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ABSTRACT

The relationship between class size and scholastic outcomes is addressed in this paper. A literature review focuses on the research of Glass and Smith (1978) and Larkin and Keeves (1984). Contradictory and inconclusive research findings about teacher effectiveness in relation to class size indicate that emphasis should be placed on training teachers in instructional strategies most appropriate for a variety of class sizes. A recommendation is that rather than establishing an absolute class size policy, class sizes should be lowered in those subjects which require more teacher/pupil interaction and which have high workloads. Overall findings do not support the cost associated with universal class size reduction and indicate that smaller investments in other educational strategies may yield similar or greater achievement gains. Two figures illustrate the research of Glass and Smith, and one table presents student/teacher ratios by state. (22 references) (LMI)

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No. 3

The Relationship of Class Size to Student Achievement: What the Research Says

By

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The Occasional Paper Series is intended to place before the educational leadership in Maine information which can assist them as they ponder solutions to complex problems confronting their communities, educational systems, or their students. Papers will be distributed periodically as topics vital to educational improvement are addressed by researchers at the University of Maine.

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THE RELATIONSHIP OF CLASS SIZE TO STUDENT ACHIEVEMENT: WHAT THE RESEARCH SAYS

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This is a revision of a paper presented at the Penquis Superintendent's Association Meeting (Orono, Maine October 20, 1988) The authors are grateful to Dr. Russ Quaglia, Dr. John Skehan, Dr. Robert Cobb. and Holly Devaul for their helpful comments and contributions.

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The relationship of class size to scholastic outcomes has been the subject of scientific inquiry for at least the last 80 years. Since the publication of A Nation at Risk in 1983, the quality of public education in America has received increased scrutiny and political attention, and the class size argument has been brought to the forefront again. Many states have recently considered reducing class size as part of school improvement programs.

Few teachers disagree with this latest educational reform. The largest professional association, the National Education Association, has been lobbying for years for an even greater reduction: "The Association urges its affiliates to seek an optimum class size of 15 students" (NEA,1986). Proponents of smaller classes usually cite the work of Glass and Smith (1978), because it provided the first scientific evidence indicating that higher achievement can be expected in smaller classes.

While Glass and Smith (1978) sought to settle the class size issue, their work has caused a sharp increase in class size research, and strong criticism of their work can be found in the educational literature (ERS,1980; Tomlinson, 1988; Slavin, 1988). While educational researchers carry on lofty discourses in prestigious journals, the public continues to wonder about the importance of the relationship of class size to achievement. So do legislators, governors, and administrators.

What do teachers and students do in class that makes the number of pupils so important? Do teachers do things differently in smaller classes that result in increased educational outcomes? Could improved classroom management work as well as mandating smaller classes? Does reducing class size from 25 to 10 students per teacher have the same effect reducing class size from 40 to 25 students/teacher? Educators are often trapped between several sets of contradictory research findings, or worse, are faced with a set of inconclusive results when they had hoped to find data that could be used as the basis for policy decisions. School boards and administrators need answers to these and other questions before policy can be formulated. This paper was designed to review the existing research and to help clarify this complicated issue for Maine's policymakers and practitioners.

The Research Evidence

Coleman (1966) reported that student-teacher ratios were not related to achievement for any group under any condition. Many people familiar with Coleman's work are not surprised by this finding, for this is the same researcher who stated that a student's ability was the only important predictor of achievement (Coleman, 1966). A problem with the majority of the class size-achievement research is the failure to control for many other important factors. To examine any achievement question without controlling for ability or prior achievement, socioeconomic status, or several other predictor variables is misleading. We do not live in a two-dimensional world, and class size is only one of many factors related to academic achievement. This paper reports on only those studies that have controlled for other independent variables, either experimentally or statistically.

The NEA's desired optimum class size of 15 is the class size that first provides a statistically defensible gain in achievement according to Glass and Smith (1978). They used a statistical technique called meta-analysis to elicit a general conclusion from the conflicting reports. Meta-analysis enables researchers to quantify and combine the findings of many related studies. An "effect-size" is calculated for each comparison between class size and achievement (in this case), and then these effect-sizes are statistically combined to produce a general result (for a more detailed explanation of meta-analysis see Glass, 1978).

