GLEN E. ROBINSON

Synthesis of Research on the Effects of Class Size

The research evidence provides little support that decreasing class size will by itself improve student learning—the most promising effects of class size reductions occur in grades K-3.

Reducing class size is often proposed as an educational intervention holding much promise for improving educational outcomes. But does research support the expectation that smaller classes will improve learning? My purpose here is to glean from accumulated class size studies those findings that are relatively consistent and meaningful, in order to provide information for making class size decisions.

Reviews of Class Size Research

Four approaches have been used to examine and interpret the research on class size.

Descriptive analysis. For several decades, class size studies were summarized and tallied according to their results. Early analyses, such as Ross and McKenna (1955) and NEA (1968), generally favored smaller class sizes. In 1978, a descriptive analysis by the Educational Research Service concluded that class size had little impact on the academic achievement of most pupils, in most subjects, above the primary grades. The analysis found some evidence of a positive relationship between smaller classes and increased academic achievement of some pupils in the primary grades.

Meta-analysis. In the late 1970s, "meta-analysis" was introduced to provide statistical, rather than descriptive, reviews of research studies (Glass 1976). A metric called "effect size" was calculated for each comparison between treatment and control groups to measure both direction and extent of the effect of treatment variables (such as class size) on outcome variables (such as pupil achievement).

The available few studies in grades 9–12 have not found that smaller classes have positive effects on achievement; moreover, the studies are seriously limited in quality.

In 1978, Cone reported a meta-analysis of 25 studies that included 124 effect sizes. Finding an overall effect size of smaller classes on pupil achievement of only +.14, Cone concluded that student achievement was not significantly higher in smaller classes. Also in 1978, Glass and Smith examined 76 class size studies and selected 14 "well-controlled" studies with 110 comparisons for their meta-analysis. They found only a 6 percentile rank difference in the mean scores of pupils taught in classes of 20 versus those taught in classes of 40; nevertheless, the authors concluded that "major benefits from reduced class size are obtained as class size is reduced below 20 pupils" (p. v).

Later, in a second meta-analysis based on 60 studies containing 371 comparisons, Smith and Glass (1979) examined "nonacademic" effects of class size, such as student behavior and teacher morale. They reported that smaller classes had a substantial positive effect on teacher morale and attitude but much less effect

on pupil behavior and attitude, instructional environment, and instructional processes.

Best-evidence synthesis. In 1986 Slavin combined elements of meta-analysis with descriptive analysis to form "best-evidence synthesis." Applying this method to class size research in 1989, he found only 8 studies that met all his criteria. The median effect size across the 8 studies was only +.13; thus Slavin concluded: "Substantial reductions in class size (from about 27 to 16, a 40 percent reduction) do generally have a positive effect on student achievement, but the effects tend to be small" (p. 251).

Related cluster analysis. The fourth method, the "clustering" approach to research analysis was first described by Light and Smith (1971) and then by Pillmer and Light (1980).

In 1986 Wittebols and I applied the cluster analysis approach to all class size research studies conducted between 1950 and 1985 in K-12 classes containing five or more pupils.[1] We grouped the 100 studies that met these criteria into "clusters" considered important for class size decisions, such as grade levels, subject areas, student characteristics, student achievement, student behavior, and teaching practices. The results of our analysis constitute the basic content of the following summary.

Class Size and Student Achievement

Of the 100 studies in our related cluster analysis, 55 dealt specifically with class size and student achievement in grades K-12. The following cluster summaries are based on the findings of those studies. Additional studies reported since publication of the cluster analysis will be described within each section.

Grades K-3 and subject. The most promising effects of small classes on pupil learning are in grades K-3. Of 22 studies concerned with these effects (see fig. 1), 11 found pupil achievement higher in the smaller classes. Two studies found differences in favor of larger classes, and 9 found no significant differences between larger and smaller classes. (In these studies, definitions of "small" classes ranged from a low of 13 pupils to a high of 29. Definitions of "large" classes ranged from 22 to 40 pupils.)

