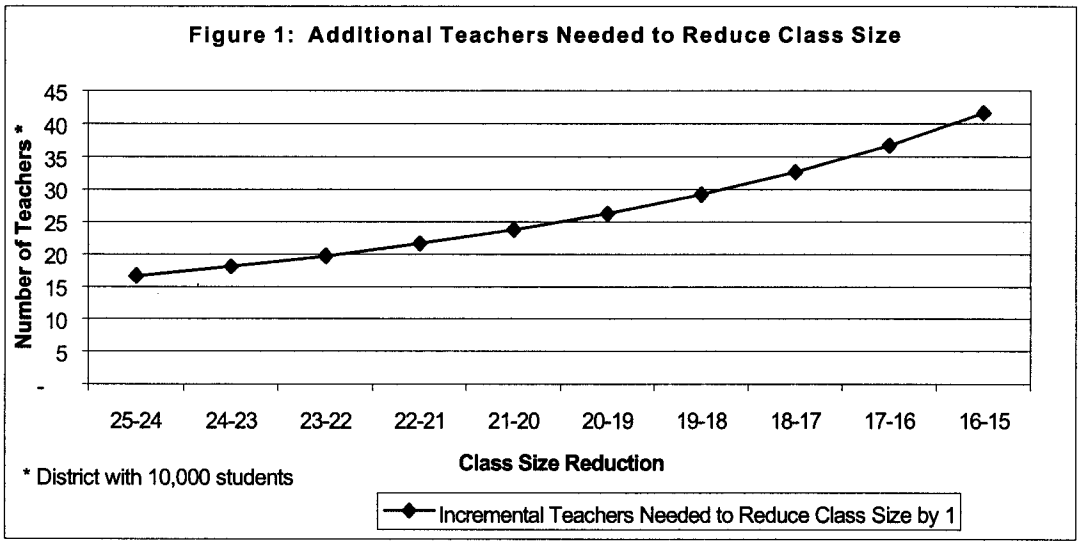
Dramatic class size reduction is expensive. California's program provides an additional $800 per student for children in K-3 classrooms with 20 or fewer students. It also provided funds for school and classroom construction. To reduce the class size from an average of approximately 29 to 20 or fewer students, the first year costs of the program were some $1.1 billion. By the end of the program's third year (1998-99), the state will have spent more than $4 billion on class size reduction.

Other states have made similar investments. Tennessee spent about $600 million between 1991 and 1996 to implement its program. In Philadelphia, Superintendent David Hornbeck has unveiled plans to reduce class size in kindergarten through third grade from an average of 27 students to 20 students by the year 2002. He estimates that the program will require 1,000 new teachers at a cost of $50 million a year, as well as 35 new schools at a

construction cost of $470 million. Philadelphia school district's annual budget is approximately $1.2 billion.

In Washington, smaller class size is encouraged through a higher staff/student ratio for K-3 in the funding formula. The annual cost of this program, which is part mandate and part incentive, is an estimated $250 to $300 million.[1] Some $90-$100 million of this amount funds the mandate portion of the program, which increased the staff ratio from 46 to 49 per 1,000 students, and the balance pays for the incentive which can bring the staff ratio to as much as 54.3 certificated instructional staff per 1,000 students.

Class size reduction efforts become progressively more expensive as class size decreases. For example, a hypothetical district with 10,000 students would need to add about 22 teachers (and classroom space) to move from 22 to 21 students per teacher (a 4.5% reduction). However, it would take about 42 more teachers to move from 16 to 15 students per teacher (a 6.3% reduction). Figure 1 shows the number of additional teachers needed to reduce class size to progressively lower levels.



Although current research supports the notion that smaller class size can lead to improved student performance, that view is not universally held among researchers. More importantly, research shows that there are alternative reforms that may be considerably more cost effective in improving student performance. In particular, many have argued that investments in additional teacher training and professional development will lead to even greater gains in student performance for each dollar spent. As the state of Washington considers further class size

[1] Under Washington Law, district basic aid is generated through a series of staffing ratios which are then converted to funding units. Certificated instructional staff are allocated on the basis of 46 staff per 1,000 pupils for grades 4-12. For grades K-3, there are two components. The first is a staffing ratio of 49 certificated instructional staff per 1,000 students that is part of a district's basic aid. The second is an additional incentive which would bring the staffing ratio to as much as 54.3 certificated instructional staff per 1,000 students, provided the district documents that the staff have been hired and are teaching in grades K-3. The net effect of raising the staff level from 46 to 54.3 per 1,000 pupils changes the ratio from one staff per 21.74 students to one per 18.42 students. At this time, Washington districts use virtually all of the additional 5.3 staff positions. It appears that districts not taking full advantage of the incentive do so largely due to fluctuations in enrollment and staff that preclude maintaining the ratio exactly.

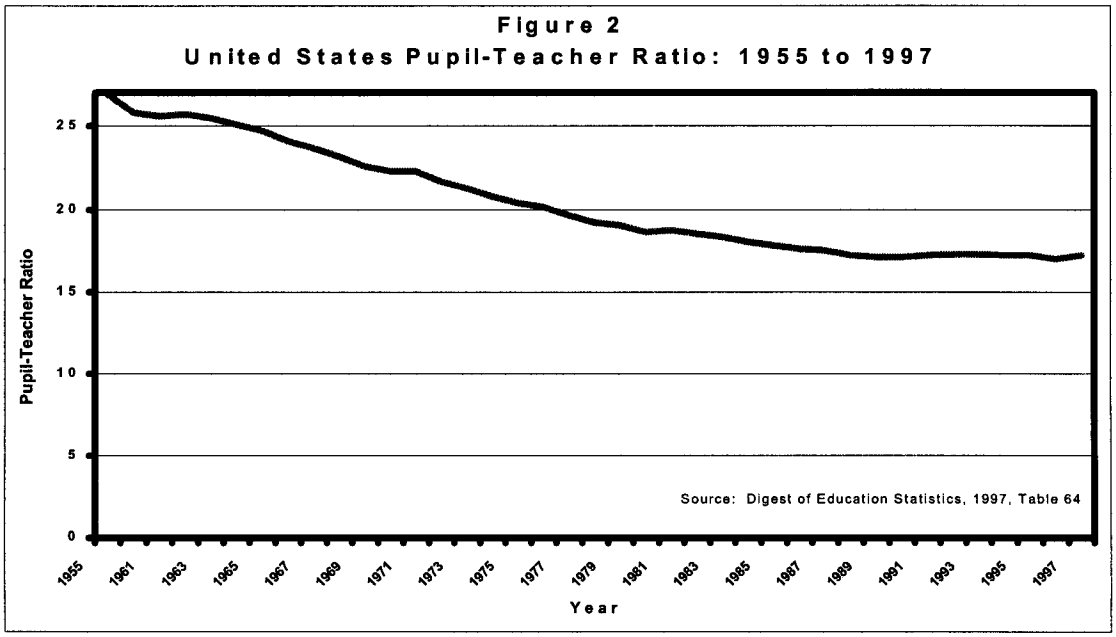
reduction measures, it is important to understand both the policy and research context of this issue.