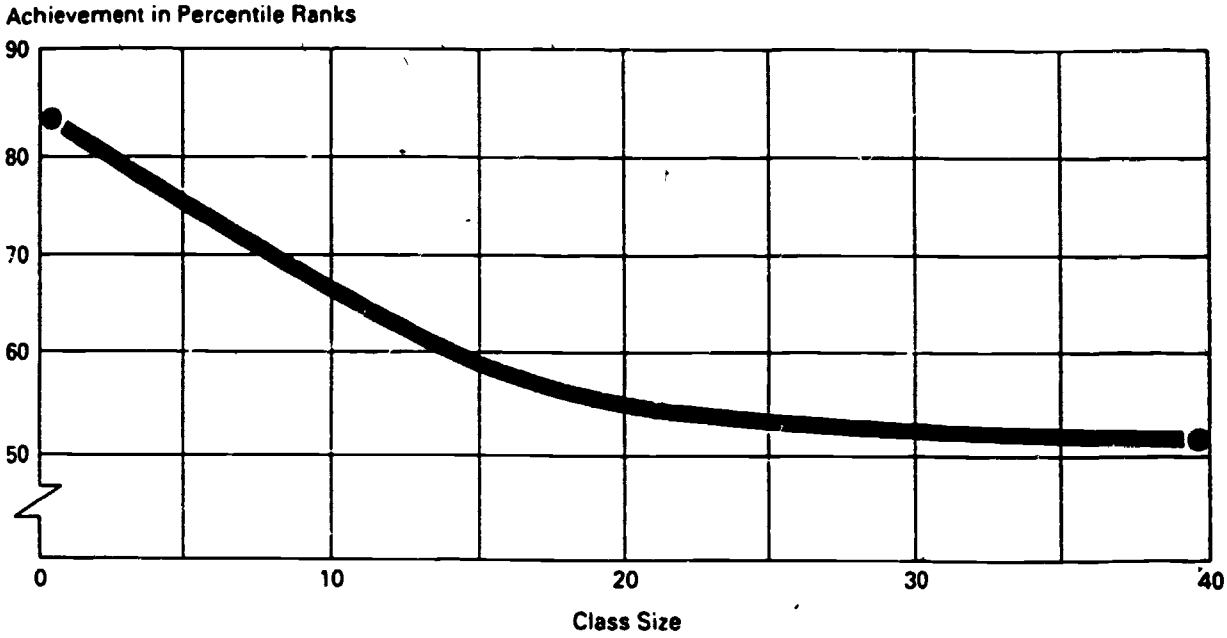
Glass and Smith examined 80 studies which yielded 725 comparisons between class size and achievement. On the average, the difference in achievement between the smaller and larger classes favored the smaller classes by about one-tenth of a standard deviation. Overall, approximately 60% of the comparisons favored smaller classes, while 40% showed achievement gains in the larger classes. Without meta-analysis, the review by Glass and Smith would leave us just as confused as before. But, the studies favoring smaller classes produced a stronger inverse relationship between class size and achievement than the direct relationships yielded by studies supporting large classes. In this instance we would expect the overall relationship to be inverse (in the direction of smaller classes), which is what Glass and Smith reported. The regression curve fitted to their distribution of effect sizes is the graph that is most often found in documents discussing the class size issue (see Figure 1).