In terms of subject areas, all 22 studies dealt with reading; 11 of them found achievement higher in smaller classes. Of the 14 studies that involved achievement in mathematics, 5 of these found achievement higher in smaller classes (Note: Johnson and others [1977] found "neither" small nor large classes improved achievement in mathematics). Of the 4 studies that involved language arts, 1 found achievement greater in smaller classes; the other 3 found no significant differences.

Tennessee's Project STAR, currently in progress, is a four-year study involving some 6,900 pupils in about 350 classes from kindergarten through grade 3. The latest data available indicate that class size reductions from about 24 to about 15 pupils in each of grades K-2 had positive effects as measured by scores on nationally standardized tests. For reading, effect sizes were +.18 for kindergarten, +.24 for 1st grade, and +.23 for 2nd grade. For mathematics, effect sizes were +.15 for kindergarten, +.27 for 1st grade, and +.28 for 2nd grade (Achilles, Bain, and Finn 1990, p. 22).

The earlier findings of the pilot study for Project STAR (Whittington and others 1985) indicated that the positive small-class gains in reading and mathematics at the end of 1st grade had evened out by the end of 2nd and 3rd grade. However, Bain and others (1988) found that the smaller classes were associated with student mastery of the district's basic skills objectives for all three years.

Two recent studies also indicate that the initial effects of class size reductions may not be sustained in subsequent years. Follow-up data to the Doss and Holley (1982) study indicated that the first year's positive effects had largely disappeared by the second and later years of the study (Christner 1987). Second, data from a cohort study in one school district of the Indiana PRIME TIME program, which reduced class size in grades K-3 from a range of 20 to 24 pupils to a range of 17 to 20 pupils, found that the gains in reading and mathematics achievement observed in grade 1 had largely disappeared by the end of grade 3 (Tillitski and others 1988). In their "Final Report" summarizing statewide data, Farr and others (1987) found "small but positive" results in PRIME TIME classes but concluded

Highlights of Research on the Effects of Class Size

The accumulated body of class size research supports the following conclusions:

- The most positive effects of small classes on pupil learning occur in grades K-3 in reading and mathematics, particularly in classes of 22 or fewer students. However, the first year's positive effects may not be sustained in subsequent years.
- Studies examining student attitudes and behavior found the most favorable effects of smaller classes in the primary grades.
- Smaller classes can positively affect the academic achievement of economically disadvantaged and ethnic minority students.
- Within the midrange of 23 to 30 pupils, class size has little impact on the academic achievement of most pupils in most subjects above the primary grades.
- The positive effects of class size on student achievement decrease as grade levels increase; however, the available studies in specific subject areas in the upper grades are limited in both number and quality.
- Little if any increase in pupil achievement can be expected from reducing class size if teachers continue to use the same instructional methods and procedures in the smaller classes that they used in the larger classes.
- Reductions in class size have small positive effects on achievement in comparison to many less costly learning interventions and strategies.

—Glen E. Robinson

that "extending PRIME TIME to 3rd grade classes did not have any significant effect for either reading or mathematics on competency test scores" (p.46).

There is some evidence that smaller classes can have positive effects on the achievement of disadvantaged and minority students.

Fig. 1. Studies of Class Size and Student Achievement Clustered by Grade Levels with Subject Areas Indicated[1]

