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ABSTRACT

Reported in one document are the highlights of the findings of three studies funded by the National Science Foundation to assess needs and practices in pre-college science, mathematics and social studies in the nation's schools. One study involved a questionnaire survey of state, district, and local school personnel. Highlights of these data are presented. A second study focused on 11 in-depth case studies in selected U.S. school systems and the executive summary of these case studies is included in this document. The third study was an extensive literature survey in science, mathematics and social studies. The executive summaries for each discipline are included here. In addition to this information, procedures for obtaining complete copies of each study are given for those readers wishing more data. (PEB)

The Status of Pre-College Science, Mathematics, and Social Studies Educational Practices in U.S. Schools:

An Overview and Summaries of Three Studies

Linda Ingison

Prepared for
National Science Foundation
Directorate for Science Education
Office of Program Integration

This document is one of seven as listed below. They are reports of three complementary studies of the status of pre-college science, mathematics, and social science education.

1. The Status of Pre-College Science, Mathematics, and Social Studies Educational Practices in U. S. Schools: An Overview and Summaries of Three Studies SE 78-71
Stanley L. Helgeson, Robert E. Stake, Iris R. Weiss, et al.
Ohio State University, University of Illinois, and Research Triangle Institute

2. Report of the 1977 National Survey of Science, Mathematics, and Social Studies Education SE 78-72
Iris R. Weiss
Research Triangle Institute

3. The Status of Pre-College Science, Mathematics, and Social Science Education: 1955 - 1975
Volume I: Science Education SE 78-73 Vol. I
Stanley L. Helgeson, Patricia E. Blosser, and Robert W. Howe
Center for Science and Mathematics Education, the Ohio State University

4. The Status of Pre-College Science, Mathematics, and Social Science Education: 1955 - 1975
Volume II: Mathematics Education SE 78-73 Vol. II
Marilyn N. Suydam and Alan Osborne
Center for Science and Mathematics Education, The Ohio State University

5. The Status of Pre-College Science, Mathematics, and Social Science Education: 1955 - 1975
Volume III Social Science Education SE 78-73 Vol. III
Karen B. Wiley with Jeanne Rice
Social Science Education Consortium, Inc.

6. Case Studies in Science Education
Volume I: The Case Reports SE 78-74 Vol. I
Robert E. Stake, Jack Easley, et al.
Center for Instructional Research and Curriculum Evaluation, University of Illinois

7. Case Studies in Science Education
Volume II: Design, Overview and General Findings SE 78-74 Vol. II
Robert E. Stake, Jack Easley, et al.
Center for Instructional Research and Curriculum Evaluation, University of Illinois

NATIONAL SCIENCE FOUNDATION

DIRECTORATE FOR SCIENCE EDUCATION

THE STATUS OF PRE-COLLEGE SCIENCE, MATHEMATICS, AND SOCIAL STUDIES EDUCATIONAL PRACTICES IN U.S. SCHOOLS: AN OVERVIEW AND SUMMARIES OF THREE STUDIES

July 1978

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FOREWORD

There can be no question about it: The two decades of activity in science and mathematics education that began in the mid-fifties are unique in the annals of American education. Under the leadership of the National Science Foundation scientists and educators were mobilized in an unprecendented effort to strengthen science and mathematics learning from elementary school through the post-doctorate.

But what was the lasting outcome? After 20 years of trying to improve instruction in mathematics and in the natural and social sciences, what is the situation today? This question, particularly as applied to elementary and secondary school education, is of interest to the Foundation, to the National Science Board, to Congress, to all of the thousands of teachers and scientists who participated in the reform effort in one way or another, and to education policy makers. It is a question that deserves an answer.

By way of an answer, the NSF decided to try to find out just what the current status is with regard to pre-college science education. After careful thought and considerable external advice, three different kinds of studies were commissioned: a national survey, a series of case studies, and a thorough literature review. This present document contains summaries of the three studies, along with an overview. The full reports are presented in six additional documents.

These studies are part of a continuing review of the National Science Foundation's role in pre-college science, mathematics, and social studies education. We hope they will be of value to all those interested in the education of the nation's youth as well as to the National Science Foundation.

F. James Rutherford
Assistant Director for Science Education
National Science Foundation
Washington, D.C. 20550

July 1978

THE STATUS OF PRE-COLLEGE SCIENCE, MATHEMATICS, AND SOCIAL STUDIES EDUCATION

AN OVERVIEW

Linda Ingison
National Science Foundation

In response to a variety of concerns from within and without the NSF, the Science Education Directorate initiated a major effort aimed at re-examining the Foundation's role in science education at the elementary and secondary school levels. A significant aspect of this re-examination was an effort aimed at assessing needs and practices in pre-college science, mathematics, and social studies in the nation's schools.

A three-way approach to the problem of assessing the status of science education was chosen. The three components of the overall study included an extensive literature review, a national survey of educational practitioners, and a series of in-depth case studies of educational programs and institutions.

The first study contributing to the three-way thrust in assessing pre-college practices and needs, was a nationally representative survey of practitioners. Dr. Iris Weiss of Research Triangle Institute directed the survey effort. The approach utilized was to question state, district, and local school personnel regarding such topics as curriculum usage, course offerings, enrollments, and classroom practices. Superintendents, supervisors, principals and teachers contributed to the data base for this study. The survey findings are reported in one document, while the raw data will be available on computer tape with an accompanying user's manual.

* Report of the 1977 National Survey of Science, Mathematics, and Social Studies Education. SE 78-72. Now available from the U.S. Government Printing Office, Stock Number 038-000-00364-0, $6.50.

* Data tape and User's Manual for the 1977 National Survey of Science, Mathematics, and Social Studies Education. Will be available from the National Technical Information Service in late summer, 1978.

The second study contributing ~~to the~~ overall needs assessment effort involved a number of in-depth case studies. Dr. Robert Stake and Dr. Jack Easley of the University of Illinois co-directed this effort. The approach taken was to conduct 11 simultaneous in-depth case studies in selected school systems in the U.S. Case study findings were then cross-checked by means of a national survey. The findings from this study are available in two volumes.

*Volume I: Case Studies in Science Education. The Case Reports. SE 78-74 I. Available from the U.S. Government Printing Office, Stock Number 038-000-0377-1, $7.25.

*Volume II: Case Studies in Science Education. Design, Overview and General Findings. SE 78-74 II. Available from the U.S. Government Printing Office, Stock Number 038-000-003763, $6.50.

The purpose of the third study, the literature review, was to search out and summarize the available published and unpublished literature on existing practices in schools and in teacher education and to identify existing needs assessment efforts for pre-college science, mathematics, and social studies. The review study was contracted to Ohio State University under the direction of Dr. Stanley Helgeson.

*Volume I: The Status of Pre-College Science, Mathematics, and Social Science Education: 1955-1975. Science Education. SE 78-73 I. Now available from the U.S. Government Printing Office, Stock Number 038-000-00362-3, $4.25.

*Volume II: The Status of Pre-College Science, Mathematics, and Social Science Education: 1955-1975. Mathematics Education. SE 78-73 II. Now available from the U.S. Government Printing Office, Stock Number 038-000-00371-2, $4.50.

*Volume III: The Status of Pre-College Science, Mathematics, and Social Science Education: 1955-1975. Social Science Education. SE 78-73 III. Now available from the U.S. Government Printing Office, Stock Number 038-000-00363-1, $6.25.

Generalized Interpretations of the Findings of the Three Pre-College Status Studies

As in any major research effort of this kind, the implications of the full set of findings and conclusions are difficult to summarize succinctly. However, to be useful, the data must be reduced and generalized. Therefore, this volume contains the executive summaries of each of the studies which were prepared by the authors/contractors.

