DOCUMENT RESUME

ED 129 594		SE 021 279
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TITLE	A Plan for Improving Mathematics Instruction in California Elementary Schools. Final Report of the Mathematics Education Task Force.	
INSTITUTION	California State Dept. of Education, Sacramento.	
PUB DATE	76	
NOTE	63p.	
AVAILABLE FROM	Publications Sales, California State Department of Education, P.O. Box 271, Sacramento, California 95802 ($1.25 plus 6% sales tax)	
EDRS PRICE	MF-$0.83 Plus Postage. HC Not Available from EDRS.	
DESCRIPTORS	*Educational Planning; Elementary Education; *Elementary School Mathematics; Instruction; *Instructional Improvement; Mathematics Education; Research; *Statewide Planning; *Surveys	
IDENTIFIERS	*California	

ABSTRACT

In a project designed to improve elementary school instruction in mathematics, the California Department of Education collected achievement and profile data from 67 elementary schools. Schools were classified according to size, socioeconomic status, minority representation and mobility of students, city size, and type of community. Profile data were related to instructional practice, teacher characteristics, leadership activities, and community involvement. Data were analyzed to identify profile elements which distinguished between high and low achievement schools in the same classification. These data affirmed 60 hypotheses whose implications are discussed in this document. These hypotheses led to plans for workshops in leadership training and for implementation workshops in the schools. The purposes, characteristics, and planning of these workshops are discussed. Appendices provide copies of the survey instrument, information on making school profiles, instruments for evaluating workshops, and transparency masters for use in workshops. (SD)

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A Plan for Improving Mathematics Instruction In California Elementary Schools

Final Report

CALIFORNIA STATE DEPARTMENT OF EDUCATION

A Plan for Improving Mathematics Instruction In California Elementary Schools

Final Report of the Mathematics Education Task Force

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This publication, which was edited and prepared in metric measure for photo-offset production by the Bureau of Publications, California State Department of Education, was published by the Department, 721 Capitol Mall, Sacramento, CA 95814.

Printed by the Office of State Printing
and distributed under the provisions
of the Library Distribution Act

1976

Copies of this publication are available for $1.25 each, plus 6 percent sales tax for California residents, from Publications Sales, California State Department of Education, P.O. Box 271, Sacramento, CA 95802. A list of other publications that are available from the Department, *Selected Publications of the California State Department of Education,* may be obtained by writing to the same address. Two other publications of particular interest to mathematics educators are *Mathematics Framework for California Public Schools* (1975) and *Inservice Guide for Teaching Measurement, Kindergarten Through Grade Eight: An Introduction to the SI Metric System* (1975). Both are available at $1.25, plus 6 percent sales tax for California residents.

Foreword

Although the subject of this publication is the improvement of elementary school mathematics, the underlying theme of the document is the achievement of excellence in education. Those in the Mathematics Education Task Force were asked to identify the features of successful mathematics programs in California. And they found out, as others have also discovered, that more than reform and innovation and money are needed to improve the quality of education. As vital as each of these may be to improved instruction, it takes people. It takes a commitment to excellence on the part of school administrators, teachers, parents, students, and the total community. Their willingness to work for excellence determines whether or not we make lasting improvements in the quality of education.

Excellence starts with all of us - with the standards we set for the performance of our duties and the standards we establish for student achievement.

We must take the lead in maintaining high qualifying standards for the job market and for higher education. We must lead the fight to establish relevant standards; then we must see that every student, minority or majority, rich or poor, goes to the labor market or the university qualified, not simply qualifiable.

Excellence depends upon our acceptance of responsibility for results for student outcomes.

Excellence depends upon our willingness to put the needs of the child before the needs of the profession or the institution.

If we want to restore excellence as the hallmark of our society, we must restore excellence as the hallmark of education.

Excellence, in the final measure, depends upon our willingness to be judged by the quality and effectiveness of our work.

If we are to have excellence, we should keep in mind these five actions which lead to improvement in the quality of education:

1. A conscious decision must be made to change - to improve the quality of education; but it must not be change simply for change's sake.
2. Responsibility for action must be identified.
3. Priorities must be established.
4. Those procedural and attitudinal changes that make a difference must be found and grouped within an appropriate framework of goals, with provision made for monitoring and evaluating the results of our actions.
5. There must be a commitment to excellence on the part of everyone who is involved in education—the taxpayers who provide the resources, the legislative bodies that allocate those resources, the policy-making bodies, the administrators, the teachers, the parents, *and the students.* Everyone of us must care about excellence.

The members of our Mathematics Education Task Force have developed a unique tool that will help you who are involved in mathematics programs bring about improved quality in your classrooms. I encourage you to take advantage of this plan for improving elementary mathematics programs.

5

In about 42 B.C., Publilius Syrus said, "It takes a long time to bring excellence to maturity." But neither we nor our children will understand or appreciate the benefits of that maturity if we never take the time to search for excellence if we never take the time to give a deeper, higher meaning to our lives.

Wilson Riles

Superintendent of Public Instruction

Preface

In 1973 the California Legislature responded to public concern about declining scores in mathematics achievement. It instructed the Department of Education to conduct a study identifying the salient characteristics of successful mathematics programs in California elementary schools and to disseminate the results to all elementary schools in the state. The empirically derived results of the study were to be incorporated into elementary school mathematics programs so that pupil achievement in mathematics would be improved.

The Department referred the legislative mandate to the Department's Mathematics Education Task Force. The Task Force attempted to identify the characteristics of successful mathematics programs by observing what certain high-achieving elementary schools do that certain low-achieving schools fail to do and vice versa. Then the Task Force examined the characteristics by type of school, using basic demographic variables that might interact with the characteristics. Finally, it developed an implementation plan that would allow a close examination of the results of the study and provide opportunities for implementation at the school and classroom level.

The members of the Mathematics Education Task Force conducting the study were Robert Tardif (Manager), Joseph Hoffmann, Delmer Lansing, and Fred Lorenzen. Valuable assistance was provided to the Task Force by Leonard Marascuilo, University of California, Berkeley, and several mem' s of the Office of Program Evaluation and Research, State Department of Education.

Special commendation is due to the hundreds of teachers and principals in the 67 sample schools in which the Task Force conducted its study. (These schools are listed on page vi.) Without their honest responses, this study would be worthless. Their honesty gives witness to the strength and vigor of the education profession and gives promise that the objectives of this study will soon be accomplished. This publication, *A Plan for Improving Mathematics Instruction in California Elementary Schools*, should be a valuable aid in attaining those objectives.

WILLIAM E. WEBSTER
Deputy Superintendent
for Programs

J. WILLIAM MAY
Assistant Superintendent
and Director, Office of Curriculum Services

7

Elementary Schools Sampled in Mathematics Study

Ada S. Nelson Elementary School, Whittier
Avalon Gardens Elementary School, Los Angeles
Barnard Elementary School, San Diego
Bennett Valley Elementary School, Santa Rosa
Broad Avenue Elementary School, Wilmington
Buena Vista Elementary School, Walnut Creek
Cajon Park Elementary School, Santee
Carlton Hills Elementary School, Santee
Carrisa Plains Elementary School, Santa Margarita
Castle Heights Avenue Elementary School, Los Angeles
Centralia Elementary School, Anaheim
Cogswell Elementary School, El Monte
Crescent Elk Elementary School, Crescent City
David Reynolds Elementary School, Fremont
Del Mar Elementary School, El Cerrito
Diamond Heights Elementary School, San Francisco
Fair Oaks Elementary School, Sunnyvale
Fieldbrook Elementary School, Arcata
Florence E. Flanner Elementary School, La Puente
Franklin Avenue Elementary School, Los Angeles
Franklin Elementary School, Anaheim
Grand Oaks Elementary School, Citrus Heights
Hacienda Elementary School, La Habra
Jackson Elementary School, San Diego
Kathryn Hughes Elementary School, Santa Clara
King Elementary School, Long Beach
Laguna Road Elementary School, Fullerton
Langdon Avenue Elementary School, Sepulveda
La Tijera Elementary School, Inglewood
Lichen Elementary School, Citrus Heights
Linda Verde Elementary School, Lancaster
Lockhurst Drive Elementary School, Woodland Hills
Loma Vista Elementary School, Whittier
Los Alamos Elementary School, Los Alamos
Lyndale Elementary School, San Jose
Magnolia Elementary School, Redding
Manchester Elementary School, Fresno
Marion Elementary School, Novato
McCandless Elementary School, Redondo Beach
Mendocino Elementary School, Mendocino
Miller Elementary School, Escondido
Murwood Elementary School, Walnut Creek
Oso Avenue Elementary School, Woodland Hills
Overland Avenue Elementary School, Los Angeles
Palo Verde Elementary School, Palo Alto
Paradise Elementary School, Modesto
Rhoda Street Elementary School, Encino
Richmond Street Elementary School, El Segundo
Riley Elementary School, San Diego
Rio Vista Elementary School, North Hollywood
Round Valley Elementary School, Bishop
San Pasqual Elementary School, Escondido
Santa Lucia Elementary School, Cambria
Santa Monica Boulevard Elementary School, Los Angeles
Shepherd Elementary School, Hayward
Skycrest Elementary School, Citrus Heights
Spreckels Elementary School, Spreckels
Twin Hills Elementary School, Sebastopol
Vallemar Elementary School, Pacifica
Victorine Klein Elementary School, Mountain View
Vista Mar Elementary School, Daly City
Warner Elementary School, Warner Springs
Washington Elementary School, San Gabriel
Waugh Elementary School, Petaluma
West Hollywood Elementary School, West Hollywood
Westmont Elementary School, Pomona
Westwood Elementary School, Santa Clara

8

Contents

Chapter 1 Introduction to the Study

In the past decade substantial criticism has been directed against mathematics education. Many persons have written and telephoned their complaints about "modern math" programs to members of the California State Department of Education and the California Legislature as well as to editors of newspapers and periodicals. In response to the public concern about the quality of mathematics programs, the California Legislature in 1973 authorized increased funding for the mathematics unit of the State Department of Education and directed the Department to identify those features of school mathematics programs which account for pupil success.

The Department of Education assigned this task to a newly created Mathematics Education Task Force, a Department unit consisting of four consultants. The task force was instructed to design a study that would reveal the information requested, conduct the study, and report the findings. It was further stipulated that the report of the study should be suitable for immediate use by individual teachers in developing programs for the improvement of mathematics instruction.

Rationale for the Study

Some research studies conducted prior to the study described in this report were designed to identify mathematics programs that had demonstrated pupil success. As a result several attempts were made to transplant "successful" programs into other settings. Unfortunately, the transplanted programs were found to be unsuitable when certain questions were asked:

Do the teachers play an important role in selecting the new program?
Does the program meet the special needs of pupils and teachers in the school?
Do teachers believe the program will succeed?
Do teachers have a personal (or emotional) investment in making the program work?

It was the position of the Mathematics Education Task Force that inattention to such questions was sufficient to jeopardize even the best efforts in program development in mathematics. Therefore, the study was conducted to equip teachers with program development information that teachers could readily manipulate and incorporate into a mathematics program. With the control of program development in the hands of teachers, the responsibility for creating the best possible programs would be theirs also.

Method of Research

The orientation of this publication and the study reported in it is to provide information useful in the development of mathematics programs that are likely to produce pupil success. The definition of an *instructionl program* as used in the research project is as follows:

> An *instructional program* is the entire set of events that lead up to and include the actual learning experience of pupils in the classroom. Thus, an instructional program includes the following: the styles and strategies of the teachers and the school administration; the instructional leadership that influences classroom instruction and management; the concern and planning related to pupil-teacher interactions; the nature of parent/community support for the school program; the quality and use of instructional materials, support materials, and media; and the climate in the classroom.

The research was conducted in 67 public elementary schools in California during the spring of 1974 by the members of the Mathematics Education Task Force. The sample schools were broadly representative in several demographic variables such as school size, ethnic characteristics, and the mean socioeconomic status of the school population. Half of the target schools had exhibited a pattern of high achievement in mathematics, and the other half had exhibited a pattern of low achievement.

The researchers spent at least a full day at each school site observing the ongoing program, interviewing teachers and principals, and securing and arranging for the acquisition of data on the entire school mathematics program. In essence the aggregate of data for all schools (about 500 pieces of data on each school) was utilized to test an extensive array of hypotheses about the importance of certain program-related variables. Statistical treatment of the data allowed the identification of 60 hypotheses most related to pupil success. Those hypotheses constitute the essence of this report.

Although the hypotheses may be referred to as recommendations for program development, they are still hypotheses; i.e., scientific guesses about those variables which seem best to account for successful achievement patterns in California elementary schools. Nevertheless, in the hands of teachers and program developers, the hypotheses represent a scientific base for designing or revising successful school mathematics programs.

Chapter 2 Research Activities

The Department of Education study was designed to identify in elementary mathematics programs those salient program characteristics that account for consistently low test performance. In a previous study conducted by the Department, grade levels at which deficiencies in mathematics achievement first appeared were identified, as were the specific content areas that accounted for the deficiencies.[1] In that study the *Comprehensive Tests of Basic Skills (CTBS): Arithmetic* and the *Sequential Tests of Educational Progress (STEP II): Computation Subtest and Basic Concepts Subtest* were administered to 3000 pupils in classes selected by a stratified random sampling scheme from grade levels four through eight. The findings of the study indicated that deficiencies in achievement appeared as early as grade four but were more intensified in grades five through eight than in grade four.

Research Strategy

The mathematics section of the *Comprehensive Tests of Basic Skills* was the measurement instrument selected to gauge the pupils' mathematical skills and concepts, as prescribed for instruction in the *Mathematics Framework for California Public Schools.*[2] The results of the *CTBS* tests administered to all sixth graders in each of the previous four years were assumed to be adequate indicators of achievement strength and weakness. Using three year-to-year differences in *CTBS* mean raw scores for schools over a four-year period, the researchers found that all the schools in the study fell into one of the categories which were established to suggest the quality of mathematics programs:

1. Three increases in mean raw scores
2. Two increases and a net increase overall (from the first year to the fourth)
3. One increase and a net increase overall
4. Two increases and a net decrease overall
5. One increase and a net decrease overall
6. No increase

The target schools in the study were sampled from two groups of schools:

1. *High test-performance schools:* (a) the upper 15 percent of all schools for 1969 1972 (categories 1 through 6); and (b) the upper 50 percent of all schools in 1972 that achieved a net increase in raw scores greater than six points (categories 1 through 3)
2. *Low test-performance schools:* (a) schools with one increase and a net decrease greater than 14 points (category 5); and (b) schools with no increase and a net decrease greater than 10 points (category 6)

The use of trends in *CTBS* scores for identifying target schools is justifiable because a trend over four years could indicate either a concerted effort for improvement or a consistent lack of program success. The use of the results of a single testing of groups of pupils would have provided a less reliable indication of program success.

The study did not attempt to evaluate *all* of the goals in mathematics that should be achieved by California pupils. For example, it would have been difficult to use simple test-score trends to assess the ability of pupils to apply mathematical skills in real-life situations, long-term retention, desire to learn independently, or similar goals. However, *CTBS* scores did provide a reliable indication of the mathematical skill under investigation in this study; namely, *computational skill.* The definition of high-performance mathematics programs used in the study must therefore by interpreted in this restricted perspective because 48 of the 98 *CTBS*

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[1] *Final Report of the Special Mathematics Achievement Study.* Prepared by the Office of Program Evaluation and Research. Sacramento: California State Department of Education, 1973.

[2] *Mathematics Framework for California Public Schools: Kindergarten Through Grade Twelve.* Sacramento: California State Department of Education, 1975.

test items were purely computational. In that sense the *CTBS* mathematics test measured computational ability well.

Selection of Sample Schools

A total of 72 schools representing a wide range of demographic characteristics were selected for the research sample. The basic demographic characteristics used for categorizing the sample schools were (a) socioeconomic status; (b) minority representation; and (c) school size (enrollment).

Schools that were determined to be alike for all three of these characteristics were compared. They were judged to be similar for a characteristic if they were in the same third of the distribution of that characteristic value for the sample schools. After the schools had been selected, they were classified further on the basis of three more demographic variables to provide a more complete description of each school. These three variables were (a) city size (population); (b) type of community (environment); and (c) pupil mobility.

The first three variables were used in the original sample selection in a way that minimized interdependence among the variables. Specifically, the schools were divided into three levels for each of three variables so that 27 categories of schools resulted. For example, one category contained schools in communities that ranked *low* in socioeconomic status, minority representation, and school size (enrollment). Another category contained schools in communities that ranked *medium* in socioeconomic status and low in minority representation and enrollment. Finally, a third category was composed of schools in communities that ranked *high* in socioeconomic status and low in minority representation and enrollment. Within each group, two of the schools were randomly selected for the high-performance sample and two for the low-performance sample. It is this pairing of similar schools that is the basis of this study.