The results presented by Glass and Smith were widely accepted by teachers, probably because it was the conclusion that was intuitively expected. But, Glass and Smith's results have been severely criticized, originally by the Educational Research Service (1980a) and later by Tomlinson (1988) and Slavin (1988). Glass answered

much of the original (ERS, 1980a) criticism in a follow-up Phi Delta Kappan article (Glass,1980), which was poorly rebutted by the ERS (1980b). Glass's strongest point was that although the body of research evidence contains mixed findings, it does not mean that we should refuse to try to conclude anything from all of these efforts. Hedges and Stock (1983) provided the most useful criticism of Glass and Smith's work. They criticized the statistical methods used by Glass and Smith and then re-analyzed the data using new sampling distributions developed by Hedges (1981). The improved meta-analysis technique did not greatly change the results of the original work by Glass and Smith. Glass and Smith (1978) were also criticized for only using the 14 most well-controlled studies to produce their now-famous graph (ERS, 1980). Glass answered this criticism by stating that the 14 most well-controlled studies agreed with their general findings, but to fit a regression curve that will have policy implications, they wanted to use the data in which they felt the most confidence (Glass, 1980). Having spent a great deal of time sifting through volumes of poorly conducted or poorly reported class size/achievement studies, we can understand Glass and Smith's reluctance to incorporate these more flawed data into their graph. For practical purposes we should look at the graph using a realistic range (15-35 students) for class size over the complete distribution of percentile ranks (see Figure 2). It is still apparent that smaller classes tend to predict higher achievement, although this graph does not contain the same shock value as the original. The key point is that smaller class sizes correlate with increased achievement, they do not 'cause' achievement gains.

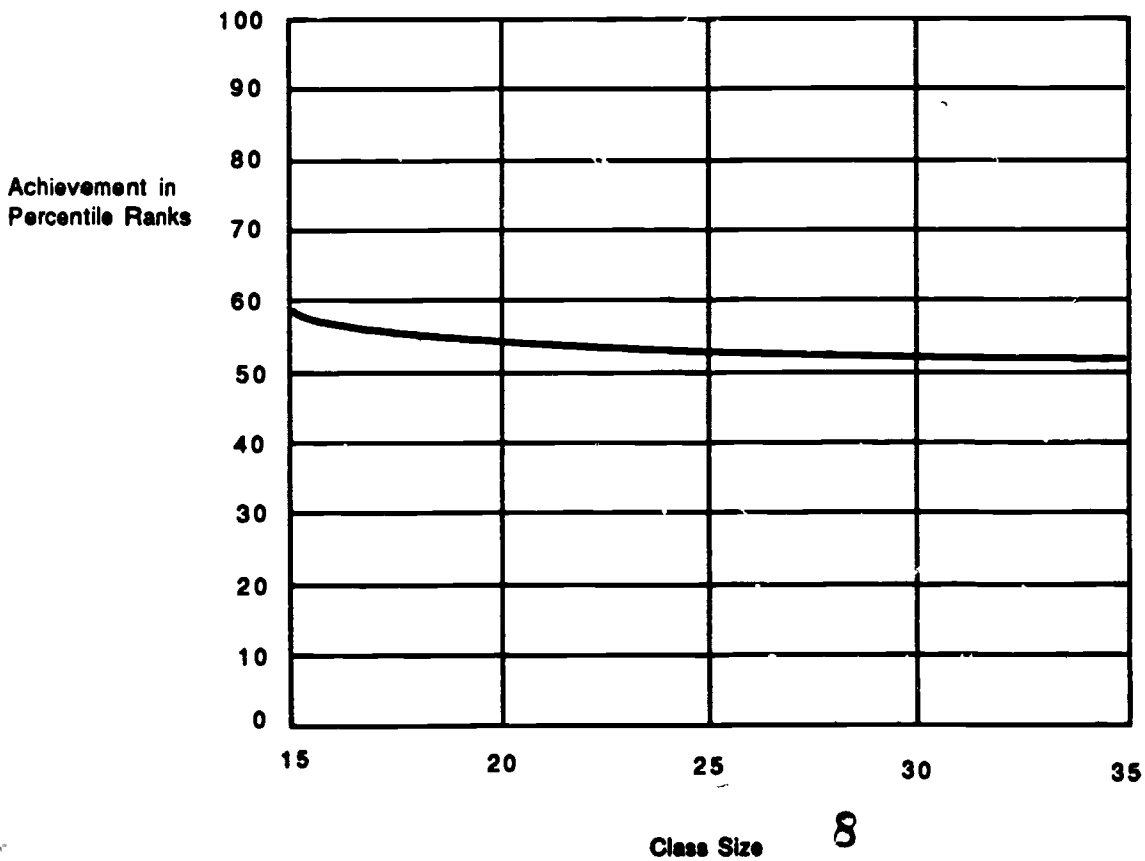
An extremely thorough study conducted by Larkin and Keeves (1984) in Australia helps to explain the relationship of several important predictor variables, including class size, to a final achievement measure in math and science. Larkin and Keeves also realized that the present literature was inconclusive, due in large part to the lack of well-controlled studies. Their feeling from the literature was that the advantages of small classes are restricted to those students who are the most vulnerable, particularly the very young or those of low ability (Larkin and Keeves, 1984). Their data were derived from the Educational Environment and Student Achievement study focusing on Year 7 students in the Australian Capital Territory (Keeves, 1972). They used multiple regression and path-analysis techniques to test the influence of several independent variables in a theoretical model. The advantage of this method is that the effect of each independent variable on the outcome measure can be calculated while statistically controlling for the effects of all of the other predictors in the model. In this case, it allowed Larkin and Keeves to examine the effect of class size on achievement, while holding many other important factors constant.