Further, in order to foster examination and interpretation of the findings of the status studies from the point of view of the practitioners or other users of this data, the NSF has sponsored the development of interpretive documents from eight organizations representing substantial groups of potential consumers of this information. The organizations developing documents are:

National Congress of Parents and Teachers
American Association of School Administrators
National Council for the Social Studies
National Science Teachers Association
National Academy of Science
American Association for the Advancement of Science
National Council of Teachers of Mathematics
Association for Supervision and Curriculum Development

The reports from each organization will be compiled in a single volume which will be available from the U.S. Government Printing Office in the early spring of 1979. The title of this document will be:

Interpretations of the 1977 Status Study of Science, Mathematics, Education and Social Studies.

It is suggested that the Government Printing Office is the best source for printed copies. These can be ordered by title only, but inclusion of stock number and price is helpful. The address is:

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1977 NATIONAL SURVEY OF SCIENCE, MATHEMATICS AND SOCIAL STUDIES EDUCATION HIGHLIGHTS REPORT

Iris R. Weiss

Center for Educational Research and Evaluation
Research Triangle Institute
Research Triangle Park, North Carolina

March 1978

The material in this report is based upon work supported by the National Science Foundation under Contract No. C7619848. Any opinions, findings, and conclusions or recommendations expressed in this publication are those of the author and do not necessarily reflect the views of the National Science Foundation.

PART I: INTRODUCTION

The 1977 National Survey of Science, Mathematics, and Social Studies Education was conducted by the Research Triangle Institute (RTI) under contract to the National Science Foundation (NSF). A national sample of teachers, principals, superintendents and local district supervisors received survey questionnaires, as did all state supervisors of science, mathematics, and social studies in each of the 50 states and the District of Columbia.

The sample design, instrument development, data collection, file preparation, and analysis procedures are described briefly in the remainder of Part I; highlights of the survey results are presented in Part II.

A. Sample Design

This survey utilized a national probability sample of districts, schools, and teachers. The sample was designed so that every superintendent and principal, and every teacher and supervisor of science, mathematics, and social studies in grades K-12 in the United States had a chance of being selected. All public, Catholic, and private schools in the country were included in the target population. This design ensured that national estimates of curriculum usage and classroom practices could be made from the sample data.

The samples were selected using a multistage stratified cluster design. First, approximately 400 public school districts were selected from 102 different geographic areas across the country. Next, schools within these districts were selected to provide a total of approximately 400 schools at each of four grade levels: K-3, 4-6, 7-9, and 10-12.[1] Finally, teachers within each sample school were selected from a list provided by the principal. Three teachers were selected from each K-3 and 4-6 sample school--one to answer questions about science

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[1] A school was eligible for selection if it contained at least one of the grades in the specified grade range. Thus, for example, a K-6 school could have been selected either for the K-3 sample, the 4-6 sample, or both.

instruction, one about mathematics instruction, and one about social studies instruction. Six teachers--two in each subject--were selected from each 7-9 and 10-12 sample school.

B. Instrument Development

The National Science Foundation had defined the areas of interest for this survey to include course offerings, curriculum usage, and classroom practices in science, mathematics, and social studies. Specifically, NSF posed the following questions:

1. What science courses are currently offered in schools?[1]

2. What local and state guidelines exist for the specification of minimal science experiences for students?

3. What texts, laboratory manuals, curriculum kits, modules, etc., are being used in science classrooms?

4. What share of the market is held by specific textbooks at the various grade levels and subject areas?

5. What regional patterns of curriculum usage are evident? What patterns exist with respect to urban, suburban, rural, and other geographic variables?

6. What "hands-on" materials, such as laboratory or activity centered materials, are being used? What is the extent and frequency of their use by grade level and subject matter?

7. What audio-visual materials (films, filmstrips/loops, models) are used? What is the extent, frequency and nature of their use by grade level and subject matter?

8. By grade level, how much time (in comparison with other subjects) is spent on teaching science?

9. What is the role of the science teacher in working with students? How has this role changed in the past 15 years? What commonalities exist in the teaching styles/strategies/practices of science teachers throughout the United States?

10. What are the roles of science supervisory specialists at the local district and state levels? How are they selected? What are their qualifications?

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[1] The National Science Foundation defines science to include the natural sciences, social sciences, and mathematics.

11. How have science teachers throughout the United States been influenced in their use of materials by Federally-supported in-service training efforts in science?

An initial review of the research literature was conducted to locate previous studies in these areas and to identify important variables. A preliminary set of research questions and data sources was developed, submitted to NSF, and revised based on NSF feedback. Preliminary drafts of questionnaires were prepared using items which could be used to answer the research questions. Most of the items were developed specifically for this study, but some were adapted from items appearing in earlier studies.

The preliminary drafts of the questionnaires were reviewed by NSF and by 18 consultants with expertise in science, mathematics, and social studies education. They were also reviewed by representatives of a number of professional organizations including the following: the American Association for the Advancement of Science; the American Psychological Association; the Social Studies Education Consortium; the Educational Products Information Exchange; and the national associations of both state supervisors and local district supervisors of science, mathematics and social studies education. The questionnaires were revised based on feedback from the various reviewers; they were then approved by the Committee on Evaluation and Information Systems (CEIS) of the Council of Chief State School Officers and by the Office of Management and Budget (OMB).

The final versions of the questionnaires included the following topics:

<u>State Supervisor</u>: time spent on various supervision/coordination activities; sources of information; attendance at NSF-sponsored workshops; dissemination of federally-funded curriculum materials; requirements for high school graduation; and problems affecting instruction in their states.

<u>District Curriculum</u>: job responsibilities; professional memberships and activities; sources of information; district guidelines; use of standardized tests; textbook selection; use of federally-funded curriculum materials; and problems affecting instruction in their district.

Superintendent: background information such as district enrollment, type of community, per pupil expenditure, funding sources, number of teachers, and number of district supervisors; and opinions about federal support for curriculum development.

Principal: school enrollment; type of community; principals' qualifications for supervising science, mathematics and social studies instruction; sources of information; attendance at NSF-sponsored activities; school facilities, equipment, and supplies; textbook selection; problems affecting instruction in their school; use of federally-funded curriculum materials; and course offerings and enrollments in science, mathematics, and social studies.

Teacher: number of years teaching; sources of information; needs for assistance; time spent in instruction; teaching techniques; use of audiovisual materials; use of federally-funded curriculum materials; attendance at NSF-sponsored activities; and problems affecting instruction in their school.

C. Data Collection

The Chief State School Officers in the states with sample schools were asked for permission to contact sample districts in their states. District superintendents were subsequently contacted, and after they had granted permission, questionnaires were mailed to teachers, principals, and local district supervisors. In districts with no district supervisors in one or more subject areas, the superintendent was asked to designate a person to answer questions about district programs.

Follow-up activities used to increase the response rates included the use of Thank-You/Reminder postcards, a second questionnaire mail-out, mailgrams, and phone calls. The resulting response rates were 90 percent for state supervisors, 73 percent for superintendents, 72 percent for district supervisors, 84 percent for principals, and 76 percent for teachers.

D. File Preparation and Analysis

Completed questionnaires were edited manually and coded to resolve multiple responses (for example, when a teacher said 50-60 minutes were typically spent on mathematics instruction, the average value of 55 minutes was used) and to assign numeric values to open-ended responses (for example, each different textbook which was written in was assigned a code number). The data were then transformed to machine-readable form using programmable terminals, and a number of machine-editing checks were performed. Responses which were outside the acceptable range for each item were coded as "bad data" and excluded from the analyses (for example, if the number of minutes reportedly spent in a lesson exceeded the number of minutes in the school day).