The 72 sample schools were selected from the 27 categories, and the last three variables were imposed on these schools after the selection. No guarantee of the independence of these variable groups was present. To have categorized the schools on all six variables prior to selection would have produced 3^6, or 729 categories, many of which would have contained only one school. Five schools were dropped from the study because of time limitations and scheduling difficulties. A total of 67 schools were examined as a research sample.

Characteristics of Sample Schools

Each group of schools was represented by a profile based on the six variables, and the majority of California elementary schools could compare with at least one profile. Each profile provided the basis for a separate analysis because the important characteristics that might discriminate between high and low schools in one profile might be insignificant in another. The following are detailed descriptions of the demographic factors used to describe and categorize the pool of sample schools.

Socioeconomic Status

An estimate of the socioeconomic status of each sample school community was undertaken by the one individual who was probably the best qualified for the task—the teacher. The estimates were made when all California public school pupils in grades two and three were being tested in reading as part of the California Assessment Program.[3] Each pupil's answer sheet was marked by that pupil's teacher for background information, including socioeconomic status. The teacher chose one of the following as indicating the family background of the pupil:

1. Executives, professionals, and managers
2. Semiprofessionals, clerical and sales workers, and technicians
3. Skilled and semiskilled employees
4. Unskilled employees (and welfare recipients)
5. Unknown

The five choices were condensed to three levels for statistical analysis:

Level one—choices 4 and 5

Level two—choice 3

Level three—choices 1 and 2

A single statistic for the socioeconomic variable was obtained for each school by computing the mean for the three levels in the item. The range of the variable had a minimum of 1.00 and a maximum of 3.00. For the purpose of dividing the total sample into three levels with approximately the same number of schools in each level, the limits of the variable were set as shown in Table 1 (see also Figure 1).

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[3] *Profiles of School District Performance, 1973-74.* Prepared by the Office of Program Evaluation and Research. Sacramento: California State Department of Education, 1974.

TABLE 1

Distribution of School Enrollments by Socioeconomic Status

Group	Limits	Sample schools		Responding elementary schools	
		Number	Percent	Number	Percent
Low	1.00–2.08	23	34.3	2258	46.9
Medium ...	2.09–2.40	22	32.8	861	17.9
High	2.41–3.00	22	32.8	1696	35.2
Total		67	99.9	4815	100.0

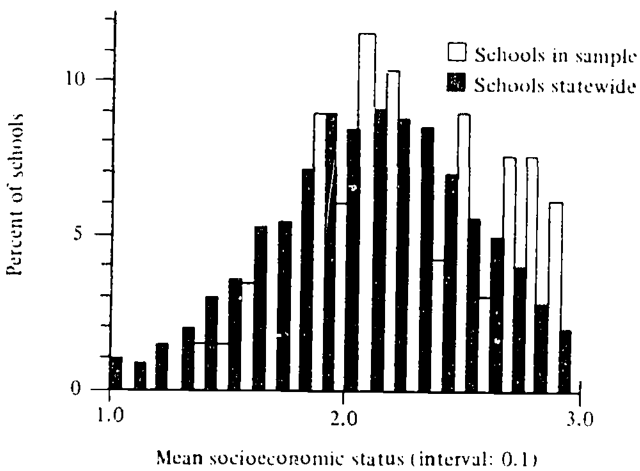


Fig. 1. Graphic distribution of school enrollments, by socioeconomic status

Minority Representation

Minority representation was determined for each school from the ethnic school survey which was administered in all California public schools in 1972, one year prior to the mathematics study reported in this publication. In the survey each principal reported the number of the school's pupils from each of the following ethnic groups: Asian, black, Chicano, Native American, and white and other.

By the use of the data provided by school principals, the total percent of nonwhite pupils was ascertained for the schools. The schools were then divided into three groups according to their minority representation as shown in Table 2 (see also Figure 2).

School Size

The school size (enrollment) for each school was taken from the elementary school questionnaire as reported by school principals to the State Department of Education in the fall of 1972, one year prior to the study described in this report. An on-site examination of enrollment at the sample schools revealed some discrepancies between the enrollments reported and the enrollments observed. However, the discrepancies were in no case large enough to change the classification of a sample school. The distribution of schools by school size is presented in Table 3 (see also Figure 3).

City Size

City size (population) for each school in the research project was determined at the time of the

TABLE 2

Distribution of School Enrollments, by Minority (Nonwhite) Composition

Group	Limits (percent)	Sample schools		Responding elementary schools	
		Number	Percent	Number	Percent
Low	0–9	22	32.8	760	25.2
Medium ...	10–28	24	35.8	1145	37.9
High	29–100	21	31.3	1116	36.9
Total		67	99.9	3021	100.0

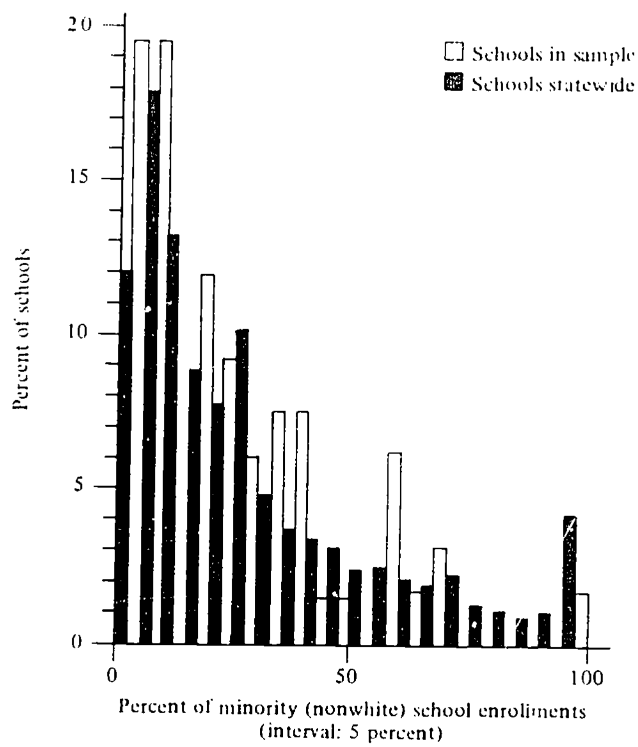


Fig. 2. Graphic distribution of school enrollments, by minority (nonwhite) composition

TABLE 3

Distribution of Schools, by Size of School

Group	Limits	Sample schools		Responding elementary schools	
		Number	Percent	Number	Percent
Low	31 349	23	34.3	2099	29.2
Medium ...	350 560	22	32.8	2149	29.9
High	561 1298	22	32.8	2942	40.9
Total		67	99.9	7190	100.0

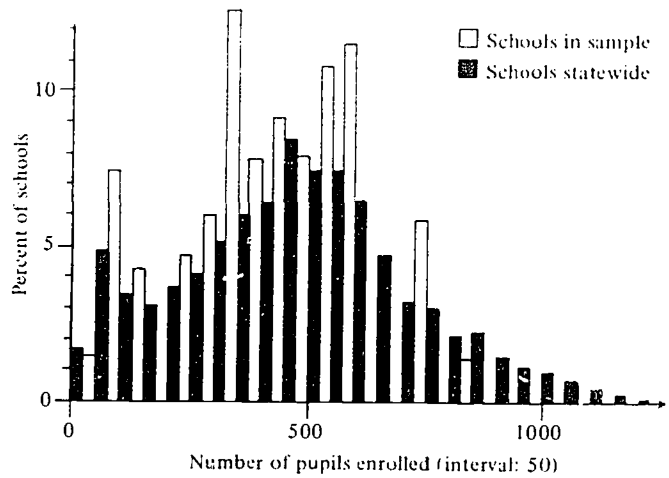


Fig. 3. Graphic distribution of schools, by size of school

visit to the school. The information was recorded during the interview with the principal and was later modified as necessary after all the data had been examined. The city size categories were *small city* (or *noncity*), *medium city*, and *large city*. For geographically isolated cities and towns, the category distinctions were based on simple population statistics. When two or more cities were clustered geographically, the observer had to make a subjective choice on the basis of apparent commercial and political spheres of influence. The population of the surrounding area was used to determine city size if any one of the following three conditions was applicable:

1. The school district boundaries included the surrounding area.
2. Some connecting streets were nonrural; i.e., commercially or residentially developed.
3. The city administrative bodies were interdependent.

Examples of the city size categories of some of the schools in the study are as follows:

Small city (or noncity)—less than 50 000
- Crescent City
- Arcata-Eureka (area)
- Santee-El Cajon (area)
- Escondido-San Marcos (area)
- Santa Rosa
- Pacifica

Medium city—50 000 to 200 000
- Citrus Heights-Carmichael-Orangevale (area)
- San Gabriel-Alhambra-Monterey Park (area)
- Fresno

Large city—over 200 000
- Inglewood-Lennox-Hawthorne (area)
- Anaheim-Fullerton-Buena Park (area)
- San Jose
- San Diego
- San Francisco
- Los Angeles

The distribution of sample schools by city size is shown in Table 4.

TABLE 4

Distribution of Sample Schools, by Size of City

Group	Limits	Sample schools	
		Number	Percent
Low	Less than 50 000	27	40.3
Medium	50 000 200 000	14	20.9
High	Over 200 000	20	29.9
Total		61[a]	91.1

[a]Of the 67 schools in the sample, six were not categorized by city size because of insufficient information.

Type of Community

The type of community surrounding each school in the study was recorded by the observer during the interview with the school principal. Two of the following three descriptions could be chosen by the interviewer:

Type 1 (low)—rural, farming
Type 2 (medium)—suburban, residential
Type 3 (high)—inner city, commercial, industrial

So that the size of each of the three groups in the sample could be made as similar as possible, the definition of Type 2 schools, the largest group, was narrowed. If the school's geographic community contained any rural or farming property, regardless of the extent of residential or industrial development, the community was categorized as Type 1. If there were no local farming property, then it was classified as Type 2 or Type 3, depending on the nature of the commercial development in the community. Type 3 was chosen when the following features characterized the community:

1. Old apartment, commercial, or industrial buildings (more than 40 years old)
2. Low-income or substandard dwellings
3. Predominantly commercial-zone property

The distribution of sample schools by type of community is shown in Table 5.

TABLE 5

Distribution of Sample Schools, by Type of Community

Group	Limits	Sample schools	
		Number	Percent
Low	Rural/farming	18	26.9
Medium	Suburban/residential	29	43.3
High	Inner city/ commercial/ industrial	15	22.4
Total		62[a]	92.6

[a]Of the 67 schools in the sample, five were not categorized by type of community because of insufficient information.

Pupil M[illegible]

A pup[illegible] mobility index for each school was computed from data collected at the time of the visit by the observer. The principal (or, in most cases, the secretary) of each school gave the number of pupils added to the enrollment between October 1, 1973, and May 1, 1974, and the number deleted during the same period. The mobility index was then derived by dividing the sum of these two numbers by the actual enrollment on October 1. All mobility indices were divided into three groups of approximately the same size as those shown in Table 6.

TABLE 6

Distribution of Sample Schools by Mobility Index

Group	Limits	Sample schools	
		Number	Percent
Low	0–22	17	25.4
Medium	23–37	17	25.4
High	Over 37	16	23.9
Total		50[a]	74.7

[a]Of the 67 schools in the sample, 17 were not categorized by mobility index because of insufficient information.

Research Instruments

Several instruments were devised to assess the characteristics of the mathematics programs in the sample schools. The instruments included an anonymous teacher-principal opinionnaire, a teacher interview guide, a principal interview guide, and two classroom observation inventories. The principal's interview included factual and policy items pertaining to the curriculum, the school, the staff, the district, and the community. The teacher's interview involved items pertaining to attitude, training, pedagogical tactics, instructional support materials, testing, and classroom climate. (See Appendix A.)

The teacher observation procedure involved a meeting with the teacher or team leader before a scheduled class period to ascertain general information about the lesson to be taught and then a series of five-minute observations of the class. A five-minute interval occurred between observation sessions. A meeting after the class with the teacher concluded the series of interviews and observations.

Chapter 3 Verification of Hypotheses

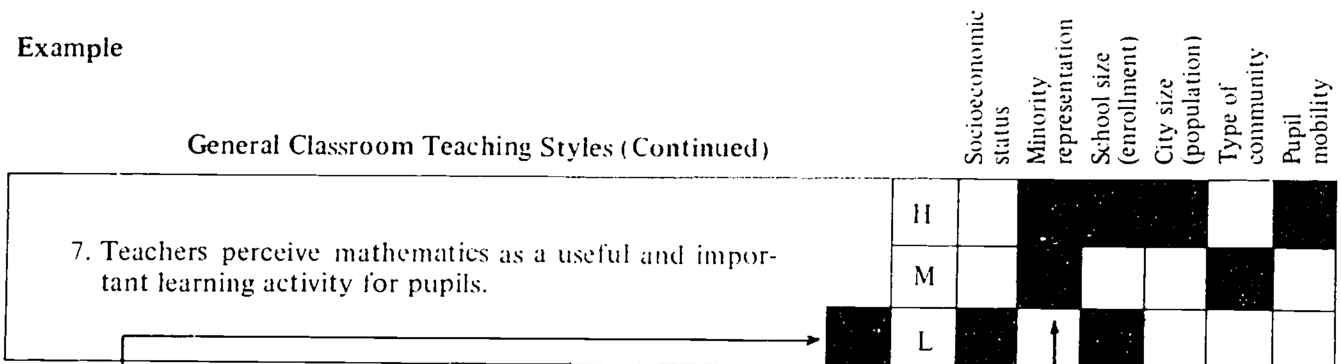
No absolute rules exist for successful teaching—only hypotheses about what works best. Educators must form hundreds of hypotheses daily in planning lessons and teaching; these hypotheses involve all aspects of the instructional program. In the research study analyzed in this report, pedagogical hypotheses were devised and categorized as follows:

1. General classroom teaching styles
2. Specific teaching techniques
3. Instructional materials
4. Teacher/pupil interactions
5. Instructional leadership
6. Parent/community involvement

Most teachers' hypotheses are never articulated explicitly; nevertheless, educators hope that their hypothetically based actions will result in pupil achievement. The implicit form of each hypothesis used in the study is that *pupils tend to exhibit higher achievement patterns if action X occurs.*

Hundreds of hypotheses were considered by the researchers and were exposed to verifications in the sampling of schools. The study was based on the assumption that an hypothesis is verified and generalized if it is used more frequently in schools with high pupil achievement than in schools with low pupil achievement.[4] It was further supposed that the hypotheses would be verified for some types of schools and not for others. Each hypothesis accordingly has been identified for the categories of schools for which it has been verified. Each hypothesis has also been identified to indicate whether it has been verified for all schools in general. The analyses of all the hypotheses led to verification of 60 hypotheses for three or more school demographic characteristics.

The absence of a black square in one of the cells does *not* imply that the characteristic was unimportant in a particular type of school. Rather, there was apparently so little difference in the use of this characteristic by high- and low-achieving schools that it had no effect on achievement.



This black square indicates that the program feature described by this hypothesis was a significantly more frequent element of programs in high-achieving schools than in low-achieving schools regardless of the background characteristics of the school.

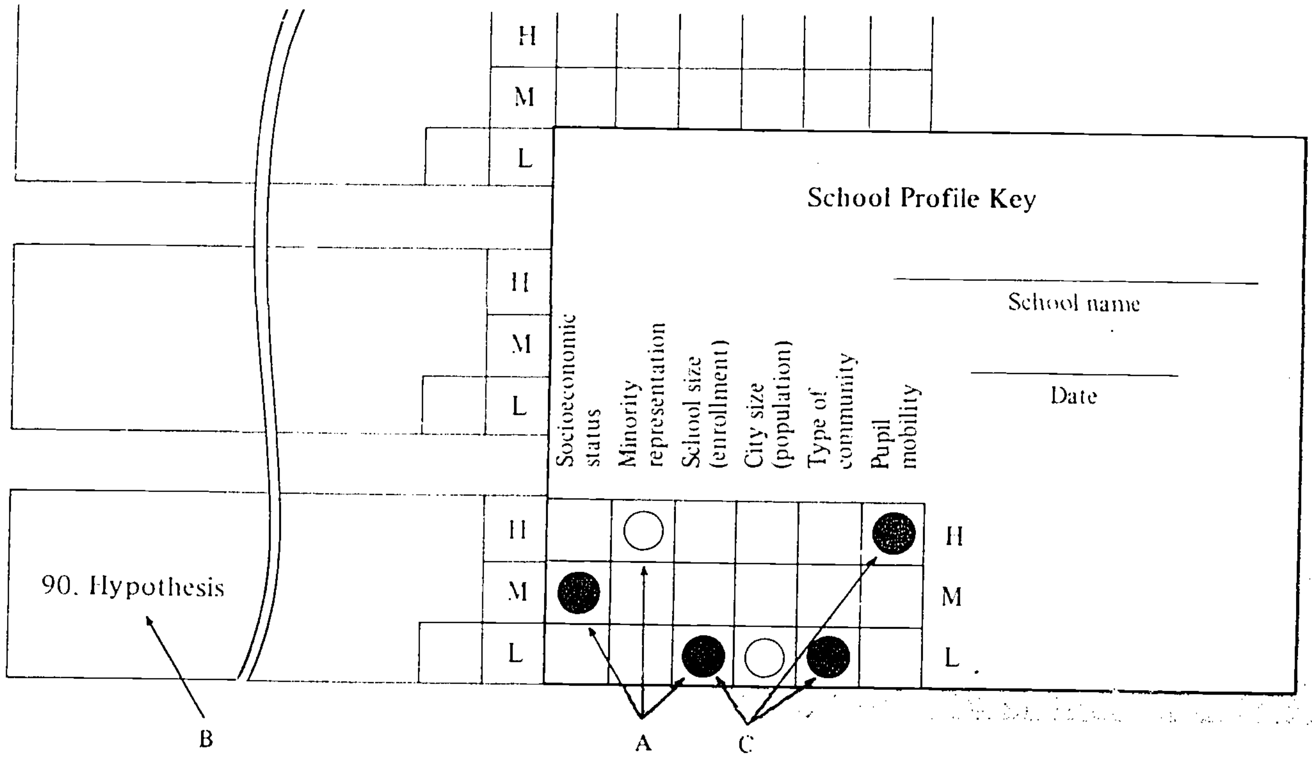
This black square indicates that in schools in which pupils from minority groups constitute between 10 and 28 percent of the school population, high-achieving schools exhibited the program feature described by the hypothesis significantly more than did low-achieving schools.