This background paper was prepared for the Joint Legislative Audit and Review Committee as part of a larger study of school finance issues. The next section of this paper establishes the policy context for the discussion of class size reduction. The second section provides a detailed review of the research literature on the effectiveness of smaller classes on student performance. In the third section, alternative policy options are discussed and compared with class size reduction programs; the last section offers some conclusions about the options facing the state of Washington.

CLASS SIZE REDUCTION: THE POLICY CONTEXT

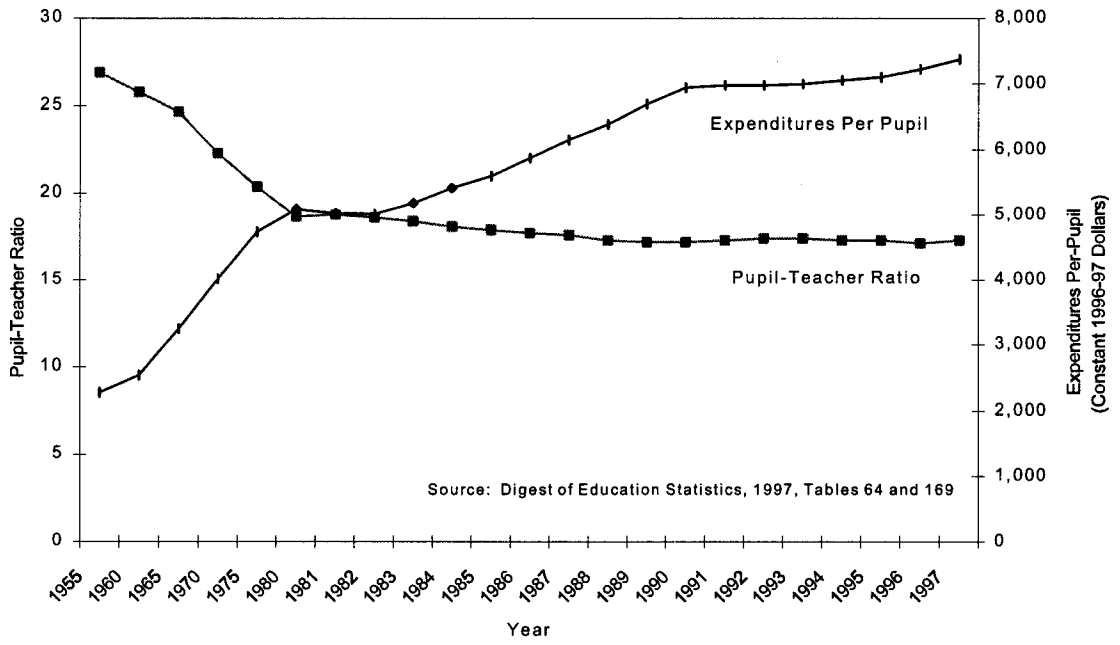
National Trends

Reducing class sizes to improve education is not a new idea. Data from the Federal Government show that the average pupil-teacher ratio in the United States has declined dramatically in the last forty years (NCES, 1997). Figure 1 shows that the pupil-teacher ratio in the United States has declined from nearly 27:1 in 1955 to approximately 17:1 in 1997. Some of this reduction can be accounted for by the increased availability of special programs for children which utilize very small classes or rely on "pull-out" programs where a teacher works with children individually or in small groups (i.e. special education and Title I). However, the data displayed in Figure 2 represent real declines in the average number of children in most classrooms across the United States. These data are shown in more detail in Table A1 in appendix A.



Nationally, as per-pupil spending increases, pupil-teacher ratios have declined. Figure 3 shows this graphically for the years 1955 through 1997. The vertical axis on the left side of Figure 3 represents the pupil-teacher ratio, while the vertical axis on the right side of Figure 3 represents per pupil spending. The figure shows that as spending has increased, pupil-teacher ratios have declined. Research by Barro (1992) found that on average, when a school district received an additional dollar of revenue, half of that dollar was spent on teachers. Of that 50 cents, 40 cents was spent on reducing class size and 10 cents on increasing salaries. Barro's findings help confirm the apparent priority educators place on smaller classes, and their willingness to trade increases in salary for smaller classes.

Figure 3: Pupil-Teacher Ratios and Expenditures Per-Pupil in Elementary and Secondary Public Schools: 1955-1997

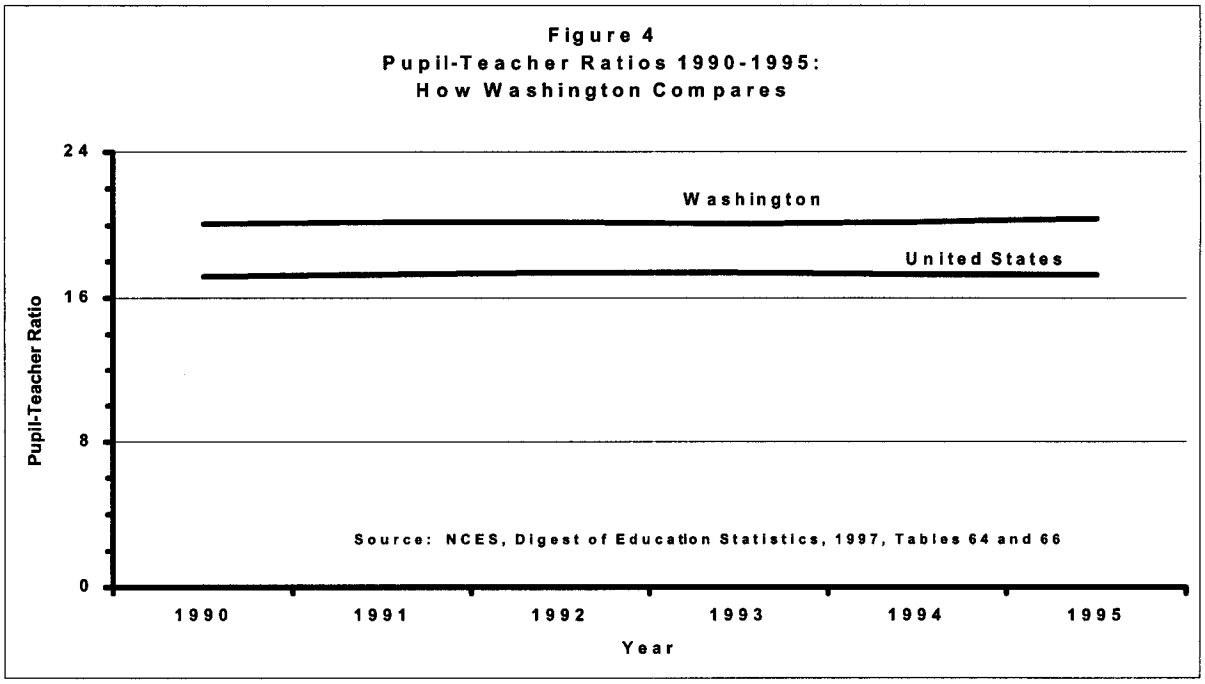


How Washington Compares

The average pupil-teacher ratio in Washington, as reported by the Federal Government's National Center for Education Statistics (NCES) is relatively high. Figure 4 shows that since 1991, the pupil-teacher ratio in Washington has been approximately three pupils per teacher higher than the national average.[2] For all six years represented, Washington's pupil-teacher ratio was among the highest in the nation, ranking 49th out of 51 in each of the years reported. This is also shown in Table A2 in appendix A. In 1995, the lowest pupil-teacher ratio among the 50

[2] The higher staff ratio for grades K-3 was implemented in 1987-88 and thus its impact is included in all of the estimates for Washington provided in Figure 3. The staff ratio for grades K-3 was increased to 48 certificated instructional staff per 1,000 students in 1987-88 when it was implemented, and raised to 49 certificated instructional staff per 1,000 in 1988-89. The incentive program allowing for an increase of as many as 5.3 more certificated instructional staff per 1,000 K-3 students was implemented in two steps between 1989 and 1993.

states and the District of Columbia was 13.8 found in both Vermont and New Jersey. The highest pupil-teacher ratio was reported for California at 24.0.