Figure 1.—Relationship Between Achievement and Class Size (Data Integrated Across Approximately 100 Comparisons From Studies Exercising Good Experimental Control).



Source: Glass, G. V. and Smith, M. L. Meta-Analysis of the Search on the Relationship of Class Size and Achievement. Far West Laboratory of Educational Research and Development, San Francisco, CA , 1978.

Figure 2. Modified Glass and Smith graph.



Larkin and Keeves (1984) described their variables as either belonging to a structural or a process dimension. Class size, teacher training and experience, student socioeconomic status (SES), and amount of time each student spends on homework, are structural variables. Process factors are centered around the various types of interactions that occur between the teacher and the student in a given classroom. Larkin and Keeves' (1984) initial correlation between achievement and class size was positive, which contradicted the meta-analysis of Glass and Smith (1978). One way of explaining this outcome was that SES was also positively correlated with class size, indicating that, for the most part, more able students were being placed in larger classes. These simple correlations, while interesting, do not explain the interaction of the various factors.

In light of Glass and Smith's study (1978) the results of Larkin and Keeves (1984) are surprising. It appears that after controlling for the presence of prior achievement, SES, classroom practices, student attitudes, and other independent measures, larger classes showed enhanced achievement levels. On the average students in larger classes also experienced greater educational and occupational aspirations, and these enhanced aspirations contributed to the higher average achievement. While these results may seem shocking at first, they can be partially explained by the finding that classroom practices did not vary greatly with class size. Teachers do not often have the training necessary to exploit the opportunities presented by smaller classes (Shapson, et al., 1980). Larkin and Keeves (1984) reached similar conclusions in their study.

Even if teachers were not using different instructional strategies in the smaller classes, how can we explain the achievement gains in the larger classes? In the larger classes the mean achievement did increase, but the divergence in the scores between the higher ability and lower ability students also increased. The smaller classes produced more equal educational outcomes, but a lower average achievement. Because regression analysis is based on the variability in a certain group of scores, the increased variability in the larger classes helps to strengthen the regression coefficient. There may also be some types of student-student interactions occurring in the larger classes (possibly increased competition) that are related to the enhanced aspirational and achievement outcomes (Larkin and Keeves, 1984).

Although Larkin and Keeves (1984) reported that, in general, classroom practices were not altered as class size decreased, their study uncovered some interesting attitudinal relationships. Among the strongest predictors for positive attitudes in math and science were the amount of positive support, time spent on homework, the amount of laughter, and the number of invitations for students to participate or inquire. They found that time spent on mathematics, time spent on

writing, number of invitations for students to participate, inquiry into academic work, and consideration of work habits all predicted enhanced achievement. Most people familiar with education will have no trouble inferring that, with the proper teacher training, methods enhancing school attitudes and achievement will be easier to introduce in smaller classes.