Grade Level	Number of Studies	Studies Showing Greater Achievement in:[2]		
		Small Classes	Neither	Large Classes
K–3	22 (50% favoring small)	Frymier 1964 (R)[3] Castiglione and Wilsberg 1968 (R) Balow 1969 (R) Heim and Perl 1974 (R, M) Johnson and others 1977 (R, M) Wagner 1981 (R) Carrington and others 1981 (R) Doss and Holley 1982 (R, M, L) Cahen and others 1983 (R, M) Indiana State Department of Instruction 1983 (R, M) Whittington and others 1985 (R, M)	Spitzer 1954 (R, M, L, O) Fox 1967 (R, M) Counelis 1970 (R) Katzman 1971 (R, M) Taylor and Fleming 1972 (R, M) Murnane 1975 (R, M) Madison Metropolitan School District 1976 (R) McDermott 1977 (R, M, L) Johnson and Garcia-Quintana 1978 (R, M, L)	Little and others 1971 (R) Mazareas 1981 (R, M)
4–8	21 (38% favoring small)	Furno and Collins 1967 (R, M) Woodson 1968 (R, M) Balow 1969 (R) Moody and others 1973 (M) Heim and Perl 1974 (R, M) Manos 1975 (G) Summers and Wolfe 1975 (G) Doss and Holley 1982 (R, M, L)	Spitzer 1954 (R, M, L, O) Lansing 1956 (O) Marklund 1963 (R, M, L, S) Fox 1967 (R, M) Johnson and Scriven 1967 (M, E) Katzman 1971 (R, M) Taylor and Fleming 1972 (R, M) Coldiron and Skiffington 1975 (G) Wright and others 1977 (R, M, L, O) Mueller 1985 (R, M, L, O)	Menniti 1964 (R, M) Flinker 1972 (M, L) Kean and others 1979 (R)
9–12	22 (18% favoring small)	Anderson 1950 (N) Mollenkopf and Melville 1956 (O) Bowles 1969 (R, M, O) Smith 1974 (E)	Miglionica 1958 (M, E, S, N) Johnson and Lobb 1961 (M, E, S, N) Williams 1962 (E, N) Engstrom 1963 (M) Anderson and others 1963 (M) Haskell 1964 (O) Meiller 1965 (N) Jeffs and Cram 1968 (O) Grove 1969 (S) Good 1970 (O) Massachusetts Association of School Counselors 1972 (E) Heim and Perl 1974 (R, M) Summers and Wolfe 1975 (E) Coldiron and Skiffington 1975 (G) DeAngelis 1977 (N)	Warburton 1961 (E) Madden 1968 (M) Beditz 1983 (N)

Source: Adapted from Robinson and Wittebols 1986.

[1] Study-effect classifications in this table indicate only the general or overall findings of the study. The effect for one subject area in a study may differ from the effects of other areas comprising the overall classification of the study. Refer to text for specific subject area effects.

[2] Studies listed in more than one cell indicate that the study reported class size comparisons for more than one grade level.

[3] Letters following study citations indicate the subject areas in each sudy. R: Reading; M: Mathematics; L: Language Arts; E: English; S: Social Science; N: Natural Science; O: Other Subjects: G: General (e.g., basic skill test scores).

Grades 4–8 and subject. In grades 4–8 the cluster of 21 studies indicates that smaller classes have a slight positive effect on pupil achievement, but the evidence is not nearly so strong as in grades K-3. Of these studies, 8 found achievement higher in smaller classes, 3 found differences in favor of larger classes, and 10 found no significant differences between smaller and larger classes (fig. 1). (The definitions of "small" classes ranged from 5 to 36 pupils; "large" classes ranged from 22 to 55 pupils.)

When examined by subject areas, 14 of the 21 studies involved reading; 5 of these found reading achievement higher in smaller classes. Of the 15 studies involving mathematics, 6 found achievement higher in smaller classes (Note: In addition to the 5 studies cited in fig. 1, Mueller's [1985] findings supported smaller classes in mathematics).

Two of the 7 studies involving language arts or English reported greater achievement in smaller classes (Doss and Holley 1982, Mueller 1985). One study found achievement higher in larger classes (Flinker 1972), and 4 found no significant difference. Two general studies found scores on the Iowa Test of Basic Skills higher in smaller classes (Manos 1975, Summers and Wolfe 1975). No significant differences in achievement were found in studies involving other subject areas.

Grades 9–12 and subject. The data in the 9–12 grade cluster do not indicate that smaller classes have positive effects on student achievement. However, these studies are severely limited both in number per subject and in methodology. Only 4 of the 22 studies indicated that student achievement was greater in smaller classes than in larger ones. But "small" classes in these studies ranged from 5 to 40 students, and "large" classes from 26 to 192—nearly half involved large classes of 45 or more students.