The pupil-teacher ratio is not the same as class size. A number of individuals certified as teachers – and treated as teachers in the calculation of the pupil-teacher ratio – have assignments that keep them out of the classroom for all or part of the day. The result of this that in most states, the estimated pupil-teacher ratio is substantially less than teacher reported class size. Picus (1994) found that on average this difference was on the order of 33 percent.[3] That is, using data from the Schools and Staffing Survey (SASS), the pupil-teacher ratio calculated at a school site was between 16 and 17 pupils per teacher. However, teacher reported class size in regular classes was closer to 24. Individual data were not computed by Picus for Washington, nor would current SASS data allow such a computation to be done.

Why Is There Such Strong Policy Interest in Smaller Class Size?

Despite the high costs, legislative efforts to reduce class size are common. Washington first implemented a higher staff to student ratio for grades K-3 in 1987-88. Today, districts generate 3 more certificated instructional staff positions per 1,000 students in grades K-3 than they do for grades 4-12. Moreover, additional incentives – which state law states are not part of a district's basic aid – allow that staffing ratio to be as much as 8.3 certificated instructional staff per 1,000 students higher in grades K-3. The K-3 pupil teacher ratio can therefore be as low as

[3] While the pupil-teacher ratio underestimates the number of children in an average classroom in any state, it is the one figure available across the 50 states, and therefore serves as both a proxy for class size and a way to compare the availability of teaching resources for children across states. For a detailed discussion of how computed pupil-teacher ratios compare to actual class size, see Picus, 1994.

18.42, or some 3.32 pupils per teacher fewer than the pupil-teacher ratio of 21.74 generated in grades 4-12 where the formula provides 46 certificated instructional staff per 1,000 pupils.

Other states have also enacted policies to reduce class size. One of the first to do so was Texas which began mandating limited class sizes with the educational reforms enacted in 1984. Today, K-4 programs must average no more than 22 students per classroom in a school. Table A3 in appendix A provides a summary of current class size reduction programs across the states. The table identifies 19 states that have some form of class size reduction. Ten of the states rely on incentives to encourage school districts to reduce class size, while eight use mandates. Washington is unique in that it relies on both a mandate (the staffing ratio of 49 in grades K-3) and an incentive, the additional 5.3 staff per 1,000 available as an incentive if districts spend the funds on certificated instructional staff who work with students in grades K-3.

Table A3 also shows that the focus of these programs is almost entirely on the primary grades, generally K-3. North Carolina's program is only aimed at grades K-2, while Oklahoma's program focuses on grades K-6 and the program in Texas on grades K-4. In Utah, grades K-2 are the primary focus and funds can only be devoted to reducing class size in grades 3 and 4 if K-2 classes are all reduced to 18 or lower.

Washington's program differs to some extent from the others. While the staff ratio established in the program amounts to approximately 18.4 students per certificated instructional staff member, the law does not require classes of 18 or 20 or some other number, only that the funds be spent on staff who work with children in grades K-3. Theoretically this allows for alternative staffing structures as determined by schools and their respective districts.

There is no question that class size reductions are an important educational policy issue. They can also be very expensive as the data above suggest. Are smaller classes effective in improving student performance? Certainly that is the general belief of most educators and policymakers. The investment is hardly worthwhile if student outcomes do not improve. The next section of this paper considers the research that has been conducted on class size in the past and focuses on its impact on student achievement.

REDUCING CLASS SIZE: A BRIEF SYNTHESIS OF THE LITERATURE

Today, it is hard to find anyone who is not in favor of reducing class size. Even those who are not convinced there is a strong research base to show that smaller classes lead to improved student performance are willing to concede that smaller classes can lead to more individualized instruction, higher morale among teachers, and more opportunities for teachers to implement instructional programs that research shows work well. Among those who are convinced that smaller classes lead to better student performance, there is only limited consensus as to what the "ideal" class size might be. This section of the paper focuses on the research that has been conducted to date with an emphasis on those studies that appear to be the most methodologically sound. It attempts to provide answers to the questions:

- Does class size reduction improve student learning?
- What is the "ideal" class size?
- Do gains in primary grades continue in the later grades?

This section begins by describing educational production functions, the approach most frequently taken to studying class size effects. Next there is a discussion of the early meta-analyses

conducted on the topic of class size, followed by a description of recent studies that have attempted to resolve some of the methodological issues identified with earlier studies.

Educational Production Functions

Understanding the effect of class size on student achievement is related to the larger question of how money impacts student performance. As Picus (1997) points out, nearly all would agree that more money is better than less. Moreover, most would agree that the expenditure of additional funds on education should lead to improved student learning. However, there is considerable disagreement among researchers as to whether or not a statistical link can be found between money and student outcomes. Obviously, the single largest expenditure item for a school district is teacher compensation (salary and benefits). Thus, for a district of a given size, the more money or revenue available to the system, the more teachers it can hire and the smaller the average class size will be.

Production functions are an economic tool used to measure the contribution of individual inputs to the output of some product. In simple terms, a production function takes the following form:

Equation 1: $O = f(K,L)$
Where: O = some measurable output
K = Capital or non-labor inputs to the production process
L = Labor

By estimating equations that include these variables, as well as other variables that control for exogenous factors known to impact the production process, it is possible to predict the impact that the application of additional units of labor and capital will have on the number of units of output produced.

This concept can be applied to education as well.[4] For example, it is possible to estimate an educational production function with the following form:

Equation 2: $P = f(R,S,D)$
Where: P = A measure of student performance
R = A measure of resources available to students in the school or district
S = A vector of student characteristics
D = A vector of district and school characteristics

Clearly, one possible measure of R would be the pupil-teacher ratio at a school or school district. In fact, the pupil-teacher ratio is in many ways an excellent choice for this particular variable as it provides an excellent proxy for the level of resources available for children (that is it is highly correlated with per-pupil spending), and it is a good proxy for class size.

Difficulties With the Educational Production Function

There are substantial methodological difficulties with estimating equations of the form presented above. First and foremost is reaching agreement on the proper measure of student

[4] For a more detailed description of production functions as they apply to education, see Monk, 1990.

performance to serve as the outcome indicator. Although there is considerable discussion about this in the education community, in recent years, the policy community – as well as most educators – have focused on the results of standardized tests as the outcome measure. The studies described below follow this trend.