The final step in file preparation was the addition of sampling weights to the file. The weight assigned to each sample member was the inverse of the probability of being selected into the sample; these weights were then adjusted for nonresponse of sample members. All results of the survey were calculated using weighted data.

It should be emphasized that these data, as in all surveys, are based on the self-report of respondents. For example, the average number of minutes spent on instruction in a subject was determined not by actual classroom observations but from teachers' estimates of time spent. In addition, the results of any sample survey, as opposed to a census of the entire population, are subject to sampling variability; it is expected that the results would not be exactly the same if a second random sample were drawn. For these reasons, the reader should exercise caution in interpreting these survey results, particularly in cases where the reported differences between groups are small.

PART II: RESULTS

A. Federally-Funded Curriculum Materials

1. Attendance at NSF-Sponsored Institutes, Conferences, and Workshops

Since 1955 the National Science Foundation has sponsored a variety of workshops, institutes, and conferences to increase the subject matter competency of science, mathematics, and social science materials. Since it is likely that many of the people who participated in these activities are no longer teaching, NSF records could not be used to determine the percentage of current teachers in these subject areas who have been reached by these activities. Therefore, sample members in this survey were asked if they had attended one or more NSF-sponsored activities and, if so, the particular types they had attended.

Figure 1 shows the percentages of current teachers who have attended one or more NSF-sponsored workshops, conferences, or institutes. Note that many more science and mathematics teachers than social studies teachers have participated in these activities. Also,

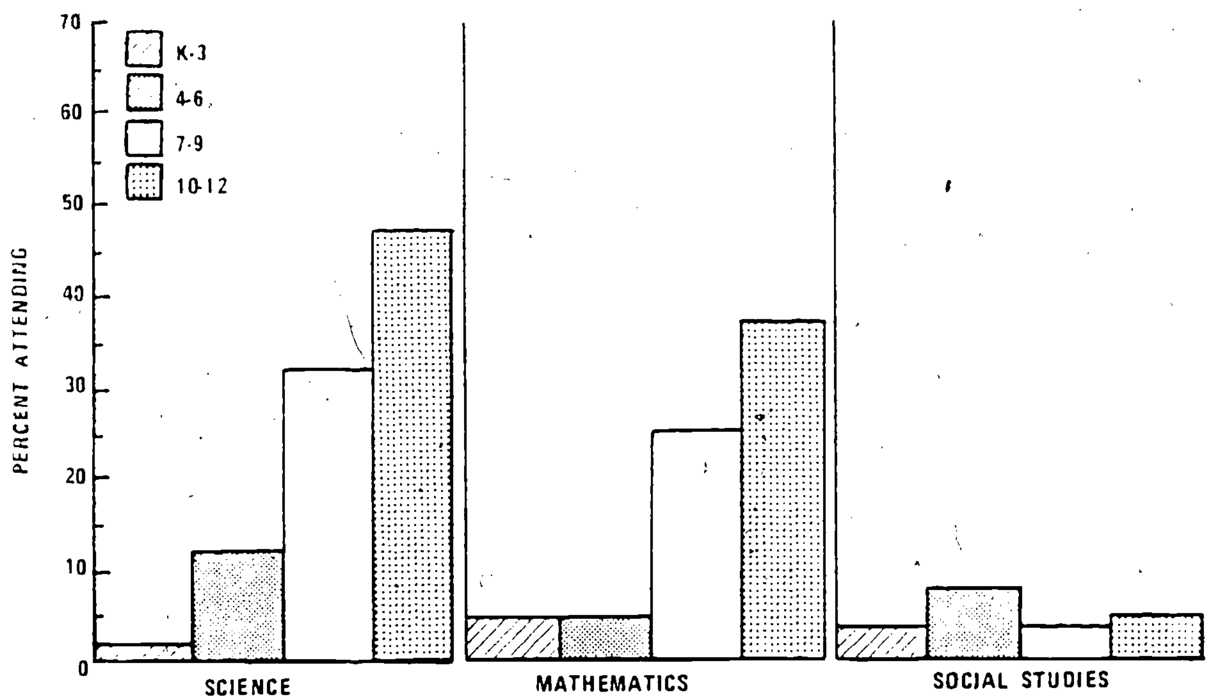

FIGURE 1: TEACHER ATTENDANCE AT NSF-SPONSORED INSTITUTES, WORKSHOPS, AND CONFERENCES

the level of participation generally increases with increasing grade level, with more than one-third of all high school mathematics teachers and almost half of all high school science teachers having participated in at least one such activity. NSF Summer Institutes and In-Service Institutes, both offered prior to 1974 only, served the largest numbers of teachers. The percentages attending NSF activities since 1974 are lower because relatively few teachers have had the opportunity to participate in these activities in the last several years.

2. Use of Federally-Funded Curriculum Materials

In addition to its teacher education activities, the National Science Foundation has supported the development of K-12 science, mathematics, and social science curricula for more than 20 years, beginning with the work of the Physical Science Study Committee (PSSC) in 1956. A major purpose of this national survey was to determine the current extent of use of the NSF-sponsored curriculum materials as well as use of other materials developed with federal funds. As can be seen in Figure 2, by far the most extensive usage of federally-funded curriculum materials is in science in grades 7-12; a total of 60 percent of the districts are using one or more of these materials, with 41 percent using more than one. At the K-6 level, approximately one-third of the districts are using one or more of the science curriculum materials. In social studies, the figures are 25 percent for grades K-6 and 24 percent for 7-12; and in mathematics fewer than 10 percent of the districts are using any of the federally funded curriculum materials.

The most commonly used of the federally-funded science and social studies materials are shown in Table 1. At both the K-6 and 7-12 grade levels, none of the federally-funded mathematics curriculum materials is used in as many as 5 percent of the districts. However, these figures are misleading. As was intended when these materials were developed, a number of the "innovations" have been incorporated into other commercially available textbooks which are being used in many districts.

Figure 3 shows the percent of teachers in each subject and grade range who are using at least one of the federally-funded curriculum materials. Note that the percent of teachers using these materials