Examined by subject areas, none of the 7 studies involving mathematics found achievement greater in the smaller classes. But Bowles (1969) found that "neither" small nor large classes were associated with higher achievement. Of the 7 studies in English, 2 reported greater achievement in smaller classes (Miglionica [1958] also found smaller classes associated with greater achievement in 10th grade English), 3 found no significant differences between larger and smaller classes, and 2 found higher achievement in larger classes. (Williams' [1962] findings favored "large" classes for English.)

Of the 14 study comparisons in other subject areas, 3 found achievement greater in smaller classes: Anderson

Fig. 2. Studies of Student Achievement in Class Sizes of 22 Students or Fewer, Clustered by Grade Levels, with Subject Areas Indicated[1]

Grade Level	Number of Studies	Studies Showing Greater Achievement in:[2]		
		Small Classes	Neither	Large Classes
K–3	13 (69% favoring small)	Castiglione and Wilsberg 1968 (R)[3] Balow 1969 (R) Johnson and others 1977 (R, M) Wagner 1981 (R) Carrington and others 1981 (R) Doss and Holley 1982 (R, M, L) Cahen and others 1983 (R, M) Indiana State Department of Instruction 1983 (R, M) Whittington and others 1985 (R, M)	Fox 1967 (R, M) Katzman 1971 (R, M) Johnson and Garcia-Quintana 1978 (R, M, L) Mazareas 1981 (R, M)	
4–8	10 (50% favoring small)	Woodson 1968 (R, M) Balow 1969 (R) Moody and others 1973 (M) Manos 1975 (G) Doss and Holley 1982 (R, M, L)	Marklund 1963 (R, M, L, S) Fox 1967 (R, M) Katzman 1971 (R, M) Wright and others 1977 (R, M, L, O) Mueller 1985 (R, M, L, O)	
9–12	4 (none favoring small)		Miglionica 1958 (M, E, S, N) Johnson and Lobb 1961 (M, E, S, N) Haskell 1964 (O)	Beditz 1983 (N)

Source: Adapted from Robinson and Wittebols 1986.

[1] Study-effect classifications in this table indicate only the general or overall findings of the study. The effect for one subject area in a study may differ from the effects of other areas comprising the overall classification of the study. Refer to text for specific subject area effects.

[2] Studies listed in more than one cell indicate that the study reported class size comparisons for more than one grade level.

[3] Letters following study citations indicate the subject areas in each study. R: Reading; M: Mathematics; L: Language Arts; E: English; S: Social Science; N: Natural Science; O: Other Subjects; G: General (e.g., basic skill test scores).

Fig. 3. Studies of Class Size and Disadvantaged or Minority Students Clustered by Grade Levels

Grade Level	Number of Studies	Studies Concerned with Achievement In:[1]		
		Small Classes	Neither	Large Classes
K–3	9 (44% favoring small)	Castiglione and Wilsberg 1968 Wagner 1981 Doss and Holley 1982 Cahen and others 1983 Whittington and others 1985	Counelis 1970 Taylor and Fleming 1972 Murnane 1975	Little and others 1971
4–8	5 (80% favoring small)	Furno and Collins 1967 Manos 1975 Summers and Wolfe 1975 Doss and Holley 1982	Taylor and Fleming 1972	
9–12	1 (all favoring small)	Bowles 1969		

Source: Adapted from Robinson and Wittebols 1986.

[1] Studies listed in more than one cell indicate that the study reported class size comparisons for more than one grade level.

(1950), Mollenkopf and Melville (1956), and Bowles (1969). Only 1 study comparison favored larger classes (Beditz 1983). The 10 other study comparisons found no significant differences between smaller and larger classes. Recently, a study of the effects of class size reductions in two California secondary schools reported that class size reductions in English, social studies, science, and mathematics did not affect student achievement (Winston 1987).