There are a number of other methodological problems to consider. There is substantial evidence that children from minority backgrounds, children from low income families, children who do not speak English as their first language, and children with disabilities do not do as well in school as other children. Therefore, if our model is to identify the impact that smaller classes have on student performance, it is be necessary to control for differences in student characteristics. Unfortunately, it is often difficult to collect these data in ways that facilitate the estimation of a production function.

For example, it is often possible to collect data on student performance and student characteristics at the individual student level. However, other data related to school or district characteristics may only be available at the district level. This is often the case with fiscal data such as per-pupil expenditures and even pupil-teacher ratios. The result is the regression equations contain variables with varying levels of precision. Unfortunately, the accuracy of the estimates of the impact of resources on student performance are only as good as the lowest level of precision. This is often the district level fiscal or resource data that are of interest to the researcher. There are statistical techniques to correct for this problem, in particular, Hierarchical Linear Modeling (HLM). However, many of the early studies on the effect of class size did not use this tool.

Another problem is that most education production function studies rely on cross-sectional data. That is they look at one point in time. Yet many of the student characteristic and schooling variables used in these equations are subject to substantial change over time. Thus it is not clear that reliance on a one-time measure of these characteristics will adequately control for their effects on student performance. Longitudinal data sets, which would resolve many of these problems, are expensive to collect, and few are available to researchers today.

Additionally, there are substantial problems with the inputs actually used. The pupil-teacher ratio often used as a proxy for class size is an example. Picus (1994) shows that there is considerable variation between the computed pupil-teacher ratio in a district or school, and teachers' self-reported class size. While self-reported class size averaged 33 percent larger than the computed pupil-teacher ratio, this figure ranged from one or two students more than the computed ratio to more than double that figure. Thus, if one is trying to estimate the effect of class size on student performance, the pupil-teacher ratio may not accurately reflect either the class size, or the variation that exists in the number of students each teacher sees in a day.

A final problem with this research is that it is generally impossible to establish a true experimental design with both an experimental and a control group. Instead, student performance at a given grade level before class size is reduced is compared with student performance at that grade level following the implementation of the treatment, in this case the smaller class size. This too reduces the confidence with which one can make statements about the relationship between class size and student performance.

Research Results

Researchers have struggled with ways to correct for these limitations. While new and more sophisticated statistical techniques and higher quality data sets at the district, state and

Federal level have improved the quality of production functions analyses, the analysis will never be perfect. The following sub-sections describe the results of this research to date.

The Early Meta-Analyses

Meta-analysis (Glass, McGaw & Smith, 1981) is a technique for looking at a wide variety of studies on a specific topic and determining if the results of those studies support a conclusion about that topic. The first step is to identify high quality studies on the subject. This is done by searching for all of the documents dealing with the topic and establishing decision rules as to whether or not to include the study in the meta-analysis. These decision rules usually pertain to the quality of the study (i.e. published in a referred journal, or high quality book) and the relevance of the actual analysis to the topic of the meta-analysis.

Once identified, researchers need to compare the findings from each of the studies. This is difficult since the studies use different data sets, have different sample sizes and analyze different variables. To compare studies, the results are standardized and the outcomes compared in terms of these standardized values.[5]

Glass and Smith (1979) conducted an early and comprehensive meta-analysis of the class size literature. They identified more than 300 studies going back as far as 1895 on the topic. Of those 300, 77 met their decision rules for inclusion in the meta-analysis. They calculated a total of 725 effects from the 77 studies. Based on their analysis of those studies, Glass and Smith concluded:

- There is a clear and strong relationship between class size and student achievement. Sixty percent of the 725 effects showed higher achievement in smaller classes.
- Students learned more in small classes.
- Class size needed to be reduced to less than 20 students, preferably to 15, if strong impacts on student learning were to be found.

These are strong and important conclusions, and many have used them to support calls for reducing class size to less than 20. Unfortunately, not everyone in the research community found this work to be convincing. Slavin (1984) criticized meta analysis arguing that the technique gives equal weight to all study findings, regardless of the quality of the study design. He argued that only 14 of the 77 studies in the Glass and Smith meta-analysis were methodologically sound. He also criticized meta-analysis generally, suggesting that the technique combines studies that are on different topics while claiming to address the same topic. For example, one of the methodologically sound studies with large effects in the Glass and Smith sample had to do with learning how to play tennis.

Slavin (1989) reanalyzed the methodologically sound studies from the Glass and Smith work. He pointed out that there were relatively few studies with fewer than 20 students in a class, and that there were no classes with between 4 and 14 students. He argued that the Glass and Smith findings were thus based on statistical interpolations of the findings in the 14 studies.

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[5] The results are standardized or normalized so that each has a mean of zero and a standard deviation of one. Then, the effects of each variable on the outcome measure can be expressed in terms of standard deviations and thus compared. For example, an overall impact of half a standard deviation means that student performance would rise from the average or 50th percentile to the 69th percentile and an impact of one standard deviation would mean average performance would rise all the way to the 83rd percentile.

He also concluded that the effects of reduced class size on student achievement were considerably smaller than Glass and Smith has determined.

Using these data from earlier meta-analyses, Odden (1990: 217) suggested that the research on class size supports "dramatic – and only dramatic – class size reductions." While he did not necessarily put a figure on what class size should be, Odden argued that reducing class size from 28 to 26, or from 24 to 22 would not be effective. He argued that class size needed to be reduced substantially more – to something like 15 to 17 students per class. This line of reasoning has major implications for policymakers interested in reducing class size. States with large class sizes will need to spend substantial sums of money to make those "dramatic" class size reductions if the policy is to succeed.

Recent Studies

In recent years there have been a number of analyses of the impact of class size on student learning. In general, they show that smaller class size leads to greater gains in student test scores. One exception to this is the work of Eric Hanushek who argues that to date we have not found a systematic relationship between resources and student outcomes. Hanushek (1989) reviewed 152 studies that used the pupil-teacher ratio as an independent variable in estimating the impact of spending and resources on student outcomes. Hanushek found only 27 studies with statistically significant findings, and only 14 of those found that reducing the number of pupils per teacher was positively correlated to student outcomes, while 13 found the opposite. Among the other 125, Hanushek found that 34 found a positive effect, 46 a negative effect and in the remaining 45 the direction of the effect could not be determined.

More recently, Hedges, Laine and Greenwald (1994) and Greenwald, Hedges and Laine (1996), after reviewing the same studies came to the opposite conclusion. Relying on newer and more sophisticated statistical techniques they argued that smaller classes did matter. Their analysis found that there were substantial gains is student performance when more money was spent on education, and that smaller class size was related to performance gains as well. Others have reached that conclusion as well. Ferguson (1991) analyzed the effect of class size and teacher preparation on student achievement in Texas, concluding that in elementary grades lower pupil-teacher ratios contributed to increases in student achievement.