In another Australian study, Bourke (1986) proposed a model to help explain the relationship between class size, teaching practices, and student achievement. In this path-analysis model, school size, SES, student ability, and teacher experience were the exogenous (controlled) variables. When this path-analysis was run without teaching practices in the equation, the data indicated that reduced class sizes tend to predict increased achievement, supporting Glass and Smith (1978). With the complete model in use, including teaching practices, class size did not have any noticeable effect upon achievement, but reduced class size strongly influenced more supportive teaching practices. The increased use of effective teaching practices was a significant predictor of achievement, second only in importance to student ability.

Two of the general classroom processes that Glass and his colleagues (Glass, et al., 1982) felt would be potentially important were the rate of student engagement and individualization practices, but these were not found to have any significant effect on achievement in Bourke's (1986) work. However, Bourke did report that students in smaller classes were given more homework and had higher achievement. Homework has been shown by other researchers to be correlated with higher achievement (Keith, 1982; Shanahan and Walberg, 1985). Bourke (1986) also found that greater attention given students through questioning helped to increase educational achievement.

Mier (1984) focused her literature and policy review on the way in which class size influenced writing instruction and achievement. Class environment is a key element in both pre-writing discussion and peer editing of earlier drafts. Teacher-student contact helps students to understand that writing is an interactive process. When class size becomes too large, this type of interaction is difficult or impossible (Mier,1984). Research suggests that in order to become better writers, students must write more often and at greater length then they do now (Mier, 1984).

Most teachers meet with five classes daily with 25 or more students in each class. If they assign one writing assignment to each student per week, then the instructor will spend a minimum of 20 hours per week correcting papers. Mier infers that lowering class size should increase student's writing achievement, in light of the close functional relationship between class size, workload, and writing instruction. As a result of this research, the National Council of Teachers of English has recommended that

secondary-level English teachers have no more than 4 classes per term with 25 or fewer students per class. For elementary teachers involved with writing instruction, the council recommends that classes should not exceed 25 students (Mier, 1984).

Implications

Teachers commonly see class size as a key indicator of the quality of the work environment, which in turn influences job satisfaction and perceptions of job effectiveness. In a 1969 NEA survey, teachers ranked class size as their second largest source of problems, and the Queensland Teachers Union found that class size did affect workload and, consequently teacher job satisfaction (Larkin and Keeves, 1984). Shapson, et al. (1980) also found that teachers believe that their experiences in smaller classes are better. These results seem obvious. If teachers are asked if they feel better about small or large classes, the majority will likely choose smaller classes. However, in one study where three teacher efficacy measures were correlated with class size, no clear pattern emerged (Fink, 1988). It appears that teachers who are positive about being teachers will be so whether or not they are in small or large classes.

We are not trying to discount teachers' feeling about class size; we do not doubt that teachers prefer to work in smaller classes where they feel that they have more management control. But the question remains, will the majority of teachers change from the lecture style to teaching methods that can take advantage of reduced class sizes (Tomlinson, 1988)? Larkin and Keeves (1984) reported that many teachers failed to exploit the alleged opportunities available in smaller classes. It seems that only reducing class size does not necessarily result in dramatic changes in teacher behavior. They found that the teacher's own style is a more important determinant of classroom activities than class size (Larkin and Keeves, 1984). As mentioned previously, Bourke (1986) found that certain teacher behaviors related to achievement were easier to implement in smaller classes. The results of Bourke's study and others (Shapson, et al., 1980; Tomlinson, 1988; Mier, 1984) indicate that emphasis should be placed on providing teachers with training in instructional strategies most appropriate for a variety of class sizes.

Where does Maine stand?

Maine has one of the lowest average pupil-teacher ratios in the nation (see Table 1), with a ratio of approximately 15.5 pupils for each teacher (Tomlinson,1988). A pupil-teacher ratio that is based on the total number of students divided by the total number of instructional personnel in that same entity (school, school district, state)

produces an under-estimate because many instructional specialists are responsible for very few students. The more realistic figure of pupils per class is probably between 20-25 students in most, if not all, Maine schools. Maine is one of approximately 20 states that has adopted a maximum allowable class size ratio, with a 25:1 student-teacher ratio permitted in grades K-8, and 30:1 in grades 9-12 (Tomlinson 1988, M.R.S.A. Chap. 125, undated).