Classes of 22 pupils or fewer. Of the 55 studies cited in Figure 1, 24 make up the cluster with class sizes of 22 or fewer students. These 24 studies yielded 27 grade-level comparisons, shown in Figure 2. In the K-3 grade cluster, 9 of the 13 studies in reading found achievement greater in the smaller classes. Four of the 9 studies that concerned mathematics found achievement greater in smaller classes. (Note that the findings of Johnson and others [1977] favored "neither" small nor large classes in mathematics).

In the 4–8 grade cluster, 5 of the 10 studies favored achievement in smaller classes. Three of the 8 studies concerned with reading found achievement greater in smaller classes. Likewise, 4 of 8 studies in mathematics found achievement greater in smaller classes. (Note the 3 studies in fig. 2, plus Mueller [1985], whose findings favored smaller classes in mathematics).

In grades 9–12, only 4 studies involved classes of 22 or fewer students. None found student achievement greater in smaller classes.

Many teachers whose classes have been reduced, even by substantial numbers of students, do not change their teaching techniques to take advantage of the smaller classes.

In addition, several recent studies have involved reductions in class size to below 22 pupils. First, as cited earlier, the latest available results from the Tennessee Project STAR study show positive effects of classes below 22 pupils on achievement in reading and mathematics at the end of kindergarten, 1st grade, and 2nd grade (Achilles, Bain, and Finn 1990). Second, a cohort study—in one school district—of Indiana's PRIME TIME program to reduce class sizes below 20 pupils found positive results at the end of 1st grade but not by the end of 3rd grade (Tillitski and others 1988). Third, the statewide third-year analysis by Farr and others (1987) found small but positive results in PRIME TIME classes. Fourth, in a New York City experimental program to reduce the size of 1st grade classes from 26 to 16 pupils, pupils in the smaller classes did not have significantly higher reading scores than pupils in the larger classes (Jarvis and others 1987).

Disadvantaged or minority students. The research rather consistently finds that students who are economically disadvantaged or from some ethnic minorities perform better academically in smaller classes. The 13 studies cited in

Figure 3 that included students from disadvantaged backgrounds or ethnic minorities as a specific factor of the study yielded 15 grade-level comparisons. Ten of the comparisons found the academic achievement of the pupils higher in smaller classes.

Of the 9 studies in grades K-3, 5 found achievement of disadvantaged or minority students higher in smaller classes. In grades 4–8, 4 of the 5 studies found achievement higher in smaller classes. The one study in grades 9–12 found larger classes negatively related to the achievement of 12th grade black students in reading but found no significant correlation with achievement in mathematics (Bowles 1969).

In addition to the studies cited in Figure 3, eight general studies have dealt with class size or pupil-teacher ratio as part of some broader analysis. These studies were included here because a substantial proportion of participating students were economically disadvantaged or from an ethnic minority. Of the 8 studies, 6 found that achievement for disadvantaged or minority students increased slightly as pupil-teacher ratios decreased (Fetters and others 1968, Mayeske and others 1969, Walberg and Rasher 1974, Walberg and Rasher 1977, Maryland Department of Education 1978, Edmonds and Fredericksen 1979).

Tennessee's Project STAR is a four-year study involving some 6,900 pupils in about 350 classes from kindergarten through grade 3.

Current data from Project STAR indicate that at the end of 2nd grade minority students in classes of about 15 students did substantially better than minority students in classes of about 25 students. The effect sizes on standardized tests were +.33 in reading and +.35 in mathematics. The data also indicate that 12.7 percent more minority students in the smaller classes than in larger classes passed the reading portion of the Tennessee basic skills test and 9.9 percent more passed the mathematics portion (Achilles, Bain, and Finn 1990).

Academic ability of pupils. Ten of the K-12 studies in the related cluster analysis included both academic ability and grade level of students. The limited data from these studies indicate that students of less ability achieve more in smaller classes, but the evidence is mixed concerning students of average or higher ability. Of the 2 studies in the K-3 cluster, 1 study (Mazareas 1981) found that below-average pupils in non-Title I schools achieved more in reading in smaller classes but that average and above-average pupils achieved more in larger classes. In mathematics, below-average and above-average students in Title I schools did better in larger classes; average ability students did better in smaller classes.