In a recent study in Alabama, Ferguson and Ladd (1996) attempted to address some of the weaknesses of earlier studies in this area. They used larger samples of students, better model specification and had access to better data than in the past. They concluded that teacher test scores, teacher education and class size "appear to affect student learning" (Ferguson and Ladd, 1996:288). They also attempted to ascertain the threshold below which further reductions in class size would no longer lead to systematic achievement gains for students. They believe that if such a threshold exists, it is in the range of 23 to 25 students per teacher. This number seems somewhat high compared to other results, but could be a result of the relatively low per-pupil spending in Alabama and the generally larger class size in that state during their study. More importantly, Ferguson and Ladd sought to measure actual class size, rather than the district or school pupil-teacher ratio. Consequently, their work may reflect a more accurate picture of the number of students in a classroom at any time.

One of the problems with this line of research has been the lack of a true experimental design. In fact, only one study with such a design has been undertaken. The Tennessee Student-Teacher Achievement Ratio Experiment (STAR) relied on an experiment in which children were randomly assigned to classes with low pupil-teacher ratios and high pupil-teacher ratios. The

study design placed students into one of three groups. An experimental group where the average class size was 15.1 students, and two control groups: a regular size class with an average of 22.4 students and a regular size class with a teacher's aide and an average class size of 22.8 students. Under the study plan, each student was to stay in the original class size assignment until the third grade. Following third grade, the experiment was concluded and all students assigned to regular size classrooms. Standardized tests were given each school year to measure student achievement. While there are some methodological and data problems in any study of this magnitude, two respected researchers have argued that the Tennessee STAR project is the best designed experimental study on this topic to date (Mosteller, 1995; Kruger, 1998). Kruger (1998) summarized the major findings of the Tennessee STAR project as follows:

- At the end of the first year of the study, the performance of students in the experimental classes exceeded that of the students in the two control groups by five to eight percentile points.
- For students who started the program in kindergarten, the relative advantage of students assigned to small classes grew between kindergarten and first grade, but beyond that the difference is relatively small.
- For students who entered in the first or second grade, the advantage of being in a small class tended to grow in subsequent grades.
- There is little difference in the performance of students in the regular size classrooms compared to the performance of students in regular size classrooms with teacher aides.
- Minority students and students who qualify for free and reduced price lunches tended to receive a larger benefit from being assigned to small classes.
- Students who were in small classes have shown lasting achievement gains through the seventh grade.

There are a number of important policy issues brought forward by the findings from Tennessee STAR. First, the results of the evaluation suggest that smaller classes do lead to improved student performance, and that those performance gains are maintained at least through the seventh grade. Moreover, the results suggest that alternative models that rely on the use of teacher aides to reduce the "effective class size" may be ineffective.

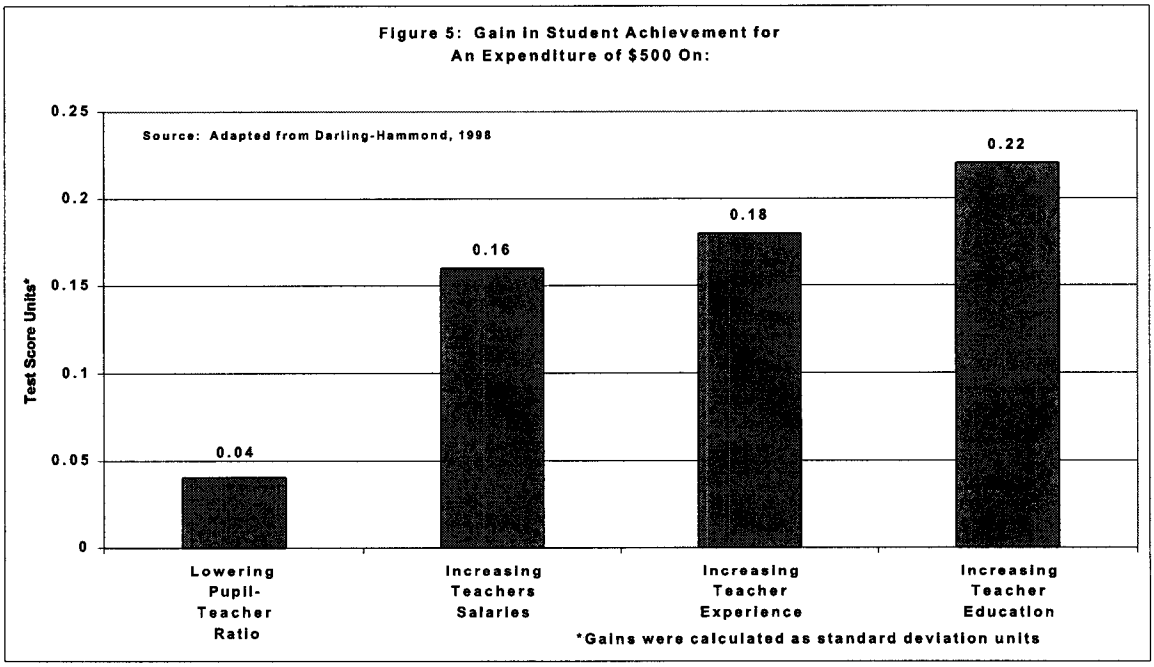
The research also suggests that simply reducing class size without changing how teachers of smaller classes deliver instruction is unlikely to improve student performance. It is important that teachers take advantage of the smaller classes to offer material in new and challenging ways identified through research. Absent that effort and the training needed to accompany such a change, expenditures for class size reduction may be relatively ineffective.

ALTERNATIVES TO CLASS SIZE REDUCTION

The research reviewed above shows that reducing class size can, and probably does, lead to improved student performance. It is, however, a very expensive option: In addition to hiring more teachers, schools need additional classroom space. Before embarking on a substantial class size reduction program, policymakers may want to consider whether or not more cost effective alternatives exist. Current research suggests that such alternatives are available and should be considered, either instead of – or in addition to – class size reduction. One range of options deals with teacher knowledge and skills, while others relate to the structure of the education program offered at individual schools. Each is discussed below.

Teacher Knowledge and Skills

Reducing class size gives students greater access to teacher resources. There is evidence this will help students learn. However, what the teacher knows and is able to do is at least as important in helping students learn. Darling-Hammond (1998:1) argues that "teacher expertise is one of the most important factors in determining student achievement..." She quotes Greenwald, Hedges and Laine's work in showing the relative impact of spending $500 more per pupil on increased teacher education, increased teacher experience, and increased teacher salaries. All three of these appear to have a greater impact on student test scores than does lowering the pupil-teacher ratio. Figure 5 shows the differences graphically: For an expenditure of $500, the greatest gains in student test scores (measured in standard deviation units from a range of tests in 60 studies) were found through increasing teacher education. Lowering the pupil-teacher ratio was the least cost effective of the four methods. Increasing teacher salaries and experience fell between lower pupil-teacher ratios and teacher education in terms of cost effectiveness.



Ferguson (1991) found that the effects of teacher expertise in Texas were so great that after controlling for socioeconomic status, disparities in achievement between black and white students were virtually entirely explained by differences in teacher qualifications. He found that teacher qualifications explained 43 percent of the variation among the factors affecting math score test gains, while small classes and schools only accounted for eight percent of the gain. Home and family factors were identified as explaining the remaining 49 percent of the variance.