[4] A 90 percent confidence interval was used for significance testing. The researchers wished to include all hypotheses that held promise for improving programs and to have hypotheses submitted for experimental testing later.

Use of the School Profile Key

A printed card is provided with this report so that the results can be easily analyzed and hypotheses applied to each school. You will need a paper punch to make the key operational.

Each school will have a unique "profile," and one key should serve the entire staff in a school. However, additional keys can be produced from 3 x 5-inch cards.



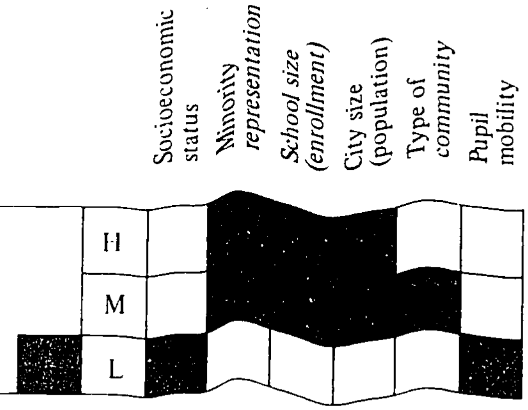
A. Punch holes in the appropriate boxes for your school according to the definitions of the demographic variables. (In borderline cases punch two holes.)

B. Place the key over the corresponding part of any item identified in the study.

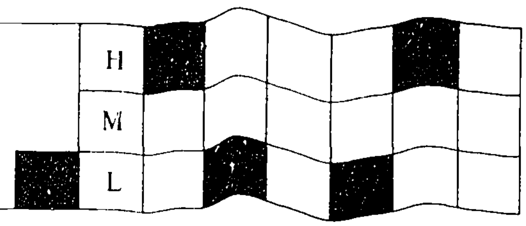
C. Note how many holes in the key are superimposed over a black square. A black square indicates that the item is a significant discriminator between high and low test performance schools for schools similar to yours. The more black squares revealed, the more important that item is to the improvement of the mathematics program in your school.

General Classroom Teaching Styles

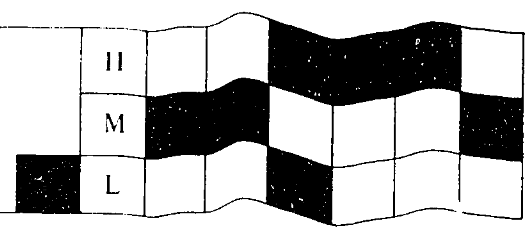
1. Discovery and inquiry are emphasized in teaching; limited use is made of "traditional" methods.



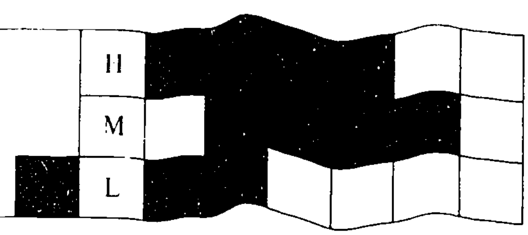
2. The teaching reflects "traditional" concerns; limited use is made of discovery and inquiry techniques.



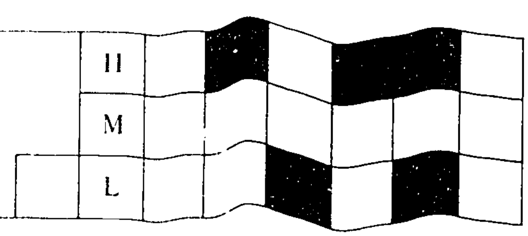
3. Learning activities make provisions for participation by all pupils; i.e., activities which appeal to a variety of interests and abilities.



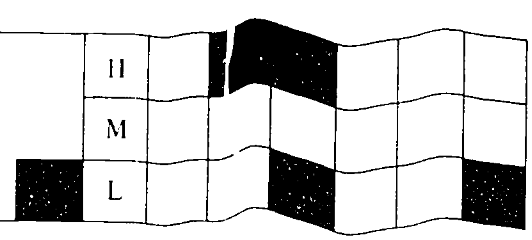
4. Mathematics lessons are prepared thoroughly.



5. The improvement of pupil attitudes is a major emphasis in classroom teaching.



6. The faculty recognizes, discusses, and attempts to remedy disruptive pupil behavior.



General Classroom Teaching Styles (Continued)

Item		Level	Socioeconomic status	Minority representation	School size (enrollment)	City size (population)	Type of community	Pupil mobility
7. Teachers perceive mathematics as a useful and important learning activity for pupils.		H		■	■	■		■
		M		■			■	
	■	L	■		■			
8. The teaching focuses on the content of mathematics.		H						
		M					■	■
	■	L				■		
9. The learning of computational skills and concepts is valued highly and is emphasized as an important goal.		H		■	■			
		M					■	■
	■	L	■	■	■	■	■	
10. The teaching activities allow pupils to refine their understanding of concepts, and a convergent mode of thinking is used.		H		■	■			
		M			■		■	■
	■	L	■					
11. The classroom activities are managed in a way that promotes orderly and quiet pupil behavior.		H		■		■		
		M			■			
	■	L						
12. A classroom esprit de corps is promoted so that pupils take pride in their behavior and achievement.		H	■	■				
		M						
		L	■	■		■	■	

Specific Teaching Techniques

13. Instruction is activity-centered, and techniques such as games, learning centers, and active learning situations are used.

			Socioeconomic status	Minority representation	School size (enrollment)	City size (population)	Type of community	Pupil mobility
		H			■	■		■
		M				■	■	
	■	L						

14. Learning assignments are differentiated for the particular needs of individual pupils.

			Socioeconomic status	Minority representation	School size (enrollment)	City size (population)	Type of community	Pupil mobility
		H						■
		M						
		L			■	■		

15. The teacher diagnoses, understands, and acts upon each pupil's learning difficulties.

			Socioeconomic status	Minority representation	School size (enrollment)	City size (population)	Type of community	Pupil mobility
		H		■				
		M	■	■			■	
	■	L				■		■

16. Pupils are involved in planning their own activities.

			Socioeconomic status	Minority representation	School size (enrollment)	City size (population)	Type of community	Pupil mobility
		H		■	■	■		
		M		■		■	■	
	■	L	■					■

17. Pupils have opportunities to engage in independent learning projects.

			Socioeconomic status	Minority representation	School size (enrollment)	City size (population)	Type of community	Pupil mobility
		H			■	■	■	
		M				■	■	
	■	L		■				■

18. Stimulating learning activities are planned for pupils; e.g., game-like activities, fascinating materials, and lively discussions.

			Socioeconomic status	Minority representation	School size (enrollment)	City size (population)	Type of community	Pupil mobility
		H	■			■		
		M					■	
		L						

21

Specific Teaching Techniques (Continued)

19. Teachers use audiovisual materials or visual demonstrations in a formal classroom atmosphere.

		Socioeconomic status	Minority representation	School size (enrollment)	City size (population)	Type of community	Pupil mobility
	H	■	■				
	M						■
■	L	■	■	■	■		

20. The teacher gives clear verbal instructions in a well-controlled classroom atmosphere.

		Socioeconomic status	Minority representation	School size (enrollment)	City size (population)	Type of community	Pupil mobility
	H	■					
	M						■
■	L	■		■	■	■	

21. The instruction is based on intensive, responsive verbal presentations in which pupils are told specifically what they are expected to know.

		Socioeconomic status	Minority representation	School size (enrollment)	City size (population)	Type of community	Pupil mobility
	H		■				
	M			■	■	■	■
■	L	■	■				

22. The chalkboard is used frequently.

		Socioeconomic status	Minority representation	School size (enrollment)	City size (population)	Type of community	Pupil mobility
	H	■	■	■	■		
	M			■		■	■
■	L				■		

23. The overhead projector is used frequently.

		Socioeconomic status	Minority representation	School size (enrollment)	City size (population)	Type of community	Pupil mobility
	H					■	
	M						
■	L	■	■		■		

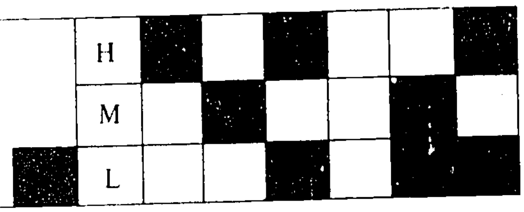
24. The teacher and aides (where available) supervise and tutor the pupils as they study.

		Socioeconomic status	Minority representation	School size (enrollment)	City size (population)	Type of community	Pupil mobility
	H						
	M		■		■	■	■
	L	■			■		■

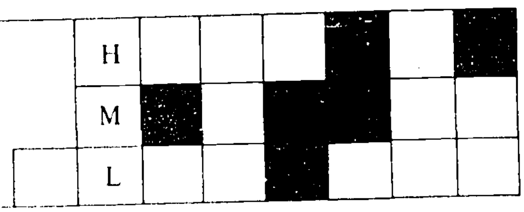
Socioeconomic status | Minority representation | School size (enrollment) | City size (population) | Type of community | Pupil mobility

Instructional Materials

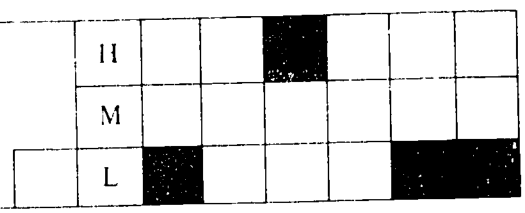
25. Teachers are given special training in effective techniques for presenting instructional materials.



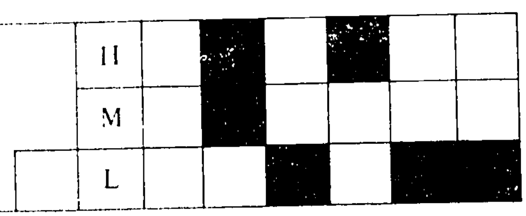
26. Assignments and directions are clear.



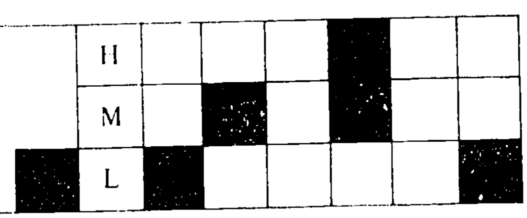
27. Additional instructional materials are acquired and used in the classroom.



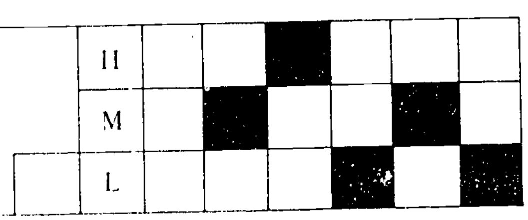
28. A broad range of audiovisual instructional materials are acquired and utilized in the classroom.



29. Teachers are encouraged to reduce dependence on textbook presentations.



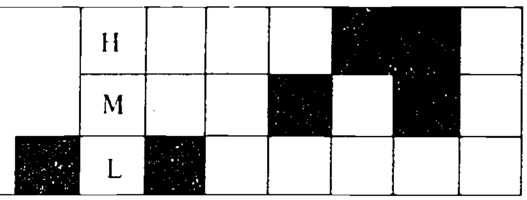
30. Manipulative aids are used in the learning of skills and concepts at all levels of ability.



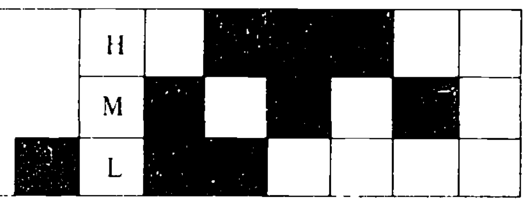
Socioeconomic status | Minority representation | School size (enrollment) | City size (population) | Type of community | Pupil mobility

Instructional Materials (Continued)

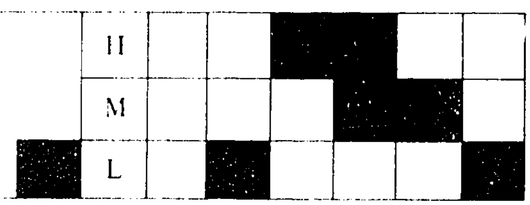
31. Mathematics is integrated with other subject areas.



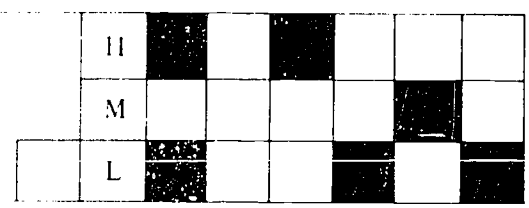
32. Pupils are allowed to accelerate individually or together to the next higher grade level of instructional materials.



33. Frequent enrichment instruction is provided for capable pupils.



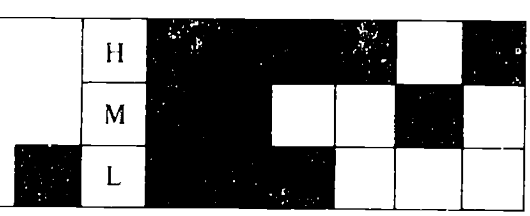
34. Mathematically gifted pupils explore abstract concepts, logic, and mathematical applications as part of their classroom learning.



35. A special mathematics program is offered to gifted pupils.

Teacher/Pupil Interactions

36. Teachers are aware of and are sensitive to the abilities, needs, and interests of individual pupils.

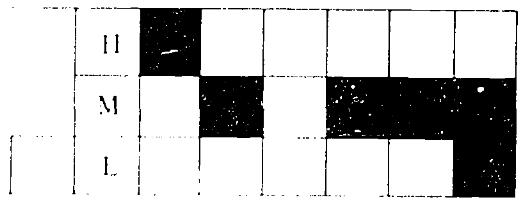


Teacher/Pupil Interactions (Continued)

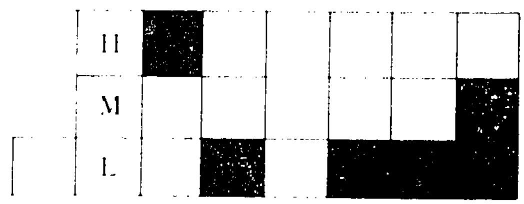
Socioeconomic status | Minority representation | School size (enrollment) | City size (population) | Type of community | Pupil mobility

37. Teachers have a positive feeling toward pupils and a feeling of being well-liked by them in return.

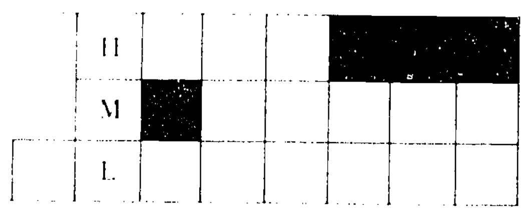
38. Teachers avoid abusive criticism of pupils and refrain from scolding or threatening pupils or arguing with them.



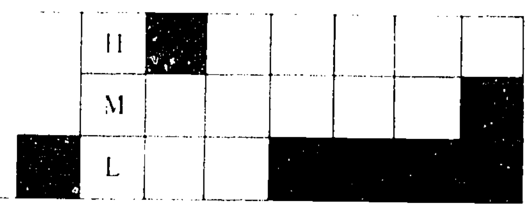
39. Teachers consistently clarify pupil misconceptions, correct pupil errors, and resolve difficulties promptly.