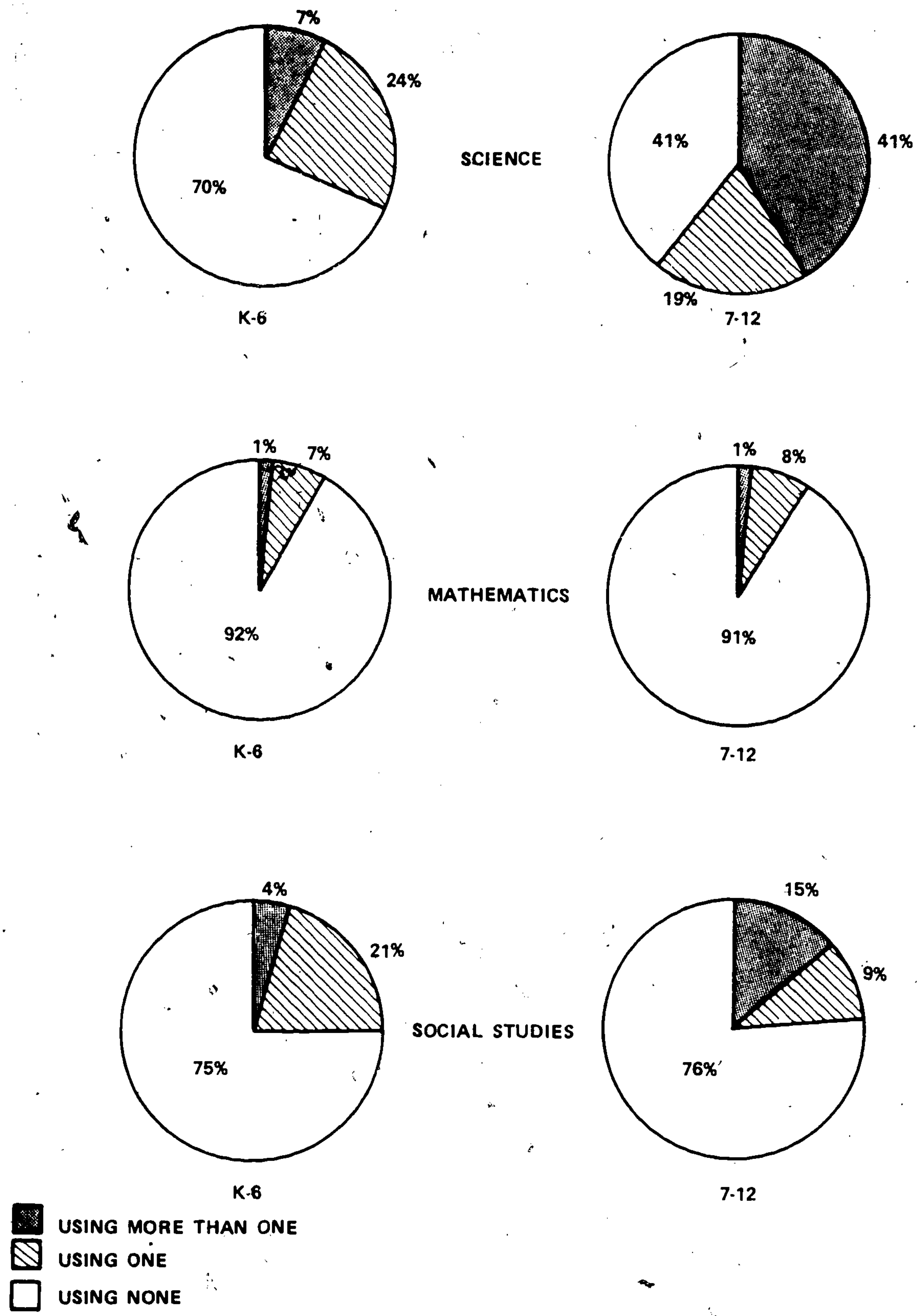

FIGURE 2: DISTRICT USE OF FEDERALLY FUNDED CURRICULUM MATERIALS IN 1976-77 SCHOOL YEAR

Table 1

FEDERALLY-DEVELOPED CURRICULUM MATERIALS BEING USED BY MORE THAN 5 PERCENT OF SCHOOL DISTRICTS

Curriculum Materials	Percent of Districts Using Materials
K-6 Science	
1. Elementary Science Study (ESS)	15
2. Science--A Process Approach (SAPA)	9
3. Science Curriculum Improvement Study (SCIS)	8
7-12 Science	
1. Introductory Physical Science (IPS)	25
2. Biological Science: An Ecological Approach (BSCS Green)	19
3. Biological Science: An Inquiry Into Life (BSCS Yellow)	16
4. Chemical Education Materials Study (CHEMStudy)	15
5. Probing the Natural World--Intermediate Science Curriculum Study (ISCS)	12
6. Project Physics Course (Harvard)	12
7. Physical Science Study Committee Physics (PSSC)	11
8. Investigating the Earth--Earth Science Curriculum Project (ESCP)	10
9. Biological Science: Molecules to Man (BSCS Blue)	8
10. Individualized Science Instructional System (ISIS)	7
11. Biological Science: Patterns and Processes	6
K-6 Social Studies	
1. Elementary Social Science Education Program Laboratory Units (SRA)	12
2. Our Working World	8
7-12 Social Studies	
1. American Political Behavior	12
2. Carnegie-Mellon Social Studies Curriculum Project (Holt Social Studies Curriculum)	10
3. Sociological Resources for the Social Studies (SRSS)	7

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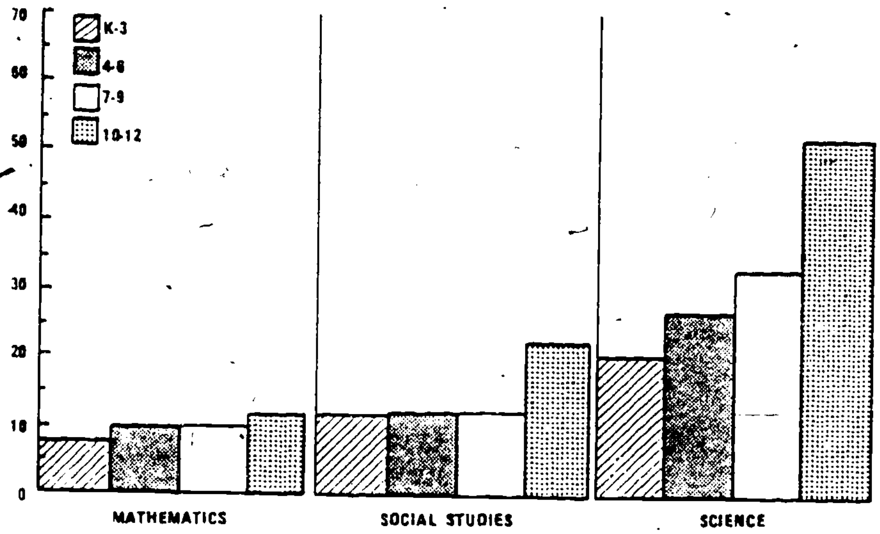

FIGURE 3: PERCENT OF TEACHERS USING ONE OR MORE OF THE FEDERALLY FUNDED CURRICULUM MATERIALS

tends to increase with increasing grade range. In fact, slightly more than half of all grade 10-12 science teachers were using one or more of the federally-funded science curriculum materials during the 1976-77 school year.

3. Superintendents' Opinions About Federal Support for Curriculum Development

Superintendents were asked to indicate if they agree or disagree with each of a number of statements about federal support for curriculum development. While 58 percent of superintendents agree that federal support for curriculum development and dissemination has improved the quality of curriculum alternatives available to schools, only 27 percent believe that these efforts have greatly improved the quality of classroom instruction. Most superintendents (66 percent) believe that continued federal support for curriculum development during the next 10 years is necessary, with 77 percent feeling that NSF should continue to help teachers learn to implement NSF-funded curricula, and 55 percent believing that the federal government should direct more attention toward disseminating the new curricula.

One frequently heard comment about federal support for curriculum development has been that it tends to create a nationally uniform curriculum; superintendents were about equally divided on this issue. Another area of frequent disagreement is whether or not federally-funded curriculum projects should deal with controversial topics; 34 percent of superintendents believe that they should not, while 60 percent believe they should, and 6 percent did not answer the question.

B. Science, Mathematics, and Social Studies Teachers

The average science, mathematics, and social studies teacher has been teaching for approximately 12 years; in general, differences among the subjects and grade ranges are quite small. Figure 4 shows the breakdown by sex of teachers in each of the four grade ranges. The results are consistent with the findings of a number of other studies: very few K-3 teachers are male, but most high school science, mathematics, and social studies teachers are male.