Darling Hammond (1998:1) summarizes these findings by stating that "teachers who know a lot about teaching and learning and who work in settings that allow them to know their students well are the critical elements of successful learning." Clearly smaller classes are better

in her view, but given limited funds to invest, her work suggests policymakers should at least take a close look at improving access to high quality professional development first.

Professional development is frequently poorly funded in school districts and often the first item to be cut when finances become tight. Darling-Hammond's research suggests this may be a mistake, and in fact, more resources should be put into professional development. If class size is still reduced, professional development may be essential to help teachers maximize their skills given the reduced number of children for whom they are responsible. Certainly investments in professional development would be complementary to class size reduction programs.

Reducing class size and providing greater training opportunities for teachers are not the only options available for improving student learning. There are many things school site leaders themselves can do to restructure for improved learning. Some of these are discussed below.

Reorganizing Schools

Many of today's educational reform are restructuring how educational resources are used. A number of the reform designs supported by the New American Schools (NAS) rely on using teaching resources differently, rather than purchasing more. (Appendix B provides more information about these designs.) While seven designs supported by NAS require some investment on the part of a school or school district, most are less expensive than dramatic reductions in class size or pupil-teacher ratios.[6] Most also come with substantial teacher training components.

Odden and Busch (1998) found substantial gains in student performance, often as high as one-third of a standard deviation, at NAS design schools. These schools reach these performance levels with relatively little additional expenditures, generally averaging around $50,000 to $250,000 a year for a school of 500 students (an extra $100 to $500 per pupil each year). Odden and Busch argue that any school can reorganize itself into one of the NAS designs by looking closely at its current allocation of teachers and aides and reassigning them as needed to meet the design specifications. In many instances this calls for eliminating many of the aides in favor of more teachers. Given the results of the Tennessee STAR project reported above, spending for teacher aides may not be productive anyway.

Another option schools can consider is restructuring the use of time. The National Commission on Time and Learning (1994) reported on a number of successful schools and school districts that had improved student performance through different ways of organizing the school day to give students more access to, and time with, teachers. Models that provide more access to learning resources, particularly teachers, may also be substantially more cost effective than class size reduction.

CONCLUSION

Class size reduction is currently one of the most popular – and most expensive – educational reforms today. At least 19 states have enacted mandatory or voluntary policies

[6] The seven school designs supported by the New American Schools include: the Modern Red Schoolhouse; Expeditionary Learning-Outward Bound; National Alliance; Audrey Cohen College; Co-NECT; ATLAS; and Roots and Wings (New American Schools, 1996; Stringfield, Ross and Smith, 1996). An eighth design, Urban Learning Center Schools, was not part of the Odden and Busch analysis.

aimed at reducing class size in the primary grades, and one (California) has even created an incentive to reduce the number of students in 9th grade English and Math classes.

The question facing state policymakers is should substantial investments in smaller classes be made? The research shows that such investments will lead to improved student outcomes. However, the research also shows that attention to teacher training and expertise may have a bigger payoff per dollar spent. Moreover, as California's experience shows, states that jump into a major class size reduction program quickly may find they have a shortage of qualified teachers. Given the importance of high quality teaching to student learning, investment in the quality of the teaching force first might be a better way to maximize the potential of the dollars that are used to reduce class size. In short, few appear to oppose class size reduction. However, there are a number of things states and school districts can do to insure that the substantial investment made in teachers and classrooms pays off to the maximum extent possible. Virtually all of them revolve around insuring that the state has the highest quality teaching force possible.

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APPENDIX A

DATA TABLES

Table A1
Pupil-Teacher Ratio for the United States, 1955 to 1997

Year	Pupil-Teacher Ratio
1955	26.9
1960	25.8
1961	25.6
1962	25.7
1963	25.5
1964	25.1
1965	24.7
1966	24.1
1967	23.7
1968	23.2
1969	22.6
1970	22.3
1971	22.3
1972	21.7
1973	21.3
1974	20.8
1975	20.4
1976	20.2
1977	19.7
1978	19.3
1979	19.1
1980	18.7
1981	18.8
1982	18.6
1983	18.4
1984	18.1
1985	17.9
1986	17.7
1987	17.6
1988	17.3
1989	17.2
1990	17.2
1991	17.3
1992	17.4
1993	17.4
1994	17.3
1995	17.3
1996	17.1
1997	17.3

Source: NCES, 1997

TABLE A2

Pupil-Teacher Ratio in Washington Compared to the United States: 1990-1995

Year	Pupil-Teacher Ratio		Washington National Rank*
	Washington	United States	
1990	20.1	17.2	49
1991	20.2	17.3	49
1992	20.2	17.4	49
1993	20.1	17.4	49
1994	20.2	17.3	49
1995	20.4	17.3	49

*Rank is determined by ranking the 50 states plus the District of Columbia from the state with the lowest pupil-teacher ratio (1) to the state with the highest (51).

Source: NCES, 1997

Table A3
States with Class Size Reduction Measures

State	Mandate or Incentive	Class Size Limit	Grade Level Affected	Year Implemented	Funding
Alaska	Mandate	18	K-3	1997	Part of Foundation Program
California	Incentive	20	K-3	1996	$1 billion in 1996-97 ($650/student in smaller classes plus $200 million for facilities). $1.5 billion in 1997-98 ($800 per student in smaller classes)
Florida	Incentive	20 (30 with full time aide)	K-3	1996	$100 million for 1997-98
Illinois	Incentive	Reduce class size with reading improvement block grants	K-3	1997	Unknown
Indiana	Incentive	18 20	K-1 2-3	1981 1988	$77 million through funding formula in 1995
Louisiana	Mandate	Not to exceed 20 without State Supt. Authorization	K-3	1986	Unknown
Maine	Incentive	15 to 18	K-3	1989	Competitive Grant Program
North Carolina	Incentive	23	K-2	1993 1995 1997	Part of foundation program
Nevada	Mandate	15	K-3 Core subjects	1989 1995	Special Revenue Fund
Oklahoma	Mandate	No more than 20 students may be assigned to a teacher	K-6	1990	Part of foundation program
Rhode Island	Incentive	Encouraged to reduce class size to no more than 15	K-3	1987 1996	Educational improvement block grants
South Carolina	Mandate	21	1-3 (math and reading classes)	1977	Through foundation program with pupil weights of 1.3 for K and 1.24 for 1-3.
South Dakota	Incentive	15	K-3	1993	Voluntary Grants for up to 3 years

Table A3 (Continued)
States with Class Size Reduction Measures

State	Mandate or Incentive	Class Size Limit	Grade Level Affected	Year Implemented	Funding
Tennessee	Mandate	20	K-3	1985	Part of foundation program
Texas	Mandate	22	K-4	1984	Unknown
Utah	Mandate	18	K-2 If attained at K-2 than allocation can be used in 3-4	1992	Weighted pupil funding formula distributes funds over four years
Virginia	Incentive	Long term goal to reduce class size in schools with high or moderate concentrations of at risk students	K-3	1996	State incremental funding along with local district match
Washington	Both	~18.42	K-3	1987-88	Part of basic aid formula along with incentive funding
Wisconsin	Incentive	Reduction of class size a requirement for receiving student achievement grants	K-3	1995	Funded through finance formula if part of special program

Source: Derived from ECS, 1998

APPENDIX B

DESCRIPTIONS OF NEW AMERICAN SCHOOLS DESIGNS

New American Schools (NAS) is a coalition organized to support the development and dissemination of restructured school designs to schools across the United States. NAS currently supports reform efforts in over 700 schools using eight different designs. The eight are summarized below. The information was taken directly from the NAS Website at http://www.naschools.org.