How much more do we need to reduce the size of our classes and can we afford to go much lower? Glass and Smith (1978) feel that while small class size is a desirable and effective pedagogic device, minor changes in the sizes of classes which commonly occur, do not produce significant effects. Using Glass and Smith's (1978) graph (see Figure 1), decreasing class size from 25 to 20 pupils would produce an increase in achievement by approximately two percentile ranks and decreasing class size from 25 to 15 students per class would likely result in an achievement increase of 6 percentile ranks. The costs that would accompany a 40% reduction in class size would be enormous, money that could likely be spent on more effective educational reforms.

Until the recent NEA push for 15 students per class, most educational researchers and teacher groups would have been happy with the present state of affairs. The N.Y. Teacher's Association in 1959 concluded that smaller classes would allow teachers to employ better teaching practices. They suggested an optimum class size of 25:1 (Tomlinson, 1988). As a matter of fact The PRIME TIME PROJECT in Indiana has reported noticeable improvement in achievement by lowering their class size from approximately 24 students to almost 19 per class. After controlling for IQ and matching control and experimental groups as carefully as possible, the PRIME TIME PROJECT reported statistically significant gains in achievement in the elementary grades (Swan, et al., 1985). We are already close to the 19:1 ratio here in Maine.

In an ideal world, every educator would desire small classes. Instead of fixing absolute numbers for every type of class, our efforts might prove more effective if we tried to lower class size in those subjects where high teacher - pupil contact rates are important and where there is a relatively high workload. Classes such as writing, foreign language instruction, art, and science laboratories would likely benefit from smaller classes, while the numbers in lecture type courses with high achieving students might be allowed to creep up. Implementing a flexible class size policy may be a politically difficult task to accomplish. The research does not appear to support the cost associated with an across-the-board reduction to 15 pupils per class. Smaller investments in other educational strategies may yield similar or greater achievement gains.

Table 1.--Pupil-teacher ratio and staff in public elementary and secondary schools: Fall 1986