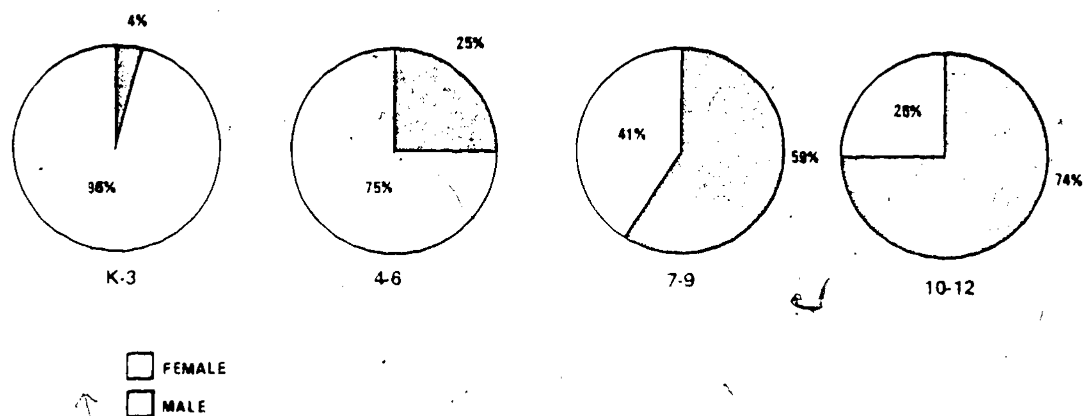

FIGURE 4: PERCENT OF MALE AND FEMALE SCIENCE, MATHEMATICS, AND SOCIAL STUDIES TEACHERS, BY GRADE RANGE

Most elementary school teachers teach in self-contained classrooms, that is, the teacher is responsible for instruction in all academic subjects. There is evidence, however, that the teachers do not feel equally prepared to teach all of these subjects. As shown in Figure 5, nearly two-thirds of all elementary teachers feel very well qualified to teach reading while only 22 percent feel very well qualified to teach science. Similarly, at the other end of the scale, 16 percent of elementary teachers feel "not well qualified" to teach science, compared to 6 percent or fewer in each of the other three subject areas.

It is interesting to note that elementary teachers' perceptions about their qualifications for teaching the various subjects are consistent with the amount of time that is generally spent in instruction in these areas. Teachers in self-contained classes reported spending the most time on reading and the next largest amount of time on mathematics instruction. The emphasis on "the basics" apparently leaves very little time for instruction in science and social studies. As can be seen in Figure 6, students in grades K-3 spend an average of only about 20 minutes each day on science and on social studies. Note that the difference between the amount of time spent on reading and that spent on other subjects decreases from K-3 to 4-6.

More than half of all school districts in the country, especially small districts and those in rural areas, have no persons responsible for district-wide supervision or coordination. And, as shown in Figure 7, while approximately 75 percent of schools with grades 10-12 have science, mathematics, and social studies department chairmen, more than half of all elementary and junior high schools do not. Furthermore, while 90 percent or more of elementary school principals feel "adequately qualified" or "very well qualified" to supervise instruction in reading, mathematics, and social studies, almost 20 percent feel "not well qualified" for science supervision. Thus, the elementary school teacher who feels inadequately prepared to teach science (and 1 out of 6 feels this way) may not be able to get help from the principal, and is unlikely to have a science department chairman or a district science supervisor to turn to for help.

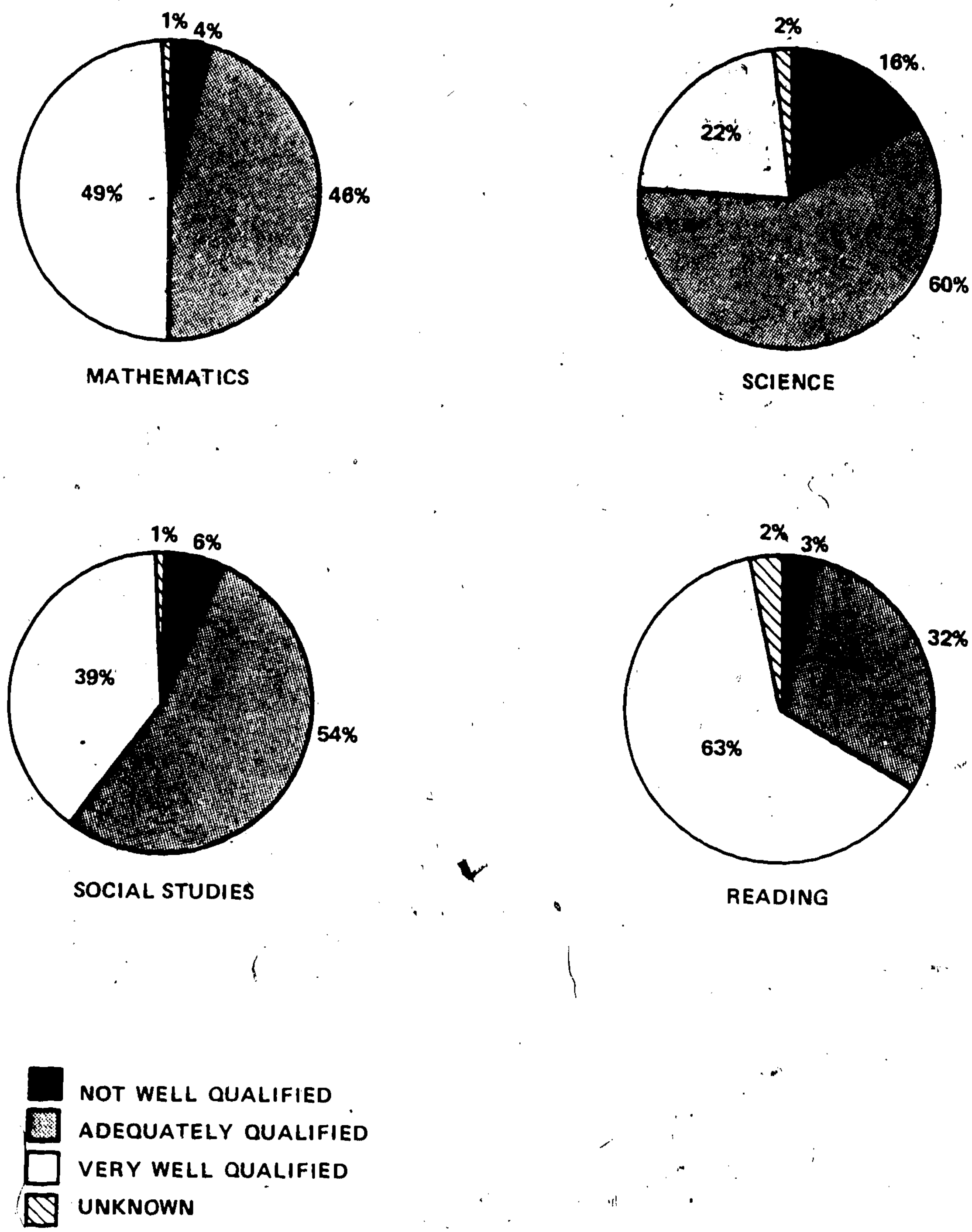

FIGURE 5: ELEMENTARY TEACHERS' PERCEPTIONS OF THEIR QUALIFICATIONS TO TEACH MATHEMATICS, SCIENCE, SOCIAL STUDIES, AND READING