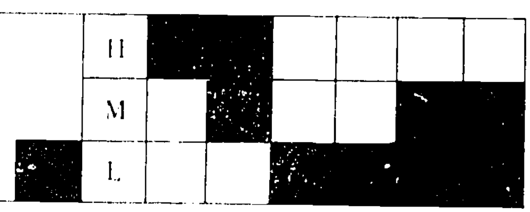
40. Teachers allow pupils to discover their own errors and be self-directed.



41. Teachers are sympathetic and tolerant and allow pupils to express their own opinions.



42. Teachers praise and encourage pupils by providing support, optimism, or an appreciation of pupil responses.



Teacher/Pupil Interactions (Continued)

43. Teachers accept and use the ideas of their pupils.

		Socioeconomic status	Minority representation	School size (enrollment)	City size (population)	Type of community	Pupil mobility
	H	■					
	M		■				■
■	L	■		■	■	■	■

44. The instructional program is focused on pupils and their needs.

		Socioeconomic status	Minority representation	School size (enrollment)	City size (population)	Type of community	Pupil mobility
	H						■
	M		■		■		
	L						■

45. The instruction is restricted to presentations, demonstrations, and selection of topics by the teacher alone.

		Socioeconomic status	Minority representation	School size (enrollment)	City size (population)	Type of community	Pupil mobility
	H		■				
	M			■			■
	L	■					

46. The teacher controls the classroom scene with interesting teacher-directed activities.

		Socioeconomic status	Minority representation	School size (enrollment)	City size (population)	Type of community	Pupil mobility
	H						
	M						
	L		■	■	■	■	

47. Teachers hold informal, relaxed conferences with their pupils to allow free exchange of opinions and discussion of needs.

		Socioeconomic status	Minority representation	School size (enrollment)	City size (population)	Type of community	Pupil mobility
	H			■			■
	M				■		
■	L		■			■	■

Instructional Leadership

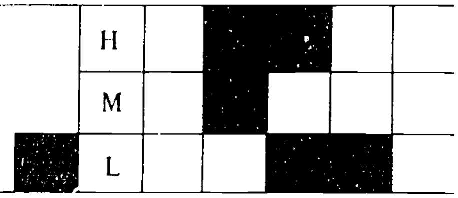
48. The school's mathematics program is made a matter of high priority.

		Socioeconomic status	Minority representation	School size (enrollment)	City size (population)	Type of community	Pupil mobility
	H	■		■	■		
	M	■	■			■	
■	L			■	■		■

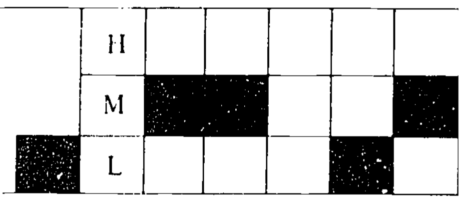
Socioeconomic status
Minority representation
School size (enrollment)
City size (population)
Type of community

Instructional Leadership (Continued)

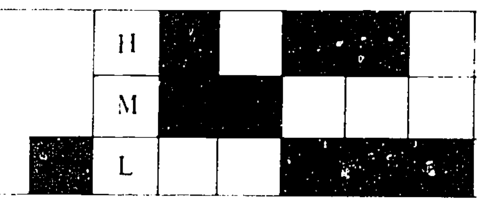
49. The school's mathematics program is updated to reflect new trends in mathematics education.



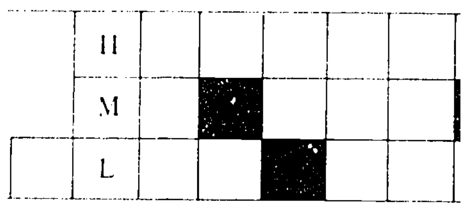
50. Schoolwide instructional objectives are developed for all subject areas.



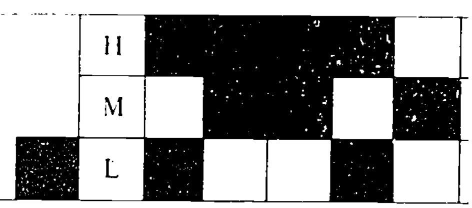
51. Instructional objectives are developed for the mathematics programs.



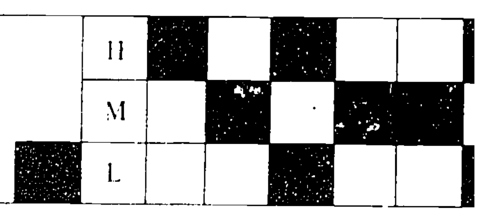
52. A consultant assists in the development and maintenance of a coherent mathematics program.



53. Teachers feel confident in their ability to teach mathematics.



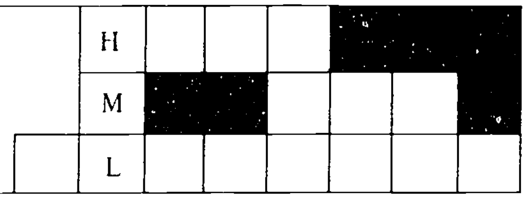
54. Teachers attend mathematics workshops and courses.



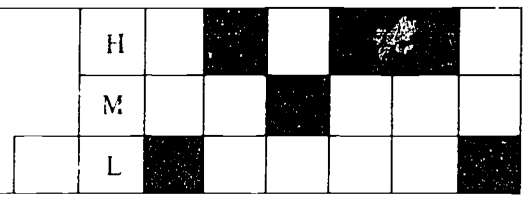
Socioeconomic status | Minority representation | School size (enrollment) | City size (population) | Type of community | Pupil mobility

Instructional Leadership (Continued)

55. A district-level emphasis on mathematics education is initiated and publicized.

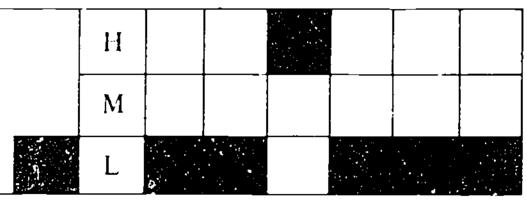


56. The school principal supports teachers who find mathematics textbooks inadequate.

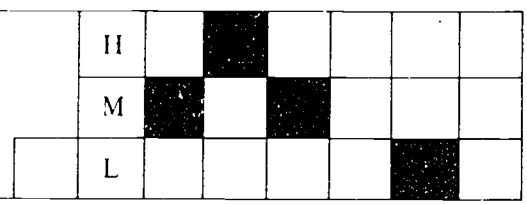


Parent/Community Involvement

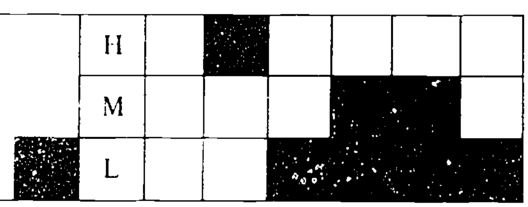
57. The mathematics program supports parental views of what should be taught.



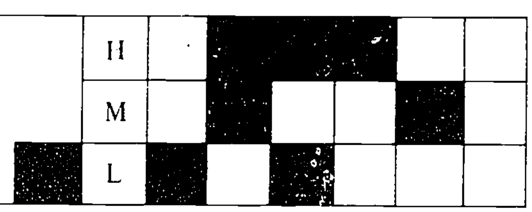
58. The school staff is involved in a community relations campaign to develop parental interest in the school's mathematics program.



59. Teachers confer with the parents of each pupil at least three times annually regarding the pupil's learning progress and problems.



60. The mathematics program is appropriate for the cultural character of the community and realistically reflects the community's needs, goals, and interests.



Chapter 4

Implications of the Hypotheses

Each of the 60 hypotheses was used in the study in the following context: Pupils tend to exhibit higher achievement patterns if . . . (hypothesis). For types of schools in which a particular hypothesis was not found to be an important contributor to pupil success, the reader should *not* assume that pupils tend to exhibit lower achievement patterns if . . . (hypothesis). Therefore, this study provides no basis for discontinuing an activity which has been designed to enhance the mathematics program in a school. Rather, the study provides a basis for establishing priorities for future program planning and program analysis.

The study indicated, for example, that except for schools in a wealthy or suburban community or in a large city, the use of stimulating learning activities (hypothesis 18) is not a characteristic which distinguishes high-achievement schools from low-achievement schools. Nevertheless, the use of stimulating learning activities should not be discontinued; the study does not assert that the use of stimulating learning activities produces low achievement.

The same interpretation applies to hypotheses for which only one or two black squares are shown for a given type of school. On the other hand, when three or four black squares are shown for a given type of school, that hypothesis deserves careful consideration for implementation. The hypothesis is especially important if the black squares shown for a given school type are the only ones given for that hypothesis. When five or six black squares are shown for a given school type, that hypothesis is an essential ingredient for successful mathematics program planning, and its implementation should receive the highest priority.

The following discussions of the implications of the hypotheses should provide the reader with useful ideas and directions for developing implementation plans. When a set of hypotheses has been identified for implementation in a given school, all of the implications should be considered and a general implementation pattern sought. It must be remembered that the hypotheses are designed as the basis for future program development and as such serve as focuses for the planning activities of teachers, administrators, and members of the community. Those who create the program will believe in its ultimate success.

1 *Discovery and inquiry are emphasized in teaching; limited use is made of "traditional" methods.*

Encouragement of pupil discovery and inquiry in mathematics represents one of the most universally accepted aspects of the mathematics revolution of the 1960s. Most educators agree that pupils should think about what they are learning; that pupils should relate what they are learning to what they have already learned; and that mathematical concepts deserve exploration by learners of all abilities. The research study led to some revealing observations about discovery and inquiry activities. To begin with, such activities must be carefully planned and executed; they tend to lose their effectiveness if overused as a motivational device. Furthermore, effective discovery activity need not involve the entire class at one time, and discovery should not always be used to introduce every topic. In most cases effective discovery and inquiry learning activities are created by inspiration. These activities—and their inspiration—should be shared liberally by teachers.

2 *The teaching reflects "traditional" concerns; limited use is made of discovery and inquiry techniques.*

A "traditional" mathematics program may mean many things to many people; but for most teachers it probably means using a program which preceded "new math." One of the characteristics of that earlier curriculum was deliberate attention to the development of computational skills. In the "new math" this attention was often diverted to developing an understanding of "modern" topics in early grades. Another characteristic of "new math" was the unfortunate requirement that teachers present textbook topics with which they were not familiar. The implications of the study are that more attention should be given to computational skills and that unfamiliar topics should not be taught until the teacher understands them thoroughly.

3 *Learning activities make provisions for participation by all pupils; i.e., activities which appeal to a variety of interests and abilities.*

Teachers must recognize the importance of participation by all pupils. Learning activities are simpler to plan if the activities involve only one ability level or one interest area; but clearly such an approach is not adequate for meeting all of the pupils' needs. If selection and purchase of instructional materials are based on the needs of all types of pupils, an improved instructional approach can be undertaken. Then, for every lesson, methods for involving all pupils in the activities must be developed.

4 *Mathematics lessons are prepared thoroughly.*

Planning and preparing mathematics lessons are not accomplished to the same degree in all schools. Sometimes, in those schools of low mathematical skill performance, extenuating circumstances may have prohibited adequate lesson preparation, but educators must realize that thorough lesson preparation will lead to improved performance in all types of schools. Lesson development may require eliminating the prohibiting circumstances of the school and developing creative plans to be shared among teachers, possibly including team teaching opportunities.

5 *The improvement of pupil attitudes is a major emphasis in classroom teaching.*

During the interviews the researchers asked teachers which instructional emphasis was considered more important: how pupils felt toward learning (attitudinal) or what pupils learned (cognitive). Teachers' responses were classified according to whether emphasis was all attitudinal, all cognitive, or somewhere in between. Although an emphasis on attitude to the exclusion of cognitive learning is not to be recommended, schools in the identified categories should consider increasing the emphasis on attitude. Most teachers indicated that they were concerned about both areas of learning and that both were essential.

6 *The faculty recognizes, discusses, and attempts to remedy disruptive pupil behavior.*

In some locations teachers and principals ranked pupil attitude toward school as a major impediment to the success of their mathematics programs, even though the pupils may have attained high achievement in mathematics. The result indicated that in those schools the faculty had recognized the problem, openly discussed it, and prepared a plan for resolving it. Most schools had the problem of poor pupil attitude, and more teachers needed to be aware of the problem and concerned about it. The research study affirmed that taking steps toward resolving the problem can improve mathematics instruction.

7 *Teachers perceive mathematics as a useful and important learning activity for pupils.*

An understanding of the purposefulness of mathematics learning is a characteristic of high-performing pupils and teachers. This hypothesis was corroborated by the questionnaire responses from teachers and principals, who apparently felt that their programs were designed to serve useful purposes and that pupil time was not being wasted. The hypothesis might, however, merely reflect teacher attitudes toward mathematics in general. In either case improvement in a school's mathematics program could be expected if purposeless and time-wasting exercises were eliminated.

8 *The teaching focuses on the content of mathematics.*

The research study indicated that some schools could expect improvement in their mathematics program if they would provide more structure, including well-written objectives, mastery-level learning criteria, pupil achievement profiles, and minimum learning requirements. Pupils in a structured program would have progress charts or a similar record of achievement. In general, emphasis in a structured program would be placed on learning the subject matter rather than on pursuing the interests of individual pupils.

9 *The learning of computational skills and concepts is valued highly and is emphasized as an important goal.*

Computational skills may be mastered by the use of manipulatives, games, and other interesting activities and need not involve heavy drill exercises. Some schools may make effective use of pupil goal setting by emphasizing computational skills as an important goal or by associating rewards with achievement of these skills.

10 *The teaching activities allow pupils to refine their understanding of concepts, and a convergent mode of thinking is used.*

A convergent mode of thinking is used in teaching when pupils may be easily confused by ambiguity or distraction. For example, the convergent mode of thinking is illustrated by the use of a single model for the addition concept; i.e., $x + y$ means taking x things and y other things all together. Ambiguities are avoided in the convergent mode of thinking, such as when the number line model or "block" arithmetic is used. Distractions are avoided also, such as in determining whether the model works when some of the x things are the same as some of the y things. In general, in the convergent mode pupils look for a single correct response; discovery and inquiry techniques are not emphasized.

11 *The classroom activities are managed in a way that promotes orderly and quiet pupil behavior.*

Orderliness and quiet are characteristic of the type of classroom management in which discussion is carefully controlled by the teacher, pupil assignments are completed quietly and intently, and pupils understand and accept the ground rules for acceptable behavior.

12 *A classroom esprit de corps is promoted so that pupils take pride in their behavior and achievement.*

A formal atmosphere was associated with high performance in several types of schools, a result that must be interpreted as to how pupils respond when visitors are present. The formalism could have been based on a desire to perform well and please the visitor, or it could have demonstrated an appreciation for the visitor taking time to watch the class. In either case the behavior indicated an esprit de corps reflecting pride in the class accomplishments and comprehension by the pupils of standards of classroom behavior. The results of the research study should not be interpreted as encouraging continuous formal classroom standards.

13 *Instruction is activity-centered, and techniques such as games, learning centers, and active learning situations are used.*

The teacher may be in a dominant role in activity-centered instruction, but the pupils are not passive. The pupils are challenged as individuals. They participate actively and learn as a result of what they are doing. The results of the study indicated that activity-centered instruction is effective when lecturing, recitation, drill, and discussion are not effective. Activity-centered instruction is different from the independent learning project, which does not involve the teacher to the extent that activity-centered instruction does.

14 *Learning assignments are differentiated for the particular needs of individual pupils.*

Differentiated pupil assignments can be used in any classroom to provide an opportunity for some individualized instruction. Assignments can be planned for two or more groups of pupils in a class so that each group's assignment provides the type of learning activity beneficial to the members of that group. The assignments may differ according to the interests of the pupils, the mathematics achievement levels, the class projects, or the rewards given for performance. Differentiated assignments should allow some pupils to explore mathematical concepts in depth and others to spend more time improving retention of basic skills. So that equality of achievement can be maintained, different amounts of study may be required.

15 *The teacher diagnoses, understands, and acts upon each pupil's learning difficulties.*

For schools with a medium or large minority representation, it is particularly important that teachers know their pupils' learning difficulties. Ethnic barriers can be overcome by a conscious program of diagnosing learning difficulties. The mode of diagnosing can be either formal (making use of special testing programs) or casual (teacher-perceived). In either case the teacher takes time to prescribe learning activities that will assist the pupil to overcome the difficulties.

16 *Pupils are involved in planning their own activities.*

Teachers and principals in many types of schools find that involving pupils in the selection of learning activities tends to produce higher performance. Arrangements vary greatly. Two ... ples are differentiated assignments and individu... rning contracts. The common characteristic of these plans is the provision of a choice of several alternative learning activities from which pupils (individually or collectively) may select what appears to them most beneficial. That some pupils will try to take advantage of this instructional method is understood. But the many advantages of the method merit its serious consideration. First of all, the opportunity to select what one does increases the interest in the selected activity. Furthermore, one learns to be responsible for making decisions. Teachers find the creativity needed in planning for alternatives to be exhilarating and rewarding. Sharing by teachers becomes a necessity and opens new avenues of teaching. Finally, selection of learning activities can be used as a reward for achievement and can be initiated on a small scale in any classroom.