State	Pupil-teacher ratio, fall 1986	Public school staff, fall 1986						
		Total	Teachers		Other staff1/		Administrative staff 2/	
			Total	Percent of total staff	Total	Percent of total staff	Total	Percent of total staff
United States	17.8	3/4,247,432	2,243,370	52.8	1,657,170	39.0	346,892	8.2
Alabama	19.8	70,907	36,971	52.1	30,862	43.5	3,074	4.3
Alaska	16.7	9,810	6,448	65.7	2,626	26.8	736	7.5
Arizona	18.4	56,207	29,104	51.8	20,384	36.3	6,719	12.0
Arkansas	17.5	46,372	24,944	53.8	17,930	38.7	3,498	7.5
California	23.0	385,244	190,484	49.4	150,936	39.2	43,824	11.4
Colorado	18.2	58,537	30,704	52.5	22,393	38.3	5,440	9.3
Connecticut4/	13.7	39,284	34,252	87.2	2,568	6.5	2,464	6.3
Delaware	16.0	10,597	5,883	55.5	3,836	36.2	878	8.3
District of Columbia .	14.3	11,945	5,984	50.1	5,007	41.9	954	8.0
Florida	17.5	177,639	91,969	51.8	77,750	43.8	7,920	4.5
Georgia	18.9	111,317	57,881	52.0	45,424	40.8	8,012	7.2
Hawaii	22.6	15,892	7,291	45.9	8,029	50.5	572	3.6
Idaho	20.4	16,039	10,234	63.8	4,566	28.5	1,239	7.7
Illinois	17.4	185,572	104,609	56.4	74,917	40.4	6,046	3.3
Indiana.....	18.3	104,482	52,896	50.6	46,993	45.0	4,593	4.4
Iowa	15.5	56,825	30,958	54.5	22,975	40.4	2,892	5.1
Kansas	15.4	47,227	27,064	57.3	16,227	34.4	3,936	8.3
Kentucky	18.6	67,721	34,507	51.0	26,359	38.9	6,855	10.1
Louisiana	18.5	88,591	42,929	48.5	38,603	43.6	7,059	8.0
Maine	15.5	22,966	13,685	59.6	6,548	28.5	2,733	11.9
Maryland	17.1	72,931	39,491	54.1	28,880	39.6	4,560	6.3
Massachusetts	14.4	101,905	58,066	57.0	33,958	33.3	9,881	9.7
Michigan	20.2	171,931	83,130	48.4	61,008	35.5	27,793	16.2
Minnesota	17.4	69,836	40,957	58.6	22,631	32.4	6,248	8.9
Mississippi5/	19.0	40,687	26,219	64.4	11,682	28.7	2,786	6.8
Missouri.....	16.4	91,609	48,902	53.4	37,864	41.3	4,843	5.3
Montana5/	15.6	12,613	9,818	77.8	2,119	16.8	676	5.4
Nebraska	15.1	31,576	17,748	56.2	10,758	34.1	3,070	9.7
Nevada5/	20.4	9,212	7,908	85.8	740	8.0	564	6.1
New Hampshire	15.9	18,352	10,300	56.1	6,797	37.0	1,255	6.8
New Jersey	14.7	139,541	75,558	54.1	44,314	31.8	19,669	14.1
New Mexico	19.0	28,548	14,876	52.1	11,860	41.5	1,812	6.3
New York	15.4	317,782	168,940	53.2	115,449	36.3	33,393	10.5
North Carolina5/	18.7	105,047	58,103	55.3	41,520	39.5	5,424	5.2
North Dakota	15.3	13,693	7,779	56.8	4,849	35.4	1,065	7.8
Ohio	18.1	182,796	98,894	54.1	68,136	37.3	15,766	8.6
Oklahoma	16.9	65,253	35,041	53.7	26,817	41.1	3,395	5.2
Oregon	18.3	46,598	24,615	52.8	18,106	38.9	3,877	8.3
Pennsylvania	16.3	197,861	102,993	52.1	76,043	38.4	18,825	9.5
Rhode Island	15.0	14,317	8,916	62.3	4,088	28.6	1,313	9.2
South Carolina	17.3	61,847	35,349	57.2	21,782	35.2	4,716	7.6
South Dakota	15.6	13,903	8,031	57.8	4,685	33.7	1,187	8.5
Tennessee	19.9	80,968	41,103	50.8	34,921	43.1	4,944	6.1
Texas	17.3	374,721	185,310	49.5	166,359	44.4	23,052	6.2
Utah	23.4	30,501	17,752	58.2	10,841	35.5	1,908	6.3
Vermont	...	(6/)	(6/)	(6/)	(6/)	(6/)	(6/)	(6/)
Virginia	16.8	108,455	58,141	53.6	45,314	41.8	5,000	4.6
Washington	20.5	65,955	37,065	56.2	23,588	35.8	5,302	8.0
West Virginia.....	15.3	41,653	22,931	55.1	15,221	36.5	3,501	8.4
Wisconsin	16.3	79,086	47,039	59.5	26,901	34.0	5,146	6.5
Wyoming	14.0	14,326	7,201	50.3	6,169	43.1	956	6.7

1/Includes guidance counselors, librarians, instructional aides, school and library support staff, and other support services staff.
2/Includes officials, administrators, and administrative support staff.
3/U.S. total includes imputations for Connecticut, Mississippi, Montana, Nevada, North Carolina, and Vermont, which are not reflected in State totals.
4/Support staff not reported.
5/Support staff underreported.
6/Data not reported.
---Data not available or not applicable.

SOURCE: U.S. Department of Education, Center for Education Statistics, "Common Core of Data" survey; and unpublished estimates. (This table was prepared January 1988.)

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