The other study (Whittington and others 1985) found significant improvement in both reading and mathematics when lower achieving 1st grade pupils were taught in classes of 15 pupils compared with classes of 25 pupils.

Of the 2 studies in grades 4–8, 1 study (Summers and Wolfe 1975) found that pupils who scored low on tests of basic skills were negatively affected by classes of 28 to 33 pupils compared with classes of fewer than 28; all groups of pupils in the study were negatively affected in classes of 34 or more. The other study (Menniti 1964) found achievement gains varied among students of differing ability levels.

Of the 6 studies in grades 9–12, 2 indicated that smaller classes can be beneficial to low-achieving students, at least in the areas of English and writing skills (Smith 1974, Summers and Wolfe 1975). The other studies reported varied results among students of differing abilities (Engstrom 1963, Jeffs and Cram 1968, DeAngelis 1977, Beditz 1983).

Current data from Project STAR indicate that at the end of 2nd grade minority students in smaller classes did substantially better than minority students in larger classes.

Class Size and Student Behavior and Attitudes

The 15 studies in our cluster analysis dealing with the relationship between class size and student behavior or attitudes in all grades (K-12) yielded 17 comparisons. Seven of the comparisons found more positive student attitudes and behavior in smaller classes, and 10 found no difference (see fig. 4).

The studies in the grade K-3 cluster show the most favorable relationship between smaller classes and positive student attitudes or behavior, with 4 of the 6 studies favoring smaller classes. In grades 4–8, 1 of the 3 studies identified a positive relationship between smaller classes and student attitudes; 2 studies found no difference. In grades 9–12, 2 of the 8 studies found student attitudes to be more positive in smaller classes, while 6 found no difference.

Fig. 4. Studies of Class Size and Student Behavior and Attitudes Clustered by Grade Levels

Grade Level	Number of Studies	Studies Showing More Favorable Behavior or Attitude in:[1]		
		Small Classes	Neither	Large Classes
K–3	6 (67% favoring small)	Cannon 1966 Johnson 1969 Rogeness 1974 Shapiro 1975	Taylor and Fleming 1972 Buczek 1981	
4–8	3 (33% favoring small)	Rogeness 1974	Taylor and Fleming 1972 Wright and others 1977	
9–12	8 (25% favoring small)	Walberg 1969 Anderson and Walberg 1972	Haskell 1964 Jeffs and Cram 1968 Grove 1969 Hughes 1969 Scott 1972 Ward 1976	

Source: Adapted from Robinson and Wittebols 1986.

[1] Studies listed in more than one cell indicate that the study reported class size comparisons for more than one grade level.

Class Size and Teaching Practices

Of the 22 studies in the teaching practices cluster in grades K-12, 13 studies found more favorable practices in smaller classes than larger classes. Eight of the 9 studies that used the Indicators of Quality or similar observational instruments to assess differences in teaching practices and classroom climate found practices and climate more favorable in smaller classes (Vincent 1968, Coble 1969, Olson 1971, Auerbacher 1973, Newell 1954, Richman 1955, Whitsitt 1955, McKenna 1955). One study (Pugh 1965) found no significant difference. Many of these studies were criticized for their use of observational instruments their critics considered biased in favor of small classes and for including practices that had not been validated as effective in improving student learning (NESDC 1975).

Nine other studies also used direct classroom observation of teaching practices but different types of assessment instruments. Six found no significant differences in teaching practices in smaller and larger classes (Fox 1967, Haberman and Larson 1968, Bernstein 1973, Smith 1975, Yeany 1976, Wright and others 1977). Three found teachers in smaller classes using more desirable practices (Taylor and Fleming 1972, Manos 1975, Cahen and others 1983).

Bourke (1986) found that some teaching practices were different in smaller classes, but he did not find any increase in the individualization of instruction in the smaller classes.

The initial effects of class size reductions may not be sustained in subsequent years.