17 *Pupils have opportunities to engage in independent learning projects.*

The use of independent learning projects as a teaching technique is difficult for the teacher but is often successful in improving mathematics learning for the pupils. The project approach has been proposed by leading educators, particularly by those in the Nuffield Project in England.[5] The technique often succeeds because pupils engage in appealing and meaningful activities that require a thorough comprehension of mathematical concepts.

18 *Stimulating learning activities are planned for pupils; e.g., game-like activities, fascinating materials, and lively discussions.*

In some classrooms the observers noted very lively, stimulating learning activities. Teachers were playing games with the pupils, presenting fascinating materials, or encouraging discussion. In contrast, in some classrooms the presentations appeared to be dull and uninteresting, most of the pupils seemed bored, and the teacher did not seem interested. If teachers are enthusiastic, are not too dependent on textbooks, and are flexible toward novel learning activities, they will make the classroom an exciting place for learning.

[5] *Beginnings*. Nuffield Foundation Mathematics Project. New York: John Wiley & Sons, Inc., 1967. See also *Mathematics: The First Three Years*. Nuffield Foundation Mathematics Project. New York: John Wiley & Sons, Inc., 1972.

19 *Teachers use audiovisual materials or visual demonstrations in a formal classroom atmosphere.*

Teachers were observed using audiovisual materials or visual demonstrations more often in high-performance schools than in low-performance schools. These learning activities sometimes involved pupils actively and sometimes passively. The study revealed, however, that the use of audiovisual materials and demonstrations depended for its effectiveness on a formal classroom atmosphere in contrast to a casual atmosphere. Constraints must be placed on the way in which demonstrations and audiovisual materials may be used to improve performance. That is, pupils must understand that, although the material presented is attractive, they are expected to consider the material as matter for study.

20 *The teacher gives clear verbal instructions in a well-controlled classroom atmosphere.*

Classroom observations of teachers disclosed frequent use of the lecturing technique—logical, clear, and matter-of-fact expository teaching. This style of teaching was effective in classrooms in which teachers tended to dominate the learning environment.

21 *The instruction is based on intensive, responsive verbal presentations in which pupils are told specifically what they are expected to know.*

In classroom observations of teachers, a technique was observed that differed from lecturing in several ways. The technique was characterized by intensity and succinctness and amounted to the issuance of authoritative statements of fact. What was to be learned and remembered was made clear. Teachers using this technique emphasized verbalization in their teaching and in evaluating learning.

22 *The chalkboard is used frequently.*

According to the research study, teachers and principals considered the chalkboard as an effective teaching tool. The value of having pupils work at chalkboards is based partially on providing an immediate check of answers and on the cross-pollination of ideas that occur as pupils watch each other work. Teachers found that examples and directions written on the chalkboard helped pupils organize and clarify their understanding.

23 *The overhead projector is used frequently.*

The use of overhead projectors was found to be valuable for the same reasons chalkboards were found valuable. Other valuable features were the convenience of facing the class; the saving of material for later review; and the "magic-like" projection from table to screen which tended to fascinate learners.

24 *The teacher and aides (where available) supervise and tutor the pupils as they study.*

A great deal of class time was used for seatwork. Pupils completed assignments independently or received individual tutoring. As the teacher moved about the classroom, a personal contact was made with each pupil who needed assistance. If the teacher could not keep up with the demands, aides and other pupils were directed to assist in the tutoring.

25 *Teachers are given special training in effective techniques for presenting instructional materials.*

The extent of inservice training in mathematics was a factor which was observed to differentiate between high-performance and low-performance schools regardless of whether the training was in content or in methods. Nearly all teachers indicated that inservice training had been beneficial and should be designed to meet specific teaching needs. Some of the topics suggested by elementary teachers were the following:

Motivation	Development of materials
Metrics	Problem solving
Laboratory	Calculators in the classroom
Slow learners	Applications
Different learning styles	Mathematics for consumers
Mathematics games	
Enrichment materials	

26 *Assignments and directions are clear.*

Clear explanations and directions for mathematics assignments were especially critical in some types of schools. New teachers often have difficulty in explaining and giving directions. The ability to explain and give directions clearly should, therefore, be a prerequisite for teachers hired to teach in these schools.

27 *Additional instructional materials are acquired and used in the classroom.*

Teachers in some schools attributed their pupils' high performance to acquisition of additional instructional materials. One may assume that the materials were carefully selected to enhance the total mathematics program. The actual amount of expenditure was unavailable, but it should be noted that the schools involved were not wealthy. Improvement in a school's mathematics program can, therefore, often be expected to accompany an increase in budget priority.

28 *A broad range of audiovisual instructional materials are acquired and utilized in the classroom.*

The high rating, by teachers and principals, of the use of audiovisual instructional media in mathematics programs was observed in several parts of the research study. This supportive evidence makes consideration of such media essential for certain types of schools. Audiovisual media included a broad range of materials and a broad range of modes of presentation, from passive to active pupil participation.

29 *Teachers are encouraged to reduce dependence on textbook presentations.*

The responses by teachers and principals demonstrated that much support existed for the use of nontextbook, nonworkbook learning activities and teacher-designed follow-up activities after completion of textbook assignments. Independence from textbook learning calls for a creative approach to teaching.

30 *Manipulative aids are used in the learning of skills and concepts at all levels of ability.*

The study revealed that the use of manipulative aids in mathematics instruction was receiving new, widespread interest. Their use was noted particularly in schools in which the staff was actively pursuing a program of improvement. Furthermore, their application appeared at all levels of pupil ability; they were not limited to remediation. The manipulative aids used were often inexpensive teacher-made materials created from objects common in the pupil's environment.

31 *Mathematics is integrated with other subject areas.*

Integration of mathematics instruction into other subject areas has been given increased attention recently. One way this integration may be accomplished is through individual pupil projects, which may be undertaken sequentially as courses evolve and as mathematical concepts arise in the various course subjects. Numerous ideas for pupil projects are suggested in the teacher guides for some mathematics textbooks.

32 *Pupils are allowed to accelerate individually or together to the next higher grade level of instructional materials.*

Accelerated programs may refer to opportunities for pupils to complete the materials assigned to their grade level at a faster pace and continue with materials normally assigned to the next higher grade level. Because of complications with crossing over grade lines, accelerated learning may also mean probing deeper into an assigned topic or exploring an independent project. Acceleration should not mean giving a pupil more practice in topics already mastered.

33 *Frequent enrichment instruction is provided for capable pupils.*

In the research study the term *enrichment instruction* was used to refer to the offering of follow-up activities for all pupils who were capable of performing them. Enrichment instruction can help in narrowing the gap between high- and low-ability pupils; enrichment stimulates teachers and high-ability pupils intellectually and motivates other pupils to learn mathematics.

34 *Mathematically gifted pupils explore abstract concepts, logic, and mathematical applications as part of their classroom learning.*

Mathematically talented pupils can be found in nearly every school. The complete mathematics program will provide opportunities for them. Those opportunities should go beyond accelerated and enrichment instruction (see hypotheses 32 and 33) by providing greater challenge and difficulty. However, such opportunities should never burden pupils with repetitive practice in topics they have already mastered.

35 *A special mathematics program is offered to gifted pupils.*

A startling result that appeared in the study that provided nearly perfect discrimination between high- and low-performance schools was a successful program of special instruction for gifted and high-achieving pupils. Low performance was found to accompany inadequate instruction for gifted and high-achieving pupils.

Programs for the gifted are usually designed to provide special instruction for pupils with abilities that meet particular criteria. Special funds are often available for such programs. In some programs for the gifted, the pupils were excused from their regular mathematics class and permitted to attend one with other gifted pupils. Every school should consider a program for pupils in the upper 10 percent of the pupil population. The abilities of that group may, however, vary greatly from school to school, and each program should be tailored accordingly.

Mathematics programs for gifted pupils entail exploring abstract concepts, learning to play mathematical games that involve logic, and applying mathematical understanding to other subject areas such as science; the social sciences; art (patterns and geometric models); and economics (see hypothesis 34). The gifted program may include field trips that are of particular interest to the pupils.

36 *Teachers are aware of and are sensitive to abilities, needs, and interests of individual pupils.*

The research study findings supported the basic principle of education that the successful teacher is sensitive to the individual pupil's abilities, needs, and interests. Suggested plans for implementing that principle are as follows:

a. A program of intraschool visitation might be a starting point to help teachers become aware of which of their classroom behaviors reflect sensitivity and which do not. The visitations must be nonthreatening and nonevaluative; they must be considered exploratory and therapeutic. Moreover, although a teacher might be considered quite sensitive to pupil needs, the experience of observing another teacher can help observers consider their own teaching and can lead to an understanding of professional strengths and weaknesses. After the visitation each teacher-observer should be able to prepare a list of specific ways in which he/she will try to be more sensitive to pupil needs. A "buddy system" whereby teachers observe and record attempts to implement the new teacher behaviors would help improve teaching through repetition and reinforcement. Educational research has shown such a plan to be effective in modifying teaching behavior.

b. A second plan might be considered as an alternative or as an extension of the previous one. In the second plan each teacher assesses each pupil in terms of objective tests, subjective reports, interviews, and parent conferences. From these observations the teacher prescribes a program of instruction for each pupil (possibly with the assistance of a team including other teachers) and implements that program for a prearranged length of time. At the end of the program, the gains are assessed for each pupil, and the program for that pupil is rated by the teacher on its effectiveness and is modified accordingly.

37 *Teachers have a positive feeling toward pupils and a feeling of being well-liked by them in return.*

Teacher evaluations of the quality of their interactions with pupils may be used as a measure of how well they relate to their pupils or, more simply, how well pupils seem to like them. Improvement in this area might be accomplished by a "buddy system" in which two teachers observe each other in all contacts with pupils. The evaluation tool could be a printed form on which to record the number of positive and the number of negative communications from teacher to pupil. The Flanders interaction analysis technique is a useful, effective model for this type of observing.[6]

38 *Teachers avoid abusive criticism of pupils and refrain from scolding or threatening pupils or arguing with them.*

In some schools avoidance of abusive treatment of pupils is critical. Although pupils may be responsible for certain classroom problems, abusive criticism by the teacher increases frustration and harms the learning processes. Alternatives to angry reactions to pupils are expressions of disappointment, redirection of activities, discriminatory approval of properly behaving pupils, or, when possible, removal of pupils causing problems (see discussion of hypothesis 37).

39 *Teachers consistently clarify pupil misconceptions, correct pupil errors, and resolve difficulties promptly.*

In some schools teachers should be constantly alert to pupil difficulties and respond promptly. Lessons need to be planned for maximum immediate assessment of pupil understanding (contrary to hypothesis 40).

40 *Teachers allow pupils to discover their own errors and be self-directed.*

In some schools prompt attention to pupil difficulties was found in the study not to be effective in improving performance (see hypothesis 39). In these schools pupils should be encouraged to check their own answers. During discussions the teacher should encourage pupils to respond to the contributions of others.

41 *Teachers are sympathetic and tolerant and allow pupils to express their own opinions.*

The teaching style described in hypothesis 41 reflects a confident, self-assured teacher who accepts the feelings of pupils. That type of teacher is often referred to as a "good listener" who never hesitates to draw out a pupil's feelings and opinions in order to understand that pupil's problems.

42 *Teachers praise and encourage pupils by providing support, optimism, or an appreciation of pupil responses.*

Praise and encouragement can be easily seen in a nod, a smile, a touch, a word or two, or an elaborate reward system. In their classroom observations the researchers were particularly attentive to the subtle expressions rather than the elaborate rewards. Teachers can improve their skills in this area by using one of the plans described in hypothesis 37.

43 *Teachers accept and use the ideas of their pupils.*

Possibly the greatest praise that pupils can receive is to have their ideas accepted by the teacher and used to help their classmates. Teachers need to have flexible lesson plans and be alert to useful pupil ideas. Sometimes the idea can be used in a simple way, perhaps as a clarification of a statement. At other times the idea may be used to rebuild an entire lesson or learning activity. The source of an idea should be broadly publicized within the class, to parents, and to other teachers.

44 *The instructional program is focused on pupils and their needs.*

Hypothesis 44 is contrary to hypothesis 8, which focuses on content. When the mathematics program focuses on the learner, more time will be spent in considering the pupil's interests and

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[6] Ned A. Flanders, *Analyzing Teaching Behavior*. Reading, Mass.: Addison-Wesley Publishing Co., Inc., 1970.

ambitions. Furthermore, teaching will be flexible to accommodate pupil suggestions. Progress will be evaluated on the basis of objectives which were mutually selected rather than preselected by the teacher or textbook.

45 *The instruction is restricted to presentations, demonstrations, and the selection of topics by the teacher alone.*

In teacher-dominated classrooms, the pupils make little contribution to the lesson. The teacher selects the lesson topic and the time schedule for it. The pupils seldom interrupt with ideas and suggestions, and their questions are answered by the teacher with authoritative finality.

46 *The teacher controls the classroom with interesting teacher-directed activities.*

In this type of classroom control, the teacher manipulates pupils to provide learning activities. Pupils perform on cue so that concepts can be illustrated and learned by classmates. The lesson may be lively and interesting, but the teacher is the primary center of attention. Misbehavior is suppressed by intensive focus on activities.

47 *Teachers hold informal, relaxed conferences with their pupils to allow free exchange of opinions and discussion of needs.*

Most teachers talk frequently with their pupils on an individual basis, but making appointments to confer with pupils is quite a different form of teacher-pupil interaction. The primary advantage of prearranged conferences is the free exchange of needs and opinions under nonstressful circumstances. That is, when a conference is held at a prearranged time, there is more of a positive client-counselor relationship and less of a negative child-adult relationship. When the reason for conferring is immed ate (i.e., not prearranged), the conference may serve as incitement for an undesirable behavior pattern (namely, misbehavior, disapproval, embarrassment). In a prearranged conference, however, this pattern need not occur, as both pupil and teacher can share goals and concerns from positions of mutual acceptance.

48 *The school's mathematics program is made a matter of high priority.*

Many schools have a cycle of priority setting for subject areas so that the mathematics program is periodically given specific attention. For some schools, however, the mathematics program should receive immediate and continuing attention.

49 *The school's mathematics program is updated to reflect new trends in mathematics education.*

High pupil performance in mathematics may in some schools result from teacher belief that their mathematics program has been updated. Therefore, to attain higher pupil performance, a school should examine and consider adopting a new mathematics program. The addition of a mathematics specialist or mathematics resource materials may also be effective. Teachers should be made to feel that their mathematics program is being improved in conformity with new trends.

50 *Schoolwide instructional objectives are developed for all subject areas.*

Schoolwide instructional objectives serve a broader purpose than providing uniform guidelines for learning: they stimulate communication between and within grade levels; they refresh the memories of experienced teachers and curb the excesses of the novices; they allay some of the fears of the parents; and they provide a finite handle on an infinite task. Instructional objectives are not meant to be a description of all the learning expected of all the pupils. Rather, they serve as a map, providing enough detail to help travelers see where they are and how to get where they would like to be. The development of instructional objectives is a major effort that should not be undertaken without careful preparation. The entire school staff, interested parents, and community representatives should participate.

51 *Instructional objectives are developed for the mathematics programs.*

Instructional objectives should be developed for coordination of the mathematics program between and within grade levels. The objectives serve as orderly guidelines for teachers to use when selecting topics. Without guidelines, unnecessary repetition or serious gaps are more likely to occur in pupils' mathematics education (see the discussion for hypothesis 50).

52 *A consultant assists in the development and maintenance of a coherent mathematics program.*

A surprisingly large number of schools operate without the services of a mathematics specialist. In some types of schools, the use of a consultant could definitely improve mathematics performance. Schools should consider the following methods of acquiring consultant help: hiring a district or interdistrict consultant; hiring a part-time consultant to serve several neighboring schools; releasing a key teacher to provide leadership; using the services of a graduate assistant from a nearby college; discovering a volunteer in the community with expertise; and soliciting help from the office of the county superintendent of schools.

53 *Teachers feel confident in their ability to teach mathematics.*

Teacher confidence in relation to the teaching of mathematics is a factor which should be considered carefully in designing inservice training. Developing confidence in one's teaching ability is particularly difficult when pupils perform poorly. As a starting point to overcome lack of confidence, teachers should search out and identify all the good aspects and successes of their programs. These positive elements should then be expanded. Thereafter, causes of failures should be identified and remedied.

54 *Teachers attend mathematics workshops and courses.*

Implicit in this hypothesis is the assumption that teachers are given opportunities and encouragement to study mathematics. Moreover, opportunities should be convenient and attractive, and workshop leaders should be both knowledgeable in mathematics and responsive to learners.