America's Choice Design Network (formerly the National Alliance for Restructuring Education)

The America's Choice Design Network (begun in 1989 as the National Alliance for Restructuring Education) is one of the largest school reform networks in the nation. A program of the National Center on Education and the Economy (NCEE), it is based on the America's Choice Design, the result of $60 million of investment over nine years. The design is built on the America's Choice Performance Standards and Assessments Program, begun in 1992 as New Standards. It incorporates a standards-based-curriculum focused on the basics, conceptual mastery, and applications; a design for quickly identifying students who are falling behind and bringing them back to standard; and a planning and management system for making the most efficient use of available resources to raise student performance as quickly as possible. The design focuses in the early years on literacy in reading, writing, and math and at the high school level on a demanding academic core intended to prepare all students for college.

The America's Choice Design was developed to make sure all but the most severely handicapped students reach an internationally benchmarked standard of achievement in English language arts, math, and science by the time they graduate. That standard is incorporated in the design's performance standards and in a Certificate of Initial Mastery (CIM), to be issued to every student who meets the standard.

Students enrolled in schools using this design will be fluent readers by the end of third grade; they will be able to write an essay of the quality of an article in their local newspaper by the end of tenth grade; they will be ready for algebra by the beginning of eighth grade; and they will have a good grasp of the basic concepts in biology, physics, and chemistry by the time they leave high school.

The America's Choice Design is a comprehensive design for schools serving kindergarten through high school students. The design has five main components:

- state-of-the-art performance standards and assessments;
- highly innovative curriculum materials and instructional programs matched to the standards and assessments;
- ways to engage community services and supports on behalf of the students;
- ways to lead, organize, and manage the school that are highly focused on getting results; and

- ways to engage the public and parents in improving student performance.

ATLAS Communities

Authentic Teaching, Learning, and Assessment for all Students (ATLAS) Communities was conceived as a partnership of four of the nation's most respected educational organizations: The Coalition of Essential Schools at Brown University, the School Development Program at Yale, Project Zero at Harvard, and the Education Development Center in Boston. These organizations and their esteemed leaders, Theodore Sizer, James Comer, Howard Gardner, and Janet Whitla, have brought to the collaboration more than 100 years of experience in school reform.

A unique and prominent feature of ATLAS Communities is the Pre-K through 12 "pathway." The "pathway" is a feeder pattern of elementary, middle, and high schools. It is also a conceptual ideal: the development of a coherent educational program for each student, from the very first day of school through graduation. For the last five years, ATLAS Communities has been working with pathways of schools in urban and suburban school districts across the country to:

- improve learning outcomes for all students (Teaching and Learning);
- evaluate student work through a variety of standard and innovative assessment tools (Assessment);
- engage teachers in serious and sustained professional development (Professional Development);
- involve families and other members of the community in the education of their children (Learning Community); and
- reorganize the internal structures and decision-making processes within schools and districts to support all of the above.
- (Management and Decision-Making).

These are the key elements of the ATLAS Communities framework. Instead of focusing on selected elements of the school experience, ATLAS believes that all of the parts must be connected to the whole. Each element is important in its own right, but cannot thrive in isolation. In order for school change to be sustained, these elements must be fully integrated.

Co-NECT

The Co-NECT design helps K through 12 educators use technology for comprehensive school change and improved academic results. The design stresses:

- high expectations and school-wide accountability for results;
- learning by doing;
- assessments that measure actual student and school performance;
- organization of the school into small learning communities; and
- sensible use of the best available technology for everyone.

The design also reflects a strong belief in the importance of school, district, and community involvement in the process of school restructuring and continuous improvement. Co-NECT schools, whether elementary, middle, or high schools, are organized around small multi-grade "clusters" of students taught by a cross-disciplinary teaching team. Ideally, students stay in the same cluster, with the same teachers, for at least two years.

Teaching focuses on authentic, interdisciplinary projects that give every student an opportunity to acquire critical skills and deep content understanding, as defined by local standards. At the high school level, teaching focuses more intensely on areas that will help prepare students for life after graduation. This can mean concentration in specialized academic areas, worksite-based projects, apprenticeships, opportunities to study at community colleges, and other such programs. Faculty representatives from each cluster serve on a school design team. Led by the building principal with input from parents and other members of the community, the school design team sets overall goals and monitors results.

Co-NECT is founded on the premise that traditional schools, with their emphasis on covering curriculum and mastering isolated skills, too often graduate students with a superficial understanding of unrelated facts and half-mastered competencies that have little use in real life. Co-NECT helps teachers adopt strategies and approaches to learning that deepen understanding and bridge the gap between academic knowledge and real-world applications.

Co-NECT helps local school design teams set concrete goals for student accomplishment in relation to local content and performance standards — descriptions of what all students are expected to produce in particular subject areas, such as a report on an original scientific investigation, a budget proposal, a collection of book reviews, or a multimedia presentation. The standards, which reflect national, state, and district standards, specify how a product should be judged, the level of performance that should be attained, and examples of products that meet the standard.

Expeditionary Learning Outward Bound

Expeditionary Learning is a comprehensive school design for grades K-12 based on principles that grow in large part out of the experience of Outward Bound, founded in Great Britain by educator Kurt Hahn in 1941. Its fundamental ideas include: 1) most people learn most things better by doing them for a purpose than by listening to other people talk about them, and 2) qualities of character and community are at least as important to nourish and teach as academic skills and knowledge.

In Expeditionary Learning schools, students spend most of each school day on purposeful, rigorous "learning expeditions," — in-depth studies of a single theme or topic, generally lasting six to twelve weeks. Each expedition revolves around projects and performances, which often take students outside of school to conduct fieldwork, bring the outside world into the classroom, and engage students in real-world investigations. Learning expeditions are aligned with and meet or exceed local and state standards. Ongoing assessment is incorporated in a planned effort to lead students to higher levels of performance. Standards for an expedition are raised each year the expeditions are taught.

To support this kind of teaching and learning, teachers, students, and school leadership develop a culture of respect, with high expectations for all. The school schedule is built around large, flexible blocks of time. Tracking is eliminated, and students stay with the same teacher for at least two years. Teachers have regular common planning time to design their expeditions, critique each other's expedition plans, and discuss portfolios of student work. The Expeditionary Learning implementation plan becomes a central part of the school's overall improvement plan, and the school does an annual self-review against Expeditionary Learning implementation benchmarks and student achievement objectives. Parents and community members are involved as visiting experts when learning expeditions touch their fields of expertise.

The Expeditionary Learning school "breaks the mold" in three dramatic and fundamental ways:

- Teaching and learning are much more active and project-based; school is both more exciting and more rigorous.

- The school is safer, physically and emotionally; there are well-observed safety protocols for field-work, small crews, or families within the school. There are also school and classroom contracts and protocols for general rules of behavior and for classroom practices like the critique of student work.