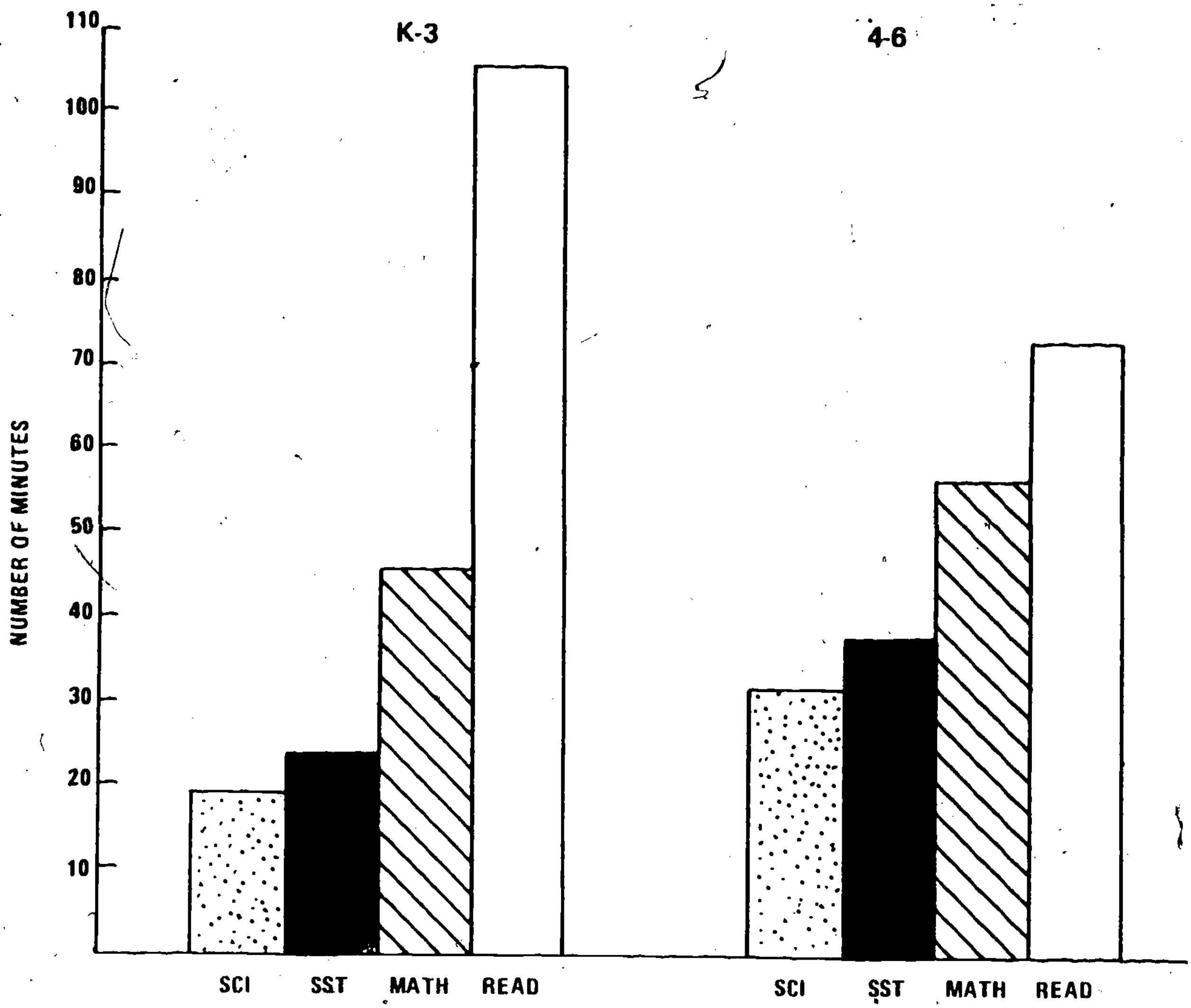

FIGURE 6: AVERAGE NUMBER OF MINUTES PER DAY SPENT TEACHING EACH SUBJECT IN SELF-CONTAINED CLASSES

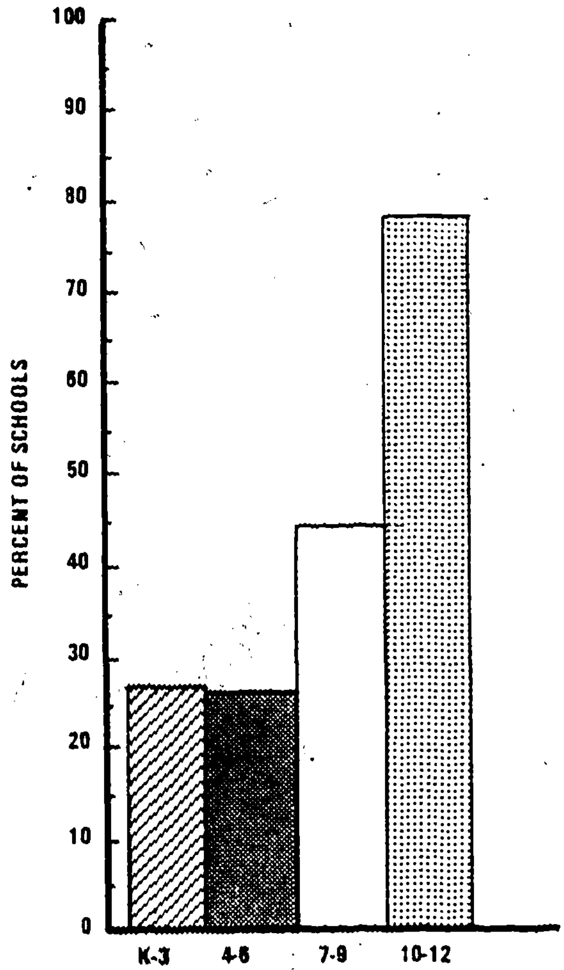

FIGURE 7: PERCENT OF SCHOOLS WITH DEPARTMENT CHAIRMEN BY GRADE RANGE

The perception that one is inadequately qualified for teaching certain subjects is not limited to elementary school teachers. Secondary teachers were asked to indicate if they are teaching any courses that they do not feel adequately qualified to teach, and if so, to specify the courses. Approximately 12 percent of the science, mathematics, and social studies teachers specified one or more courses. Interestingly, the vast majority of these teachers listed courses in their sample subject area; for example, most of the science teachers who indicated they are inadequately qualified to teach one or more courses were referring to courses within science. The problem of teaching "out of field" is apparently a greater problem within each major discipline than across disciplines.

Teachers were asked to indicate specific areas in which they would like assistance from a subject matter resource person but receive little or none, those areas in which they are already receiving adequate assistance, and those in which they usually do not need assistance from a subject matter resource person. More than 75 percent of all science, mathematics, and social studies teachers indicated they do not usually need assistance in lesson planning, actually teaching lessons, and maintaining discipline. Areas in which a sizable number of teachers would like additional assistance include obtaining information about instructional materials, learning new teaching methods, implementing the discovery/inquiry approach, and using manipulative or hands-on materials.

Teachers were also given a list of possible sources of information about new developments in education and were asked to rate the utility of each. The results showed that many science, mathematics, and social studies teachers rely on other teachers for information; approximately half of them rate this source "very useful" while most of the others consider teachers "somewhat useful." Other particularly valuable sources of information for teachers include: journals and other professional publications, especially for teachers in the higher grades; college courses; and for elementary teachers, local in-service programs. Principals, local subject specialists, federally sponsored workshops, meetings of professional organizations, and publishers and sales representatives are also considered useful sources of information by quite a few teachers, while the majority of teachers rated teacher union meetings and state department personnel as "not useful."

C. Instructional Materials and Techniques

The textbook continues to play a central role in science, mathematics, and social studies classes. With the exception of K-3 science and social studies, virtually all science, mathematics, and social studies classes use published textbooks or programs.[1] While most classes use a single textbook or program, approximately one-third use

[1] Approximately one-third of K-3 science and social studies classes use no published textbook or program.

multiple textbooks. In most districts, teacher committees and individual teachers are heavily involved in selecting the textbooks to be used. In many cases principals, superintendents and district-wide supervisors are also involved in these decisions. Very few districts involve students, parents or school board members to any great extent in the textbook selection process.

Lecture and discussion are the predominant techniques used in science, mathematics, and social studies classes. Discussion occurs "just about daily" in half or more of these classes. Approximately two-thirds of the classes in each subject have lecture once a week or more, with many of these having lectures "just about daily."