Courses should be designed to accommodate the wide range of background and ability of the teachers. The teachers should be shown relationships between the mathematical concepts they teach and the broader structure of mathematical systems. Encouragement to attend such special mathematics courses is given real credibility by the school's arranging for substitutes, staging special assemblies for the pupils of released teachers, and having the principal teach classes for the teachers. Encouragement calls for real effort on the part of the principal.

55 *A district-level emphasis on mathematics education is initiated and publicized.*

The degree of emphasis given mathematics by the district administration is an important consideration in pupil performance. It has been found, for example, to be in the best interests of the pupils in one school of a district to increase the emphasis on mathematics in the other schools of the district. Specific proposals delineating mathematics program goals and plans should be carefully designed for each district.

56 *The principal supports teachers who find mathematics textbooks inadequate.*

It was found in the study that in those schools in which principals felt that the mathematics textbooks were inadequate, the teaching was such that pupils performed well. This finding reveals the worth of mathematics programs which are not dependent on textbook teaching and further reveals the important role of the principal in schools with such programs.

57 *The mathematics program supports parental views of what should be taught.*

In the schools in which the teachers felt that parents' views were reflected in the mathematics program, pupil performance was better. The staff in those schools may have sensed parental satisfaction with the program and may have actually promoted that satisfaction in every contact with parents. Teachers in such schools may use parental evaluation as a source of program planning for individual pupils as well as for the entire school.

58 *The school staff is involved in a community relations campaign to develop parental involvement in the school's mathematics program.*

Parental involvement is a way to improve a school's mathematics program. Developing the interest and involvement of the parents is a frequently recurring theme in teachers' meetings because it is recognized as an important factor in pupil performance. Parents usually become involved not as the result of the efforts of teachers to do something individually but rather as the result of a schoolwide community relations program similar to a political campaign. Strategies must involve current community issues, grass-roots support and work, and advertisement of the school's potential role in helping to produce a better life in the community. Parent-teacher associations, the school board, and parent advisory groups are valuable instruments in such a campaign.

59 *Teachers confer with the parents of each pupil at least three times annually regarding the pupil's learning progress and problems.*

Many teachers in high-performance schools indicated that they conferred with parents of each pupil at least three times per school year. The teacher-parent conferences included in the research study were only those in which a pupil's progress was discussed. The setting for most conferences was after school in the classroom, but many meetings were held in the homes of pupils or sometimes in unplanned meeting places.

60 *The mathematics program is appropriate for the cultural character of the community and realistically reflects the community's needs, goals, and interests.*

An important relationship between the success of a school's mathematics program and its cultural relevance in the community was disclosed by the research study. In schools where teachers and principals felt that their program addressed itself to the cultural character of the community, pupils performed better. The research study was based on the assumption that different programs must be designed for different communities to maximize pupil performance, and the results corroborated that position. Clearly, a program to improve the performance of pupils in a given school must be based on the application of alternatives according to the needs and goals relevant to the community.

38

Chapter 5 Implementation of a Plan for Improvement

So that the results of this study can be put into the hands of teachers for the greatest effect, a two-stage dissemination plan has been included as an integral part of an overall implementation plan. In the first stage of the plan, the results of the study will be presented to school teams consisting of a principal or an administrator and a classroom teacher. In the second stage each school team will conduct a program for implementing the results of the study in the school's mathematics program. Both stages of the dissemination plan are based on a workshop format. The workshop for the first stage is designed for leadership training, and the workshop for the second stage is designed for classroom implementation.

Workshops in Leadership Training

The first stage of the plan for improving elementary mathematics programs will consist of leadership training workshops. The suggestions given here are directed to a district, county, or state supervisor, administrator, or consultant responsible for the elementary mathematics curriculum in more than one school. The workshops can, however, be integrated into any inservice training program concerned with mathematics teaching at the elementary level. The steps to be taken in conducting a leadership training workshop are the following:

1. Arrange for the participation of school teams from 20 to 40 local schools approximately six weeks in advance of the workshop. Reserve the use of a suitable, centrally located meeting room on a convenient day for a three-hour workshop. An assistant will be useful at the workshop for providing hospitality and for helping participants analyze their school's mathematics program profile. The motivation for attending the leadership workshop should be that participants will identify ways of improving their mathematics programs.
2. Send a copy of Appendix B of this publication to each participating school approximately two weeks in advance of the workshop, including the cover letter explaining the importance of collecting the requested information prior to the workshop.
3. Collect the following materials, one copy for each participating school (The materials may be duplicated from this publication, or additional copies may be purchased from Publications Sales, California State Department of Education, P.O. Box 271, Sacramento 95802. The price is $1.25 plus 6 percent sales tax for California residents.):
   a. Printed materials
      - Implementation workshop outline
      - Hypotheses for improving elementary mathematics programs
      - Implications of hypotheses
      - School profile key (card)
      - Evaluation of workshop in leadership training (see Appendix C)

   b. Transparencies for use on overhead projector (see Appendix D)
      - Selection of sample schools for this study
      - Instruments used in study of schools
      - Sample hypothesis
      - Categories of hypotheses
      - School profile key
4. Conduct the workshop, using the following guidelines (total time—180 minutes):
   a. *Part One* (50 minutes)
      - Registration—Premeeting
      - Distribution of name tags
      - Workshop introduction
      - Overview, charge, and instructions
        - List of main topics in these guidelines
        - Explanation of purpose and responsibility
        - Suggestion: note-taking

Discussion of the research
Selection of sample schools (transparency): all types of schools identified; definition of high-achieving and low-achieving schools; and sampling procedure
Instruments used in study (transparency), on-site observation of teaching; interviews of teachers and principals; and anonymous questionnaires
Hypotheses (transparency): 500 hypotheses tested; 60 hypotheses verified statistically; and hypotheses checked by type of school
School profile key (transparency): method of recording school information on key and using the key to select applicable hypotheses (demonstration of sample hypotheses transparency)
Categories of hypotheses (transparency): examples of each category
Questions about the research methods (ten-minute maximum)

b. *Part Two* (40 minutes)
School profile key preparation
Transparency
Individual assistance
Completion by every team
Identification of applicable hypotheses
Use of school profile key
Recording of number of black squares shown for each hypothesis (mark only those hypotheses with three or more black squares)
Careful reading of applicable hypotheses
Workshop break (included in the 40-minute period)

c. *Part Three* (60 minutes)
Implications of hypotheses
Hypotheses with most black squares to be first items
Hypotheses to be read and corresponding implication and illustrative remarks to be made as time permits
Discussion of one category of hypotheses at a time
Explanation of hypotheses as likely but not guaranteed ways of improving programs
Application of hypotheses to known situations in participating schools
Not all hypotheses to be discussed

d. *Part Four* (30 minutes)
Discussion of implementation workshops
Outline of workshops to be reviewed
Workshop be held within two to four weeks
Advance publicity to begin immediately
Questions and problems; concluding remarks
Evaluation of leadership training workshops
Purpose: to assist State Department of Education in planning future workshops
Completion of suggested form (see Appendix C)

5. Include in the follow-up:
Telephone calls to aid in arranging workshops
Query made to find whether evaluation forms were turned in
Evaluation sent from leadership training workshops

Implementation Workshops

Immediately after a leadership training workshop has been completed, planning should be begun for implementation workshops at the school level. The persons involved in the planning will be the members of the school teams that participated in the leadership training workshop. The steps to be taken in conducting an implementation workshop are the following:

1. *Act promptly.* A two-hour planning meeting for all teachers, administrators, resource personnel, and instructional aides in the school should be scheduled two to four weeks in advance of the workshop. (Much of the value of the leadership training workshop could be lost if the implementation workshop is held more than four weeks after the leadership workshop.) If possible, the workshop should be scheduled on the afternoon of a shortened day. Time should be allowed for teachers to take care of lesson plans, reports, and clerical duties prior to the workshop.

   The productivity of the workshop will be enhanced if the meeting place is away from school and administrative offices. A nearby business office, church, home, restaurant, or other facility can provide a pleasant and relaxed atmosphere with few distractions, interruptions, and reminders of frustrations.

2. *Publicize the workshop.* Publicity will help establish expectations and relieve anxieties. The teacher on the school leadership team should take primary responsibility for publicizing and presenting the workshop. Greater productivity and program improvement often result when reform is initiated by classroom teachers.

Posters in the teachers' room, announcements in the daily bulletin, and other media should reflect the team's creativity and the school's special needs. Some questions that might be considered are: (a) What are we doing about mathematics? (b) How effective is the mathematics program in our school? (c) Is our mathematics program up-to-date? and (d) Why can't Johnny add?

3. *Prepare the workshop training materials.* Preparation requires listing the hypotheses (without the black squares) in the order of importance to the improvement of the mathematics program. The list for each of the six categories of hypotheses should be on a separate page, and one copy should be made for each teacher. An explanatory sheet should explain briefly that the hypotheses apply specifically to this type of school and that if teachers can find ways to implement the hypotheses, improvement in the pupils' mathematics achievement can be expected. One copy of Appendix E should be prepared for each participant.

4. *Conduct the workshop according to specific guidelines.* The workshop should provide ample opportunity for open discussion about the applicable hypotheses. Teams of three to five persons should then prepare implementation plans and ensure that the plans are carried out.

   a. Introduction and explanation (20 minutes)

      Explain the need for improvement in the school's mathematics program.

      Explain the hypotheses verification procedure used in the research.

   b. Discussion of hypotheses (60 minutes)

      Seek ideas for implementing the hypotheses.

      Discourage negative, pessimistic opinions.

      Use implications printed in the report to stimulate discussion.

      Take notes on each idea for implementation, including who made it.

      Look for plans that implement more than one hypothesis.

   c. Assignments on implementation teams (30 minutes)

      Select plans with high potential or interest.

      Name the plans and start a sign-up sheet for each one.

      Allow time for each teacher to select two teams on which to participate.

      Set an initial meeting time for each team.

      See that the leader serves on all teams.

   d. Evaluation of implementation workshop (10 minutes)

      Purpose: Assist State Department of Education personnel in planning future workshops.

      Complete the form in Appendix E.

5. *Carry out follow-up activities:*

   a. Remind teachers of their team meeting.

   b. Seek a leader for each team.

   c. Publicize the plans developed by each team.

   d. Provide liaison between teams.

   e. Seek cooperation between teachers and administrators.

   f. Send evaluations to the coordinator of the leadership training workshop.

Recommendations for Further Research

A number of ideas emerged during the planning stages of the study that deserve further examination. The most obvious additional research needed in connection with the study is follow-up in the following areas:

- Which hypotheses created the most profound changes in mathematics programs?
- Which types of schools were helped the most?
- How much improvement in pupil achievement occurred as a result of implementation of the various hypotheses?

Furthermore, a school-by-school survey of implementation plans developed by school staff could be a valuable resource. A comparison of teacher-perceived effectiveness and the actual effectiveness of the approach to program improvement suggested in this study might also be made.

Replication of this study for another sample of schools in California or for schools in another state would be useful. Verification could be accomplished by the use of different observation instruments, interview procedures, and questionnaires. In particular, more subtle interview questions might provide better insight into such teacher characteristics as sense of mission, empathy, rapport, perception of individual pupil needs, ability to listen, and innovativeness. Interview questions with structured response choices might be designed to provide more uniformity of interpretation. The questionnaires might also be modified to ensure uniformity of interpretation, and open-ended question techniques might be utilized. The observation instruments could be simplified and checked for observer reliability.

As to the demographic variables used in the study for categorizing sample schools, data are available for a different basis for measuring each school's socioeconomic status and pupil mobility. Other variables might be considered that statistically or logically provide better categories than those selected in this study. The additional variables could include mean family income, variance of the distribution of family incomes, educational expenditure per pupil, educational achievement for parents, pupil-teacher ratio, age and type of school building, and variables that affect learning but lie beyond the direct control of a school's staff.

The study might be improved by excluding those schools from the sample for which certain major changes in demographic variables have occurred during the period used for establishing the trend of mathematics achievement. Likewise, some assurance should be present that the mathematics program scrutinized in the study at each sample school is basically the same one which produced the trend in achievement at that school. At least the factors that account for the trends should be identified.

Despite the wide range of program characteristics selected prior to visits at the sample schools, many more characteristics exist, some of which may be significant for program improvement; e.g., the kind of homework assignments and the amount of emphasis placed on them; the type of report cards; and the quality of interaction between the principal and the pupils. Other characteristics might be revealed by researchers concentrating on one type of school, comparing features of high-achieving school programs with features of low-achieving school programs. Characteristics thus found might be quantified so that their occurrence could be recorded for one type of school in the sample. After verifying or rejecting the various hypotheses regarding features of mathematics programs for that type of school, the researchers would move on to another type of school and repeat the process.

Many of the recommendations for mathematics programs made in this study can also be applied to the teaching of other subjects, particularly reading, spelling, and grammar; that is, subjects that utilize mental processes and skills similar to those used in the study of mathematics. Furthermore, achievement scores for these subjects are available from the same source as the mathematics achievement scores.

This research study has provided useful information for organizing and implementing changes in the mathematics program of a given school. The hypotheses are verified for different types of schools on the basis of total school scores. It is unlikely that a single teacher could implement all the hypotheses that apply to that teacher's school, nor could a single teacher expect all the applicable hypotheses to be effective in improving achievement in one classroom. An additional useful study might be undertaken in which the classroom is made the basic unit.

The number of control variables would have to be expanded considerably in a classroom-level study beyond the demographic variables used in this school-level study. Descriptors of the schoolwide mathematics programs would become variables over which the individual teacher would have no control, but these variables would nevertheless affect the mathematics program in each classroom. Such a classroom-level study would aid individual teachers in a given school setting independently of the success or failure of other teachers in the same school. This strategy would be particularly advantageous in a school with weak internal communication channels, uncooperative factions, or an influential group of unadaptive teachers. A classroom-level study might also be used effectively in the various departments and divisions of secondary schools, grades seven through fourteen.

In summary, the model for educational research proposed in this report has many possible variations and implications for improvement in instructional programs at all levels in all subject areas. Hopefully, educational researchers will use this new mathematics program model to provide frontline teachers with guidelines for "what to do when the students arrive on Monday morning."

Appendixes

Appendix A. Observation Instruments Used in the Study

Appendix B. Cover Letter and Information Needed to Make a School Profile

Note: The material contained in Appendix B should be sent to those invited to attend a leadership training workshop. The material should be sent well in advance of the workshop, and those invited should be reminded of the location and time of the workshop. (See instructions for workshops in leadership training on page 30.)

Appendix C. Evaluation of Workshop in Leadership Training

Note: The evaluation form is to be completed at the conclusion of the workshop. Each participant should be given an evaluation form. (See instructions for the evaluation of workshops in leadership training on page 31.)

Appendix D. Transparency Masters

Note: A complete set of transparencies should be made from the masters provided. (See the outline of the presentation of the transparencies on page 31.)

Appendix E. Evaluation of Implementation Workshops

Note: The evaluation form is to be used at the conclusion of the implementation workshop. Copies may be provided to workshop leaders for their use when they conduct implementation workshops in their own schools. Or a single copy may be given to each leader with instructions to make copies for the teachers at his/her school. (See reference to implementation workshops on page 32.)