Many teachers whose classes have been reduced, even by substantial numbers of students, do not change their teaching techniques to take advantage of the smaller classes. For example, in their two-year experimental study in Toronto, Wright and others (1977) reported that a substantial majority of teachers whose classes had been reduced from 37 to 16 pupils said they had given more individualized attention to students and had made changes in classroom management, pupil evaluation, and classroom layout when working with smaller classes. However, these teacher-reported changes in teaching procedures were not found in classroom observations by the researchers.

Jarvis and others (1987) evaluated the recent New York City experimental study that reduced 1st grade classes from 26 to 16 pupils. "Although it was expected that the reduced-class size would permit teachers to provide more small group and individualized instruction in all curriculum areas," they reported, "no meaningful differences in the amounts of small group and individual instruction were observed between program classes and comparison

schools classes." However, several factors had a bearing on the experiment: lack of classrooms, late notification of experimental schools, quick hiring of additional teachers (many inexperienced), and no specific training or help for teachers in using techniques appropriate for small classes.

Class Size and Learning Interventions

Several researchers have examined different learning interventions in terms of their effects on student achievement. For example, in his studies, Bloom (1984) held class size constant and varied instructional methods and other factors in an effort to raise student learning in classes of 30 to match the levels of learning that he and his coworkers achieved with one-to-one tutoring. Through one-to-one tutoring, they raised student learning levels "2 sigmas" (2 standard deviations) above the level of pupils taught by conventional methods in classes of 30 pupils. By using the feedback-corrective techniques of mastery learning in classes of 30 pupils, they raised student achievement "1 sigma" above the level of pupils taught in classes of 30 using conventional teaching methods. Bloom concluded that even in classes of 30 pupils, large numbers of teachers "can use the feedback-corrective procedures [of mastery learning] to get the 1 sigma effect [in student learning]" (p. 6).

A recent study by Pinnell, DeFord, and Lyons reported sustained long-term effects with the one-to-one tutoring techniques of Reading Recovery.

In an examination of nearly 3,000 studies of educational interventions and their relationships to educational productivity, Walberg (1984) found that class size reductions showed the smallest positive effect (effect size, +.09) on student learning of some 35 interventions studied. The instructional methods found to have the largest effects on learning were reinforcement (+1.17), acceleration (+1.00), reading training (+.97), and cues and feedback (+.97). Walberg pointed out that 2 of the 4 highest ranked interventions (reinforcement and cues and feedback) were components of Bloom's mastery learning.

Slavin (1989), in applying the results of his class size best-evidence synthesis to Chapter 1 programs, questioned whether Chapter 1 funds should be used in schoolwide projects to reduce class size and what the optimum class size is for Chapter 1 pull-out programs. He concluded that research would not justify reliance on class size reductions alone as a means of improving the achievement of low achievers. In answering the second question, Slavin stated, "Leaving aside the question of cost-effectiveness, providing low achievers with one-to-one tutors for some portion of their school day is probably the most effective instructional strategy we have" (p. 255). A recent study by Pinnell, DeFord, and Lyons (1988) reported sustained long-term effects with the one-to-one tutoring techniques of Reading Recovery. This early intervention program, directed at the 20 percent of 1st graders having the most difficulty learning to read, requires specially trained teachers to tutor pupils individually for 30 minutes every day. In an average of 14 weeks, according to a longitudinal study conducted in the Columbus, Ohio, schools, three-fourths of the bottom group of students were brought up to the average reading level of their classes. Most important, the reading gains were sustained through the 3rd grade *without* further intervention.

Class Size and Cost-Effectiveness

Some researchers have attempted to measure the relative cost-effectiveness of improving student learning by a school district spending additional amounts of money to upgrade specific learning interventions. Reporting data on 6 output measures of pupil performance in Boston elementary schools, Katzman (1971) found that differences in school pupil-teacher ratios of 14 to 1 and 31 to 1 did not significantly affect pupil achievement in reading and mathematics. He concluded that expenditures per student are weakly related to student performance "because many expensive resources, like small classes or new buildings, have little impact on learning" (p. 171).