Science and social studies classes are generally more likely than mathematics classes to use alternative activities such as library work, student projects, field trips, and guest speakers. Similarly, films, filmstrips, film loops, slides, tapes, and records are more frequently used in science and social studies classes than in mathematics classes. On the other hand, individual assignments, chalkboard work, and tests occur more frequently in mathematics classes than in social studies or science classes. Televised instruction, programmed instruction, computer-assisted instruction, and contracts are rarely used in any of the three subjects. Finally, simulation activities (e.g., role-play, debates, panels) are common in social studies but rare in science and mathematics.

The use of "hands-on" or manipulative materials is most frequent in science classes, with 48 percent of the classes using them at least once a week compared to 38 percent of mathematics classes and 24 percent of social studies classes.[1] Figure 8 shows the frequency of use of manipulatives in science classes in the four grade ranges. Note that the overall use of manipulatives in science classes increases with increasing grade level. Meter sticks and rulers are frequently used at all grade levels, while living plants and animals are frequently used in the lower grades, and balances and scales are frequently used in the

[1] While manipulatives are used more frequently in science classes than in mathematics and social studies classes, science educators may be concerned that 9 percent of science classes never use manipulative materials and another 14 percent do so less than once a month.

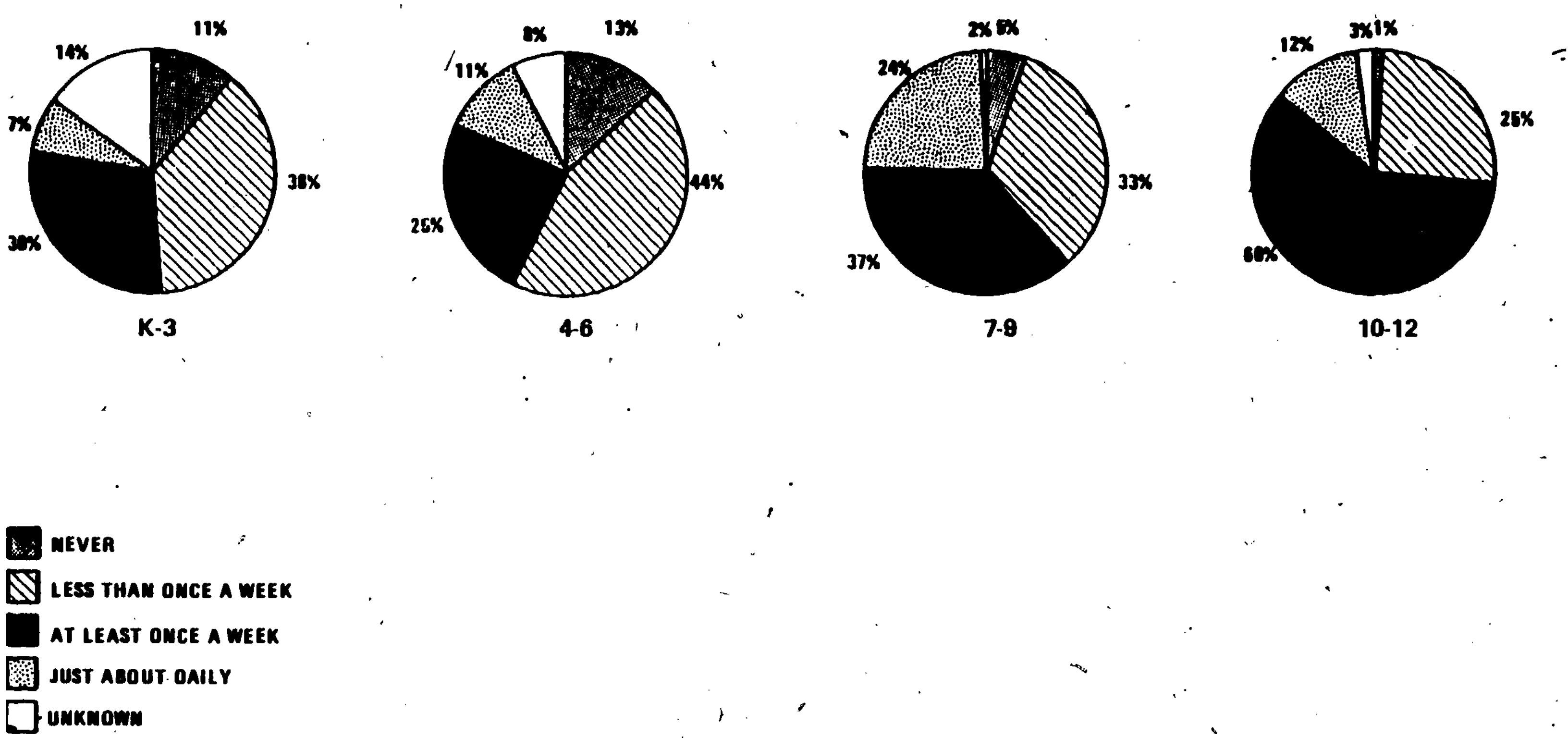

FIGURE 8: USE OF MANIPULATIVES IN SCIENCE CLASSES

higher grades. Interestingly, science teachers who have attended one or more NSF-sponsored activities are considerably more likely than other science teachers to use manipulative materials in their classes. (This is not the case for mathematics or social studies teachers.)

In mathematics, the use of manipulatives is more common in the lower grades. Games and puzzles, activity cards or kits, and numeration and place value manipulatives such as rods and blocks are frequently used in grades K-6. At all grade levels, non-metric measurement tools are more frequently used than metric measurement tools. In social studies, the use of manipulatives is again more common in the lower grades, with maps, charts, and globes being used quite frequently.

Science and mathematics teachers were asked about the use of the metric system in their classes. As shown in Figure 9, the use of metric concepts increases with increasing grade level in science classes; approximately 90 percent of the 7-9 and 10-12 science classes make use of the metric system. In mathematics, on the other hand, use is higher in the lower grades; by grades 10-12 only 56 percent of mathematics classes use metric concepts. In addition, mathematics classes are more likely to use the metric system only in a special unit, while science classes are more likely to introduce the concepts in a special unit and then use them throughout the course.

D. Facilities, Equipment and Supplies

Principals were asked if each of a number of types of equipment is available in their schools. The results, shown in Figure 10, indicate that secondary schools are considerably more likely than elementary schools to have greenhouses, computers or computer terminals, hand-held calculators, and darkrooms.

Teachers were asked about the actual use of various types of equipment. The results showed that some types of equipment are available in many schools but are used in relatively few classes. For example, while more than three-fourths of elementary schools have microscopes, only 28 percent of the K-3 science classes and 59 percent of the 4-6 science classes ever make use of them. Similarly, while 36 percent of 10-12 schools have computers or computer terminals, only 9 percent of 10-12 science classes and 16 percent of 10-12 mathematics classes ever use them.