Appendix A | Observation Instruments Used in the Study

Mathematics Program Inventory (School Level)

A. Description of Your School's Mathematics Program

Check the items which best describe your school's mathematics program:

- ☐ Exemplary
- ☐ Experimental
- ☐ Relevant
- ☐ Content-centered
- ☐ Pupil-centered
- ☐ Teacher-centered
- ☐ Accelerated
- ☐ Remedial
- ☐ Team effort
- ☐ Innovative
- ☐ Traditional
- ☐ Contemporary
- ☐ Creative
- ☐ New program
- ☐ Same old program
- ☐ High priority
- ☐ Medium priority
- ☐ Low priority
- ☐ Differentiated staffing
- ☐ Differentiated pupil assignments
- ☐ Modular scheduling
- ☐ Homogeneous grouping
- ☐ Heterogeneous grouping
- ☐ Reflects teachers' views
- ☐ Reflects administration views
- ☐ Reflects parental views
- ☐ Reflects societal needs
- ☐ Based on modern curriculum program
- ☐ Schoolwide performance objectives

Other ____________________

B. Teaching Methodology Used in Your School's Mathematics Program

Check the items which best describe the teaching methodology used in your school's mathematics program:

- ☐ Much individualization
- ☐ Some individualization
- ☐ Little/no individualization
- ☐ Discovery approach
- ☐ Individually prescribed instruction
- ☐ Diagnosis of learning difficulties
- ☐ Independent projects/inquiry
- ☐ Some enrichment instruction
- ☐ Some gifted instruction
- ☐ Manipulative aids
- ☐ Multimedia approach
- ☐ Performance contracts
- ☐ Learning packages
- ☐ Task cards
- ☐ Role playing
- ☐ Mathematics games
- ☐ Peer tutoring
- ☐ Teacher-pupil conferences
- ☐ Frequent practice/drill
- ☐ Emphasis on computational skills and concepts
- ☐ Textbook-oriented
- ☐ Workbook-oriented
- ☐ Worksheet-oriented
- ☐ Chalkboard
- ☐ Overhead projector
- ☐ Classroom learning centers
- ☐ Resource center outside of room
- ☐ Small-group projects

Other ____________________

C. Description of the Teaching Style in Your School's Mathematics Program

Rank numerically (1, 2, 3, and so forth) the teaching modes in the order of usage:

- ___ Lecture/demonstration
- ___ Discussion
- ___ Question/answer (not discussion)
- ___ Recitation/drill
- ___ Individualized instruction
- ___ Small-group instruction
- ___ Peer tutoring
- ___ Demonstration
- ___ Tutoring
- ___ Programmed instruction

Other ____________________

D. Appraisal of the Pupil Levels in Your School's Mathematics Program

Indicate the approximate number of pupils in your school (or room) mathematics program for each characteristic:

Achievement level:	___ Under	___ At grade level	___ Over
Motivation level:	___ Low	___ Average	___ High
Ability groups (if used):	___ Low	___ Middle	___ High

What is the grouping criterion? ____________________

E. Improvement of Your School's Mathematics Program

Rank numerically (1, 2, 3, and so forth) the ten items which you feel describe the most effective ways which have been used to improve your school's mathematics program:

___ Additional faculty
___ Additional aides
___ Additional resource personnel
___ District mathematics consultant
___ District involvement
___ Administrative support
___ Mathematics workshops
___ Workshop topics
___ Higher salaries
___ Smaller classes
___ Better ethnic balance
___ Additional instructional materials and aids
___ Better classrooms (better physical environment)
___ Open classrooms
___ Greater emphasis on reading skills
___ More ability grouping
___ Less ability grouping
___ Adequate textbook guide
___ Greater parental interest and involvement

Other ____________________

F. Identification of Factors Limiting Program Success

Rank numerically (1, 2, 3, and so forth) the characteristics which you perceive as limiting the success of your school's mathematics program:

___ Faculty abilities in mathematics
___ Faculty attitudes toward mathematics
___ Pupil attitudes toward school
___ Pupil attitudes toward mathematics
___ Pupil motivation levels
___ School's traditionalism
___ Ethnic composition
___ De facto segregation
___ Class size
___ Condition of buildings
___ Program irrelevancy
___ Lack of concern for individual pupil needs
___ Diluted program
___ Shortage of aides
___ Ability grouping scheme
___ Mobility/absenteeism rate
___ Resistance to change and innovation
___ Lack of program objectives
___ Inappropriate textbook
___ Ineffective use of existing resources

Other ____________________

45

G. Your Opinion of Your School's Mathematics Program

Check the appropriate box of the scale which best describes your opinion of your school's mathematics program:

	Superior	Satis-factory	Needs improve-ment
1. Sensitivity to individual abilities, needs, and interests	☐	☐	☐
2. Purposefulness of mathematics tasks and assignments	☐	☐	☐
3. Encouragement of pupil discovery and inquiry in mathematics	☐	☐	☐
4. Quality of teacher/pupil interaction	☐	☐	☐
5. Inservice training in mathematics content	☐	☐	☐
6. Inservice training in mathematics methods	☐	☐	☐
7. Planning and organization of mathematics program	☐	☐	☐
8. Instructional objectives for mathematics program	☐	☐	☐
9. Planning and preparation of mathematics lessons	☐	☐	☐
10. Provision for participation by all students	☐	☐	☐
11. Diagnostic and prescriptive methods for learning	☐	☐	☐
12. Extent that pupils are involved in selecting mathematics activities	☐	☐	☐
13. Special instruction for gifted and high achievers	☐	☐	☐

	Superior	Satis-factory	Needs improve-ment
14. Extent mathematics program is integrated with other subjects	☐	☐	☐
15. Relevancy of mathematics program for cultural character of the school	☐	☐	☐
16. Extent mathematics program has been updated	☐	☐	☐
17. Adequacy of basic mathematics textbook	☐	☐	☐
18. Extent of independence from textbook to workbook	☐	☐	☐
19. Clarity of explanations and directions in mathematics	☐	☐	☐
20. Use of audiovisual media in mathematics	☐	☐	☐
21. Use of manipulative aids in mathematics	☐	☐	☐
22. Use of small-group working situations	☐	☐	☐
23. Opportunities for independent mathematics projects and experiments	☐	☐	☐
24. Use of activity-centered mathematics instruction	☐	☐	☐
25. Teacher's confidence with mathematics	☐	☐	☐

Mathematics Teacher Inventory

Personal

Sex ________ Age level (decade) ________ Ethnicity ________ Socioeconomic status ________
Daily teaching load (in hours) ________

Education

College major ________ College minor ________
Recency of formal mathematics training (year) ________
Number of college courses in mathematics methods ________ Number of college courses in mathematics content ________
Number of inservice mathematics courses ________ Number of workshops in mathematics ________

Experience

Total experience (in years) ________ District experience (in years) ________ Motives in choosing career ________

Satisfaction with grade level ________ Satisfaction with socioeconomic status, ethnicity ________
Satisfaction with school ________ Satisfaction with school district ________
Satisfaction with community ________ Type of school (socioeconomic status, ethnicity, community) preferred ideally ________

Choice of teaching career again? ________

School Goals

Does the teacher have a perception of school goals? ________
View of school goals, purposes ________

View of school priorities ________
View of current school objectives/priorities attained ________
View of school problems ________
View of textbook ________ Supplementary materials ________
Adherence to textbook ________ Page by page? ________
Variance of mathematics program/strategy from day to day (or week to week) ________

Encourages alternate methods in pupil problem solving ________
Extended assignments (hour/week) ________ Number of monthly use of media sources: Overhead projector ________ 16mm film ________ ITV ________ Tape ________ Filmstrip ________ Other ________
Awareness of pupil weaknesses/strengths ________
Radical changes in teaching methods/organization (past four years) ________ In what area? ________
Individualized instruction ________ Ability grouping ________ Manipulative aids ________
Less emphasis on textbooks ________ Activity centers ________ Other changes ________
Preference/avoidance of certain mathematics topics ________
Flexibility in developing/using new strategies ________
Preference/avoidance of certain mathematics topics ________
Source of new podagogical ideas ________
Techniques used to stimulate interest and motivate pupils ________

Relationships/Committees/Improvements

View of effectiveness of teacher/parent communication ________
View of parent support of mathematics program ________
View of parent support of teacher innovation/experimentation ________
Actual participation on committees/curriculum planning ________
Opportunity for participation on committees ________
Number of teacher/parent conferences (this year) ________
Standard mathematics achievement tests administered and frequency ________

Are test data available to teacher? ____
Do classroom physical facilities, equipment, furniture appear to be adequate? ____
Does teacher experiment with new strategies? ____
Does textbook restrict the way the teacher teaches mathematics? ____
Is class time efficiently used? ____
Number of aides ____ Part-time ____ Full-time ____
Aide used in tutoring? ____ In recordkeeping? ____
In drill? ____ In testing? ____
In centers? ____ Other? ____
Is aide efficiently used (observe)? ____
Is primary emphasis of instructional objectives aimed at: Attitudinal change ____
Cognitive change ____ Motivational change ____
Does teacher use a variety of strategies? ____
Are teaching strategies consistent with objectives? ____

Mathematics School Inventory

Principal Variables

Sex ____ Age level (decade) ____ Ethnic origin ____
Who plans mathematics inservice workshops? ____
Greatest parent contribution to mathematics program in past year ____
Prediction of greatest contribution parents might make to mathematics program in next year ____

Number of visitations to each mathematics classroom per year ____
Support/encouragement of mathematics program (nonvisitation) ____
View of the need for evaluation of mathematics program ____
Actions/programs to improve mathematics achievement test scores ____
Understanding of the potentials/limitations of teacher ____
Encouragement of teacher self-improvement ____
Extent of encouragement of teacher innovation/experimentation in mathematics program ____
Faculty ability to identify with school/community ____
Involvement with school/community/parent committee ____

School Variables

Mathematics consultant in district? ____
Other curriculum consultant working in mathematics? ____
Consultant role in planning of the mathematics curriculum/program ____
Rating of mathematics program in district (low, medium, high) ____
Number of mathematics workshops this year ____ Last year ____
Workshop topics ____
Priority level of mathematics in district ____ Number of teachers with M.A. degree ____
Number of teachers in probationary status ____
School reputation in district (low, medium, high) ____ Number of disadvantaged pupils ____
School priorities ____
School problems ____
Faculty strengths/weaknesses ____
Is mathematics program relevant to social needs? ____ To pupil needs? ____
Which needs of pupils are not met by program? ____

Textbook publisher ____
View of textbook ____ Supplementary materials ____
When adopted ____

Workshops critically needed ______________________________
____

Enrollment (ADA) ______________ District expenditure per pupil ______________
School expenditure per pupil ______________ Length of school day (in minutes) ______________
Number of full-time faculty ______________ Part-time ratio ______________ Number of male faculty ______________
Teacher male/female ratio ______________ Number of instructional aides: Full-time ______ Part-time ______________
Paid ______ Volunteer ______ Parent ______ Other ______________
Number of new pupils added since October 1 ______ Number of pupils leaving school since October 1 ______________
Pupil mobility rate (annual) ______________
Physical environment/neighborhood characteristics: Inner city ______ Commercial ______ Industrial ______
Suburban ______ Rural ______ Farming ______ Economically depressed ______ Small city ______
Medium city ______ Large city ______ Luxury housing ______ Custom housing ______ Tract housing ______
Apartments ______ Substandard housing ______________
Number of blacks ______________ Number of Chicanos ______________ Number of Asians ______________
Number of Native Americans ______________ Percent of pupils bused for de facto segregation ______________
Does the community favor busing? ______________ Ethnicity index (percent white) ______________
Socioeconomic status index: Low ______________ Medium ______________ High ______________
Number of AFDC families ______ Teacher mobility (last year) ______________
School needs assessment conducted? Describe. ______________
Temporary state/federal funding affecting mathematics program ______________
Source ______________
Number of resource/consulting personnel ______________ Title I personnel ______________
Number of pupils receiving free lunch ______________
Title I mathematics projects affecting school ______________
Funding level ______________
Title III mathematics projects affecting school ______________
Funding level ______________
Number of teachers who are very talented in mathematics ______________
Number of teachers who show high interest in mathematics ______________
Number of teachers whose classes score high on district mathematics achievement tests ______________
Percent of pupils obtaining free lunch ______________ Number of special mathematics programs ______________
Percent of pupils in remedial reading programs ______________
Percent of pupils in remedial mathematics programs ______________

Observed Classroom Behaviors and Organization

Verbal Behavior

Teacher

	None	Some	Much
1. Accepts feeling	☐	☐	☐
2. Praises/encourages	☐	☐	☐
3. Accepts/uses pupil ideas	☐	☐	☐
4. Asks questions	☐	☐	☐
5. Answers pupil questions	☐	☐	☐
6. Lectures (explains, tells)	☐	☐	☐
7. Corrective feedback	☐	☐	☐
8. Gives directions	☐	☐	☐
9. Criticizes pupil/justifies authority	☐	☐	☐
Pupil			
10. Pupil-initiated talk	☐	☐	☐
11. Pupil response	☐	☐	☐
12. Pupil questions	☐	☐	☐
Nonverbal Behavior			
Teacher			
13. Teacher demonstration/AV usage	☐	☐	☐
14. Teacher supervision/monitoring	☐	☐	☐
15. Teacher clerical activity	☐	☐	☐
Pupil			
16. Pupil-directed practice/activity	☐	☐	☐
17. Pupil inattentiveness/confusion	☐	☐	☐

Room grouping	Number of pupils	Leader		
Large-group	______	T	A	P
Small-group	______	T	A	P
Small-group	______	T	A	P
Small-group	______	T	A	P
Small-group	______	T	A	P
Individual	______	T	A	P

Teaching style

- ☐ Lecture
- ☐ Question/answer
- ☐ Discussion
- ☐ Supervision
- ☐ Overhead projector
- ☐ Demonstration
- ☐ Testing
- ☐ Tutoring
- ☐ Chalkboard

Room layout/equipment

- ☐ Self-contained
- ☐ Open space
- ☐ Mathematics table
- ☐ Mathematics bulletin board
- ☐ Row/column layout
- ☐ Cluster layout
- ☐ Individual layout
- ☐ Desks
- ☐ Tables
- ☐ Learning centers
- ☐ Individual AV setups
- ☐ Manipulative aids (group)
- ☐ Manipulative aids (pupil)

Strategies

- ☐ Discovery
- ☐ Didactic
- ☐ Drill
- ☐ Rule/example
- ☐ Mathematics games
- ☐ Worksheet activity

Notes:

Classroom Observation Scale

Pupil Behavior

1. Apathetic	1 2 3 4	Alert
2. Obstructive	1 2 3 4	Responsible
3. Uncertain	1 2 3 4	Confident
5. Lacking in enthusiasm	1 2 3 4	Enthusiastic
6. Compliant	1 2 3 4	Self-directed
7. Lacking in participation	1 2 3 4	Full participation

Teacher Behavior

8. Partial	1 2 3 4	Fair (impartial)
9. Autocratic	1 2 3 4	*Democratic*
10. Aloof	1 2 3 4	Responsive
11. Restricted	1 2 3 4	*Understanding*
12. Harsh (cold)	1 2 3 4	Kindly
13. Dull	1 2 3 4	Stimulating
14. Stereotyped	1 2 3 4	*Original*
15. Apathetic	1 2 3 4	Alert
16. Unimpressive	1 2 3 4	*Attractive*
17. Evasive	1 2 3 4	*Responsible*
18. Erratic	1 2 3 4	Steady
19. Excitable	1 2 3 4	Poised
20. Uncertain	1 2 3 4	Confident
21. Disorganized	1 2 3 4	Systematic
22. Inflexible	1 2 3 4	Adaptable
23. Pessimistic	1 2 3 4	Optimistic
24. *Immature*	1 2 3 4	Integrated (mature)
25. Narrow (rigid)	1 2 3 4	Broad (accepting)
26. Unenthusiastic	1 2 3 4	Enthusiastic
27. Impatient	1 2 3 4	Patient
28. Uncontrolling	1 2 3 4	Controlling
29. Inhibited	1 2 3 4	Uninhibited
30. Unprepared	1 2 3 4	Prepared
31. Inefficient	1 2 3 4	Efficient
32. Lacking in humor	1 2 3 4	Sense of humor
33. Ignores pupils	1 2 3 4	Listening ability
34. Frustrated	1 2 3 4	Happy
35. Unimaginative	1 2 3 4	Resourceful
36. Subjective	1 2 3 4	Objective
37. Coarse	1 2 3 4	Refined
38. Uncooperative	1 2 3 4	Cooperative
39. Lacks ambition	1 2 3 4	Ambitious
40. Inconsiderate	1 2 3 4	Considerate
41. Worried	1 2 3 4	Buoyant
42. Unreliable	1 2 3 4	Reliable
43. Dependent	1 2 3 4	Self-reliant

Classroom Environment

44. Teacher-centered	1 2 3 4	Pupil-centered
45. Structured	1 2 3 4	Unstructured
46. Passive	1 2 3 4	Activity-oriented
47. Grouped (15)	1 2 3 4	Individualized(<3)
48. Lacks manipulation	1 2 3 4	Manipulative
49. Lacks media	1 2 3 4	Multimedia
50. Aimless tasks	1 2 3 4	Purposeful tasks
51. Formal	1 2 3 4	Casual
52. Unattractive	1 2 3 4	Attractive
53. Restricted movement	1 2 3 4	Free movement
54. Disorderly	1 2 3 4	Orderly
55. Quiet	1 2 3 4	Noisy
56. Didactic (telling)	1 2 3 4	Discovery-oriented
57. Flexible materials	1 2 3 4	Textbook-oriented
58. Rigid layout	1 2 3 4	Flexible layout
59. Uniform tasks	1 2 3 4	Differentiated tasks
60. Convergent thinking	1 2 3 4	Divergent thinking
61. Teacher-selected tasks	1 2 3 4	Pupil-selected tasks
62. Nondiagnostic	1 2 3 4	Diagnostic
63. Self-contained	1 2 3 4	Open

Notes:

Appendix B | Cover Letter and Information Needed To Make a School Profile

(COVER LETTER)

Dear Friend:

You recently received an invitation to attend a special workshop to be presented in your area. In anticipation of your attendance, we would remind you to make all the necessary arrangements and to obtain the information requested below.

The workshop is based on a study completed by the Mathematics Education Task Force of the California State Department of Education. To apply the results to your school, you must classify your school according to six variables:

- Socioeconomic status
- Minority representation
- School size (enrollment)
- City size (population)
- Type of community
- Pupil mobility

Each of these variables has three classifications: low, medium, and high.

The information on the attached sheets describes the variables and defines the limits of the three classifications for each variable. Before the workshop presentation, current information and statistics should be collected for your school. On the basis of this information, a profile key card will be punched at the workshop and used to determine which recommendations apply to your school. In the case of incomplete or inconclusive information, decisions about the classifications will be made at the workshop before the profile key card is punched.