Later, Heim and Perl (1974), using data from 63 school districts in New York, compared gains in student achievement when per-pupil expenditures were increased in $100 increments for each of 4 types of improvements: (1) reducing the pupil-teacher ratio, (2) increasing teacher degree status, (3) increasing teacher experience, and (4) increasing principal degree status. Of the 3 teacher-related improvements, only reduction in class size was found to have a systematic impact on student achievement at the K-2 grade level. In grades 3–5, all 4 factors appeared to yield improvements in reading achievement but varied in cost-effectiveness. The most cost-effective improvement was found to be upgrad-

ing the degree status of principals (14 percentile point gain), followed by upgrading teacher degree status (9 percentile points), lowering pupil-teacher ratio (1 percentile point), and increasing teacher experience (0.7 percentile). In arithmetic achievement, only the principal and teacher degree status inputs appeared to yield any real improvement.

Using a computer model, Levin, Glass, and Meister (1984) tested the relative cost-effectiveness of adding $100 per student for each of four interventions: (1) lowering class size (35 to 30, 30 to 25, 25 to 20, and 35 to 20); (2) tutoring (peer, adult, and combinations of both); (3) computer-assisted instruction (10-minute daily session); (4) increased instructional time (30 minutes a day per subject). They found peer tutoring, in which upper elementary students tutored pupils in lower grades, to be the most cost-effective of the four interventions. Peer tutoring was about 4 times as effective in improving pupil achievement in mathematics (effect size, +.46) as reducing class size from 35 to 20 pupils (+.11). Computer-assisted instruction (+.10) showed about the same effectiveness as reducing class size in improving mathematics achievement, while increasing instructional time by 30 minutes a day had the smallest effect (+.05) per unit of cost. In improving reading achievement, the effectiveness of peer tutoring (+.22) was followed closely by computer-assisted instruction (+.19) and by increasing instructional time (+.12), with class size reduction (+.06) the least effective.

Recently, Stern (1987) examined achievement data of pupils in grades 3 and 6 in California schools related to teacher salary data and controlled for socioeconomic characteristics. He found achievement to be positively and significantly associated with teacher salary levels but not positively associated with teacher-pupil ratio. The author concluded that "raising teachers' salaries would be more cost-effective in improving student achievement than reducing class size in grades 3 and 6.

Reductions in class size have small positive effects in comparison to many less costly interventions.

Making Decisions about Class Size

Although class size reductions are often proposed as a way to improve student learning, research does not support the expectation that smaller classes will of themselves result in greater academic gains for students. The effects of class size on student learning varies by grade level, pupil characteristics, subject areas, teaching methods, and other learning interventions. To enhance the possibility of increasing student learning by reducing class size, research indicates that class size reductions should be targeted to specific groups of pupils for specific purposes and that teachers should receive the training and resources they need to make the most of the learning opportunities in smaller classes.

Certainly, class sizes should be within reasonable ranges in which the most effective teaching and learning can occur. But in terms of increased pupil learning, research evidence does not justify an absolute limitation on class size or small overall reductions in class size or pupil-teacher ratios as a matter of general policy in isolation of the many other factors involved.□

[1]Glen E. Robinson and James H. Wittebols, *Class Size Research: A Related Cluster Analysis for Decision Making*. Arlington, VA: Educational Research Service. 1986. 222 pp.

[2]Note: The studies in Figure 1 are grouped according to their *general* or *overall* findings regarding class size effects. In cases where multiple-subject-studies reported findings in a subject area that differed from the general classification of the study, the exceptions are noted in the text.

Editor's Note: Space limitations prevent inclusion of the lengthy list of references accompanying this article. The basic references are available in Robinson, G.E. and J.H. Wittebols, *Class Size Research: A Related Cluster Analysis for Decision Making*. Arlington, VA: Educational Research Service. 1986. 222 pp. A list of the full citations of all references in the article is available upon request from the author at the address below.

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