- High expectations for students' achievement and character development are manifested in demanding student demonstrations of intellectual, physical, and character development and achievement to audiences that go beyond the classroom and school. There is a "culture of revision," where many drafts are the norm and nothing less than your best work is expected. All students keep portfolios of their work, including not only final products but also the stages along the way.

Modern Red Schoolhouse

The little red schoolhouse of yesteryear was a place that drew people together for common purposes. It led them to set priorities by working out their differences, finding universal values in their different backgrounds, and sharing in one of the most important responsibilities of any community — readying the next generation to take its place in that community by socializing the young, transmitting the culture, and equipping future workers, citizens, and parents with essential knowledge, skills, and habits.

When it worked well, the little red schoolhouse did all those things and more. But it never worked well for everyone. Lots of people dropped by the wayside; many did not learn a great deal; and only a handful learned enough to prepare for higher education or leadership roles. That may have been serviceable in a time when the U.S. did not need vast numbers of highly educated people, but it will not suffice now.

The Modern Red Schoolhouse takes the virtues and principles of the little red schoolhouse and makes them work in today's diverse, complex society. The Modern Red Schoolhouse takes the expectations for achievement and community support embodied in its predecessor and infuses them with technological and informational resources. The Modern Red

Schoolhouse is different from the little red schoolhouse in the high academic standards for all students used at all Modern Red Schoolhouse sites, in its comprehensive view of school restructuring, and in its use of a sophisticated instructional management system that allows for detailed tracking of student progress and continuous reflection on the curriculum.

The Modern Red Schoolhouse standards may be viewed as relatively traditional — they focus on traditional disciplines. The design is modern in its pedagogy, and has to be so if it is to succeed in its chief goal — having all students attain high academic standards. It is comprehensive in that it has implications for each school in these core areas: organization and finance; technology; community involvement; curriculum, standards, and assessment; and professional development. Each school establishes task forces in these key areas to plan and execute school restructuring efforts.

Audrey Cohen College Schools

The school design for grades K through 12 runs under the auspices of the Audrey Cohen College, an accredited, private, nonprofit institution of higher education. Since its founding in 1964, the College has been dedicated to preparing individuals to assume leadership roles in a rapidly changing world. The College has adapted its education system for elementary and secondary schools to serve the learning needs of all students.

Purpose-Centered Education focuses all student learning — from math and science to English and social studies — on a complex, meaningful, overarching Purpose that contributes to the world at large. Students become eager, confident learners, who are proud of their ability to take charge of their own learning and to make their communities better places to live. Teachers become enthusiastic advisors and facilitators, assuming new leadership roles as they collaborate with other teachers, parents, and community members to support student learning.

Students achieve the semester's Purpose by planning, carrying out, and evaluating a Constructive Action® in which they use their knowledge and skills to benefit their community and the larger world. In using what they know and applying what they learn, students not only achieve a meaningful Purpose, but also learn to be effective and caring citizens able to manage their lives and help to make the world a better place. In the early grades, each class addresses its Purpose as a group, planning and implementing a Constructive Action in the community with the guidance of the teacher. Older students plan and implement their own individual Constructive Actions with teacher involvement.

There are 24 enriching, developmentally appropriate Purposes, generally one for each semester at each grade level. Examples are:

- We Work for Safety® (Grade 1);
- We Help People Through the Arts® (Grade 3);
- We Work for Good Health® (Grade 4);
- I Take Charge of My Learning® (Grade 7); and
- I Use Science and Technology to Help Shape a Just and Productive Society® (Grade 10).

Roots and Wings

Roots and Wings is centered upon this guarantee: Every child will progress successfully through the elementary grades, no matter what it takes. Roots and Wings is a comprehensive restructuring of education for children from pre-kindergarten to age 11. The goal of Roots and Wings is to ensure every child a firm foundation in the knowledge and skills needed to succeed in today's world and to go far beyond this to higher-order learning and integration of knowledge.

"Roots" refers to strategies designed to ensure that every child can meet world-class standards: early intervention for preschoolers, research-based curriculum with extensive training support, one-to-one tutoring for children struggling with reading, and family support. "Wings" refers to improvements in curriculum and instruction designed to let children soar. A key component of "wings" is a science/social studies program called WorldLab, which creates a set of simulations and group investigations in which students apply knowledge and skills in flexible, creative, and integrated ways to solve problems. MathWings is based on the standards set by the National Council of Teachers of Mathematics and challenges students to reach new heights in problem solving as well as fluency with mathematical concepts. Innovative, regularly administered, performance-based assessments measure students' progress toward world-class standards.

Family Support. A school-family support team works to build positive home-school collaboration and ensures that any students who are having problems in their learning receive whatever services are required to correct these problems. The team works with the student's family and community agencies to alleviate home, health, individual, or other problems that may be interfering with the student's achievement.

Urban Learning Centers

The Urban Learning Centers (ULC), formerly known as the Los Angeles Learning Centers, is a comprehensive pre-K through 12 model for urban schools. The Learning Centers design calls for significant changes in teaching, learning, school management, and governance. It also addresses the health and well-being of students in order to overcome barriers to student learning. The design seeks to create a learning environment strongly connected to its community, where a well-organized and well-managed school supports high-quality instruction.

The Urban Learning Centers design is premised on the conviction that all children, regardless of circumstances, deserve an ambitious educational program and a nurturing educational environment. To meet the individual learning needs of children, the design breaks the mold of the child as a passive learning vessel and a non-participant in his/her own education, and creates a community of continuous learning where adults and children are actively engaged in the teaching and learning process.

The Urban Learning Centers design is organized into three components:

- The Teaching and Learning component ensures that all students are taught in a preK-12 community of learners that uses effective educational practices and quality curriculum materials.

- The Learning Supports component coordinates intervention strategies and social services to help overcome barriers to learning by addressing the health and well-being of students and their families.

- The Governance and Management component engages parents, staff, and community members in decision-making and school management to ensure that a Learning Center can improve and evolve.

Two additional features underlie the successful implementation of the essential components above:

- Technology facilitates access to information, as well as the ability to construct and disseminate this information. The ULC design integrates an array of technologies into every aspect of the Learning Center community to support and foster changes in learning, teaching, and assessment, and to improve general operations and strategic decision-making.

- Professional Development incorporates new knowledge about how students learn through constructivist teaching methods as well as the implementation of standards and assessment procedures that measure student progress in the teaching and learning environment. It also focuses on developing collaboration and communication skills. This results in a setting which not only replicates a democratic society, but inducts students as participating members.

The Urban Learning Centers design was developed through the collaboration between a school district, a teachers union, and an external partner: the Los Angeles Unified School District (LAUSD), United Teachers of Los Angeles (UTLA), and the Los Angeles Educational Partnership (LAEP). Considerable support was provided by other educational, corporate, and community organizations.

ULC schools can consist of both single and multiple sites. A family of schools in a "pathway" or "feeder" pattern can decide to work together to become a Learning Center. There are currently two model Learning Centers in the Los Angeles Unified School District. Additionally, the Design Team is also providing design-based assistance to a family of 11 LAUSD pre-K through 12 schools.