Sincerely yours,

Information Needed to Make a School Profile

Six demographic variables are used to analyze the results of this study. Every school ranks in one of the three levels of each variable: low, medium, or high. The limits of those levels, along with instructions, are as follows:

Socioeconomic Status

The level of a school's socioeconomic status is determined by the following computation:

Three (3) points for each percent of all pupils whose supporting parent is an executive, a professional or semiprofessional, a manager, a clerical worker, or a college-trained technician

Two (2) points for each percent of all pupils whose supporting parent is a skilled or semiskilled employee

One (1) point for each percent of all pupils whose supporting parent is an unskilled employee, is unemployed, or is receiving welfare assistance

Scale:	High	241–300
	Medium	209–240
	Low	100–208

Example:	20 percent professional	60 points
	70 percent skilled	140 points
	10 percent unskilled	10 points
Totals:	100 percent	210 points

Socioeconomic status level: Medium (between 209 and 240)

Minority Representation

The minority representation level of a school is determined by combining the percent of Asian, black, Chicano, and Native American pupils enrolled:

Scale:	High	29–100 percent
	Medium	10–28 percent
	Low	0–9 percent

School Size (Enrollment)

The enrollment figures should be taken from the most recent records available. If significant changes are anticipated, the projected enrollment figure should be used.

Scale:	High	Over 560
	Medium	350–560
	Low	Under 350

City Size (Population)

City size is determined by the combining of population figures for residentially or commercially connected communities.

Scale:	High	Over 200 000
	Medium	50 000–200 000
	Low	Under 50 000
Example:	High	Anaheim–Fullerton–Buena Park (area) Los Angeles
	Medium	Citrus Heights–Carmichael (area)
	Low	Santee–El Cajon (area) Santa Rosa Pacifica

Type of Community

The classifications for the community environment are not quantified, but the "high," "medium," and "low" labels are retained for convenience. If a school's geographic community contains any rural or farming industry, regardless of the extent of residential or industrial development, it falls in the "low" category. If there is no farming but there are old commercial or industrial buildings, substandard dwellings, or predominantly commercial zoned property, then the community falls into the "high" category. Other communities are suburban residential and are labeled "medium." The communities from which bused pupils come are not considered in this classification.

Scale:	High	Old commercial or industrial buildings, substandard dwellings, commercially zoned (no farming)
	Medium	Suburban, residential (no farming, no industry)
	Low	Rural, farming

Pupil Mobility

The pupil mobility index used in this study is the sum of the pupils added to or deleted from the school's enrollment between October 1 and May 1 divided by the actual enrollment on October 1 and expressed in percent. A projected sum for the seven-month period may be used if a trend has been established.

Scale:	High	Over 37 percent
	Medium	23–37 percent
	Low	Under 23 percent

Appendix C | Evaluation of Workshop in Leadership Training

Name (optional) ______________________ Title of position ______________
School ______________________ Telephone number ______________
School address ______________________ City ______________
County ______________________ ZIP code ______________
Workshop leader ______________________ Date ______________

Record of school profile key:

	Socioeconomic status	Minority representation	School size (enrollment)	City size (population)	Type of community	Pupil mobility
H						
M						
L						

Please mark all items which indicate your opinion.

1. **Discussion of the Research:**

☐ Clear ☐ Interesting ☐ Too short ☐ Important
☐ Unclear ☐ Boring ☐ Too long ☐ Unimportant
Comments: ______________________

2. **Marking of Applicable Hypotheses:**

☐ Clear ☐ Interesting ☐ Too short ☐ Important
☐ Unclear ☐ Boring ☐ Too long ☐ Unimportant
Comments: ______________________

3. **Implications of Hypotheses:**

☐ Clear ☐ Interesting ☐ Too short ☐ Important
☐ Unclear ☐ Boring ☐ Too long ☐ Unimportant
Comments: ______________________

4. **Discussion of Workshop in Leadership Training:**

☐ Clear ☐ Interesting ☐ Too short ☐ Important
☐ Unclear ☐ Boring ☐ Too long ☐ Unimportant

Comments: ____________________

5. **General Rating of the Workshop Experience:**

☐ Helpful ☐ Needed ☐ Interesting ☐ Pleasing
☐ Useless ☐ Unneeded ☐ Uninteresting ☐ Disappointing

Comments: ____________________

6. **Plans for Implementation Workshop in Your School:**

☐ Already scheduled (date ____________).
☐ Intend to set date promptly; no problems.
☐ Intend to set date, but there are problems. Explanation: ____________________

☐ Not likely. Explanation: ____________________

7. **Anticipated Attitude of Teachers to Implementation of the Study in Your School:**

☐ Very helpful ☐ Somewhat helpful ☐ Probably helpful ☐ Harmful

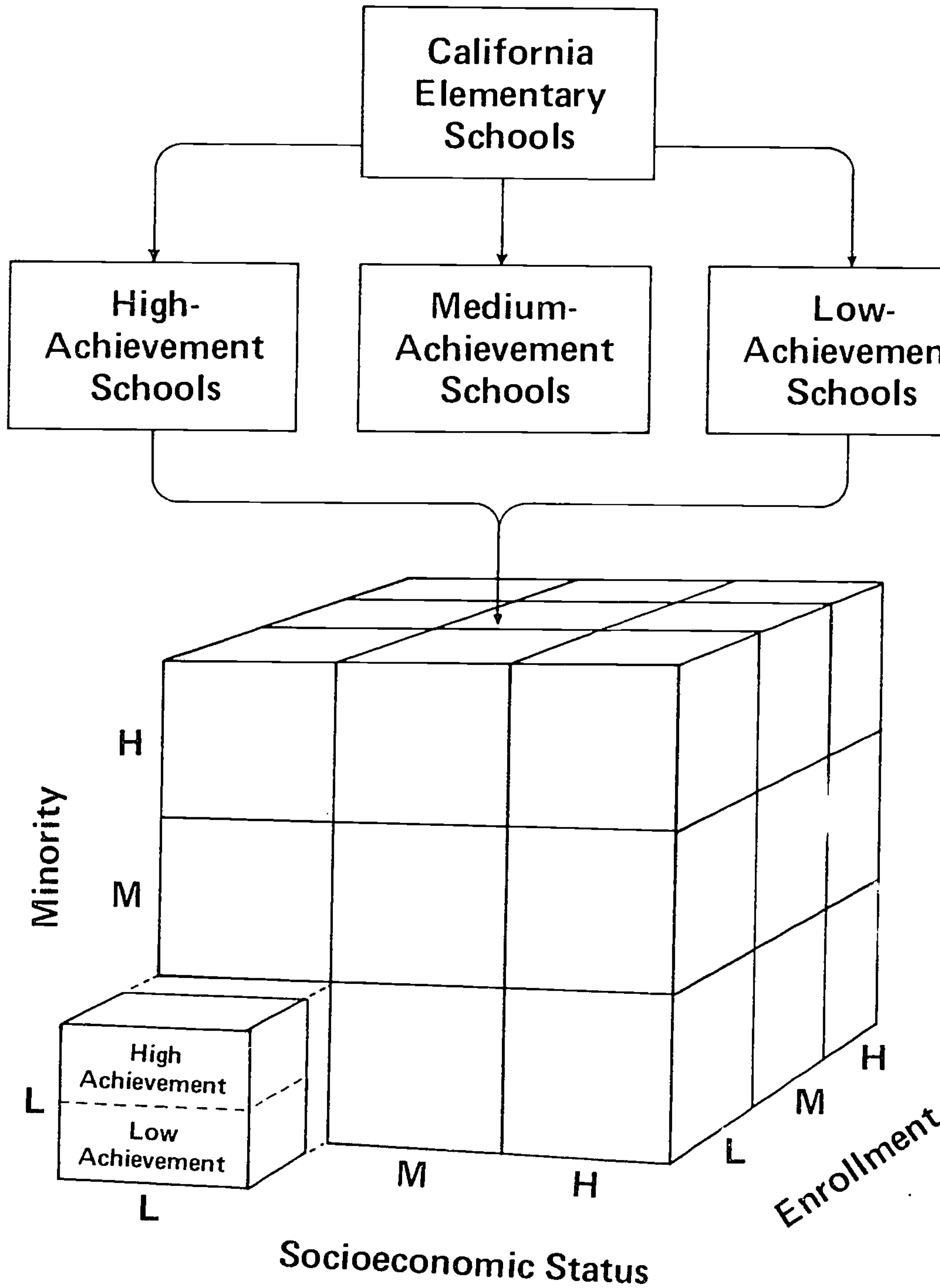
Comments: ____________________

Please hand this evaluation to the leader before leaving. Thank you.

Appendix D

Transparency Masters

Selection of Sample Schools for Mathematics Study



Instruments Used in Mathematics Study at the School Level

1. Teachers' and principals' selection of descriptors for their matł matics program*

2. Teachers' and principals' ranking of ten descriptors for th(mathematics program*

3. Teachers' and principals' ranking of ten methods used to impro their mathematics program*

4. Teachers' and principals' ranking of ten problems that affected tl success of their mathematics program*

5. Teachers' and principals' rating of their success in attaining certa objectives in their mathematics program*

6. Observers' rating of classroom attitudes, behaviors, and atmosphei on the Likert Scale of Opposites

7. Observers' count of types of classroom interactions and techniqu(

8. Information about schools obtained in interviews with the princip;

9. Information about teachers obtained in personal interviews

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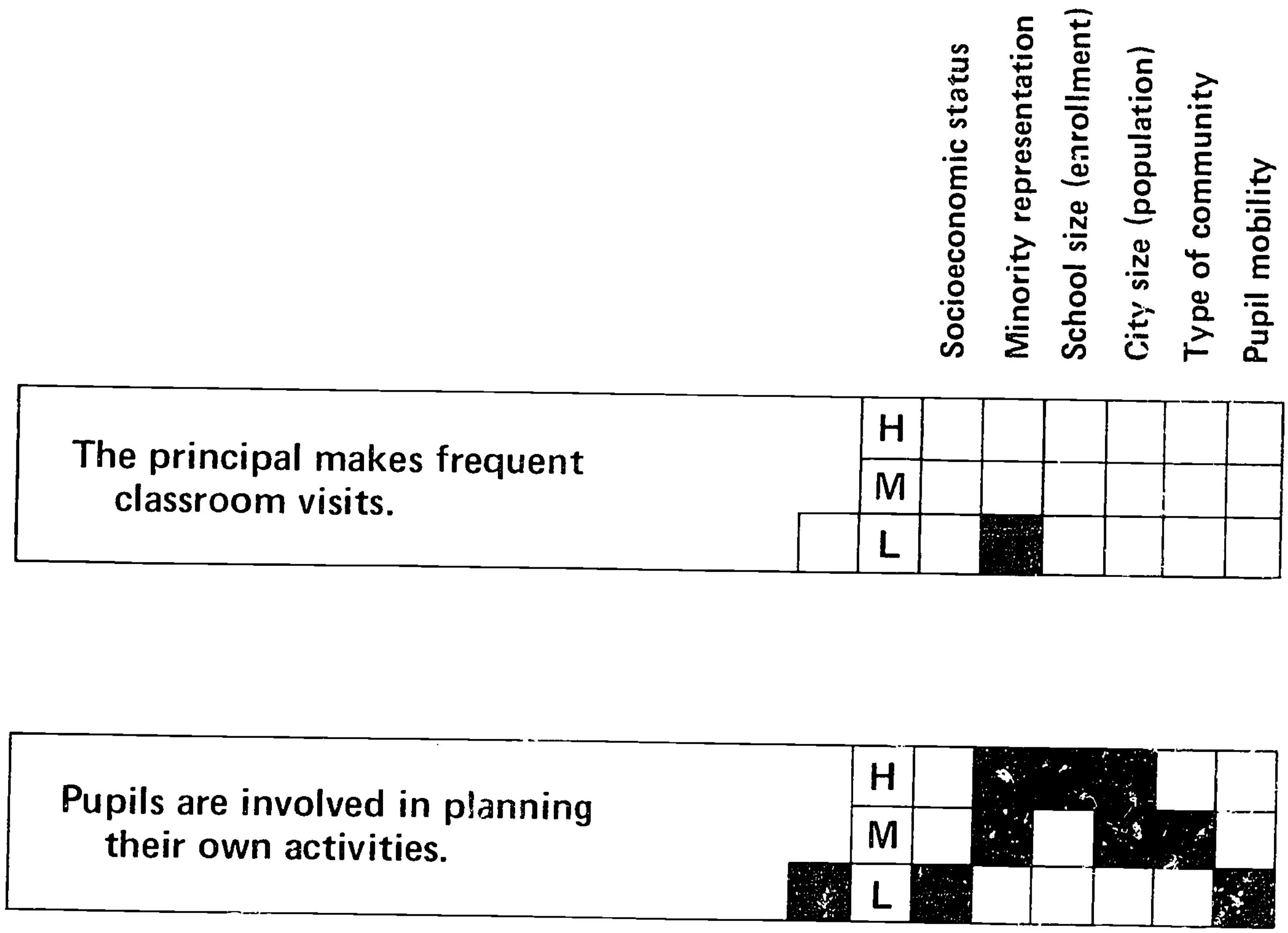
*Anonymous questionnaires

Sample Hypothesis

Pupils tend to exhibit higher achievement patterns if . . .



Categories of Hypotheses

- General classroom teaching styles
- Specific teaching techniques
- Instructional materials
- Teacher/pupil interactions
- Instructional leadership
- Parent/community involvement

School Profile Key

	Low	Medium	High
Socioeconomic status	100–208	209–240	241–300
Minority representation	0–9	10–28	29–100
School size (enrollment)	Under 350	350–560	Over 560
City size (population)	Under 50M	50M–200M	Over 200M
Type of community	Rural	Suburban	Industrial
Pupil mobility	Under 23	23–37	Over 37

School Profile Key

Socioeconomic status	Minority representation	School size (enrollment)	City size (population)	Type of community	Pupil mobility	
						H
						M
						L

____
School name

____
Date

Appendix E | Evaluation of Implementation Workshop

Name (optional)__________ Title of position__________
School__________ Telephone number__________
School address__________ City__________
County__________ ZIP code__________
Workshop leader__________ Date__________

Please mark all items which indicate your opinion:

1. Explanation of Workshop Purpose and Plan:

☐ Clear ☐ Interesting ☐ Too short ☐ Important
☐ Unclear ☐ Boring ☐ Too long ☐ Unimportant

Comments: __________

2. List of Hypotheses:

☐ Clear ☐ Interesting ☐ Too short ☐ Important
☐ Unclear ☐ Boring ☐ Too long ☐ Unimportant

Comments: __________

3. Discussion of Implementation of Hypotheses:

☐ Clear ☐ Interesting ☐ Too short ☐ Important
☐ Unclear ☐ Boring ☐ Too long ☐ Unimportant

Comments: __________

4. General Rating of Workshop Experience:

☐ Helpful ☐ Needed ☐ Interesting ☐ Pleasing
☐ Useless ☐ Unneeded ☐ Uninteresting ☐ Disappointing

Comments: __________

5. Anticipated Effect of This Plan on Improvement of the Mathematics Program in Your School:

☐ Very helpful ☐ Somewhat helpful ☐ Probably helpful ☐ Harmful

6. Additional Information

List the hypotheses by number which seem to you to be most important for improving the mathematics program in your school:

List the hypotheses which you will be most concerned with on your implementation teams:

If you are the leader of a team, (a) circle the numbers of the hypotheses listed above which your team will implement; and (b) briefly describe the plan for implementation as you see it. Use the other side of this sheet.

Please return this evaluation form to the workshop leader.

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SCHOOL PROFILE KEYS

Issued as a supplement to *A Plan for Improving Mathematics Instruction in California Elementary Schools: Final Report of the Mathematics Education Task Force* (Sacramento: California State Department of Education, 1976). The use of the school profile key is explained on page 9 of the publication.

School Profile Key

School name

Date

Socioeconomic status	Minority representation	School size (enrollment)	City size (population)	Type of community	Pupil mobility	
						H
						M
						L

School Profile Key

School name

Date

Socioeconomic status	Minority representation	School size (enrollment)	City size (population)	Type of community	Pupil mobility	
						H
						M
						L

School Profile Key

School name

Date

Socioeconomic status	Minority representation	School size (enrollment)	City size (population)	Type of community	Pupil mobility	
						H
						M
						L

School Profile Key

School name

Date

Socioeconomic status	Minority representation	School size (enrollment)	City size (population)	Type of community	Pupil mobility	
						H
						M
						L

School Profile Key

School name

Date

Socioeconomic status	Minority representation	School size (enrollment)	City size (population)	Type of community	Pupil mobility	
						H
						M
						L

School Profile Key

School name

Date

Socioeconomic status	Minority representation	School size (enrollment)	City size (population)	Type of community	Pupil mobility	
						H
						M
						L

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