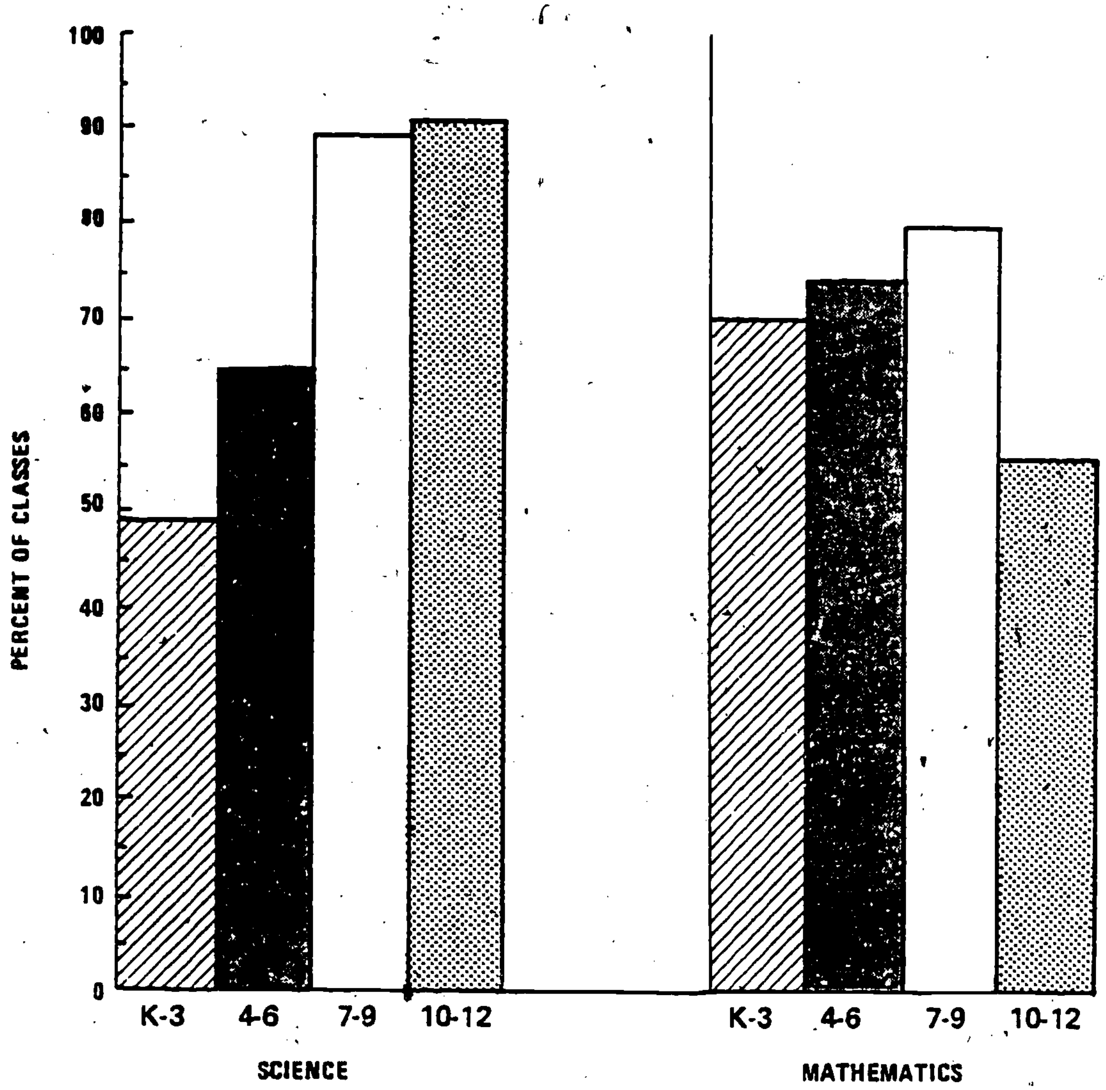

FIGURE 9: USE OF THE METRIC SYSTEM IN SCIENCE AND MATHEMATICS CLASSES

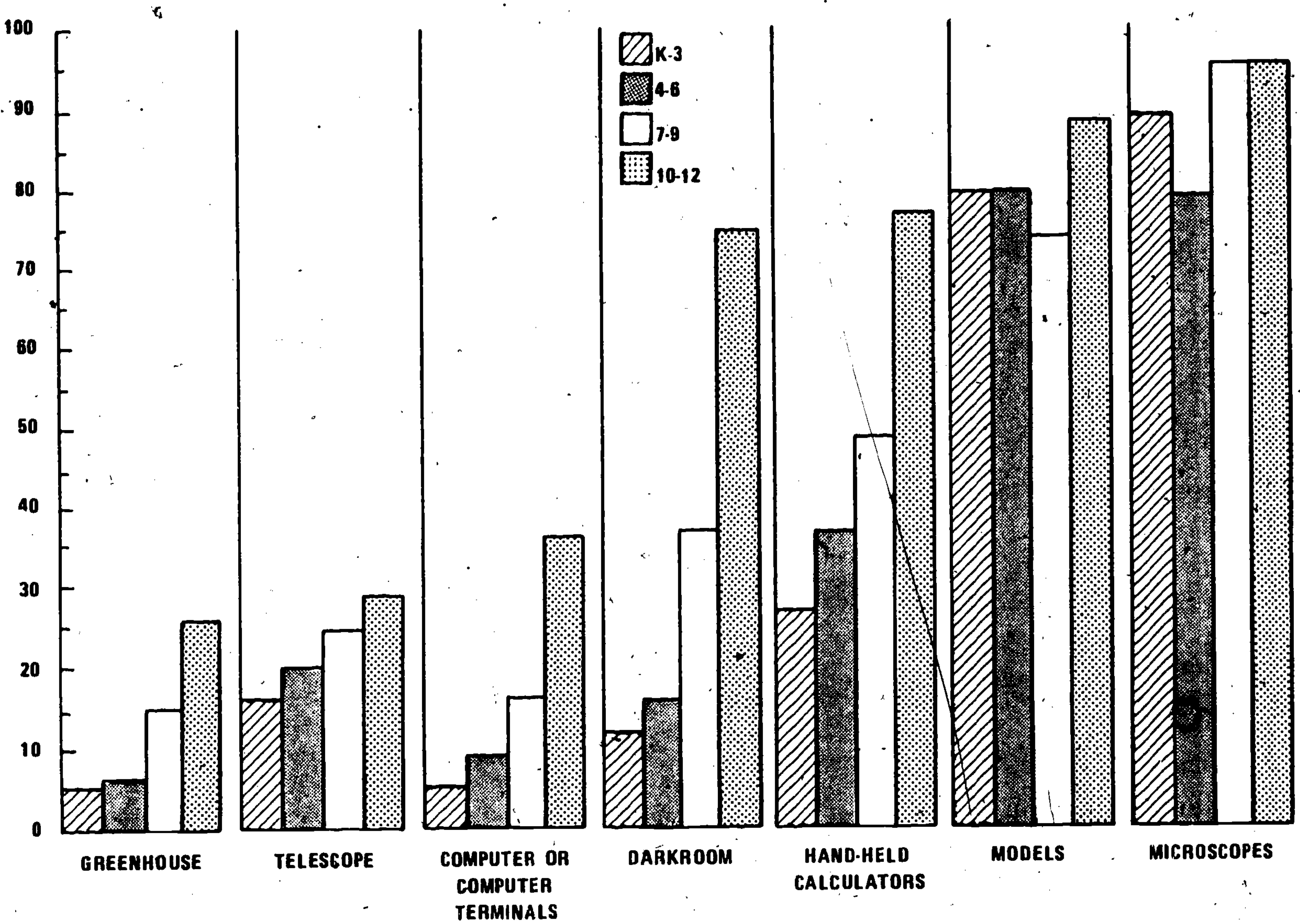

FIGURE 10: AVAILABILITY OF EQUIPMENT IN SCHOOLS, BY GRADE RANGE

Teachers of science in grades K-6 were also asked about the facilities they use for teaching their classes. Slightly more than half of all elementary school classes receive science instruction in classrooms with portable science materials. As shown in Figure 11, only 4 percent of the elementary science classes (and virtually all of these are grade 4-6 classes) are conducted in laboratories or special science rooms; more than a third of the classes are conducted in classrooms with no science facilities at all.

Teachers were also asked to rate the adequacy of various aspects of facilities, equipment and supplies for teaching their classes. The two areas rated "improvement needed" by more than half of the teachers were availability of laboratory assistants or paraprofessional help and money to buy supplies on a day-to-day basis. These two problems were considered serious in all subjects and at all grade levels.

E. State and Local District Supervision/Coordination

State course requirements for high school graduation are heavier in social studies than in mathematics or science: in grades 9-12, most states require only 1 year of mathematics and science but more than 1

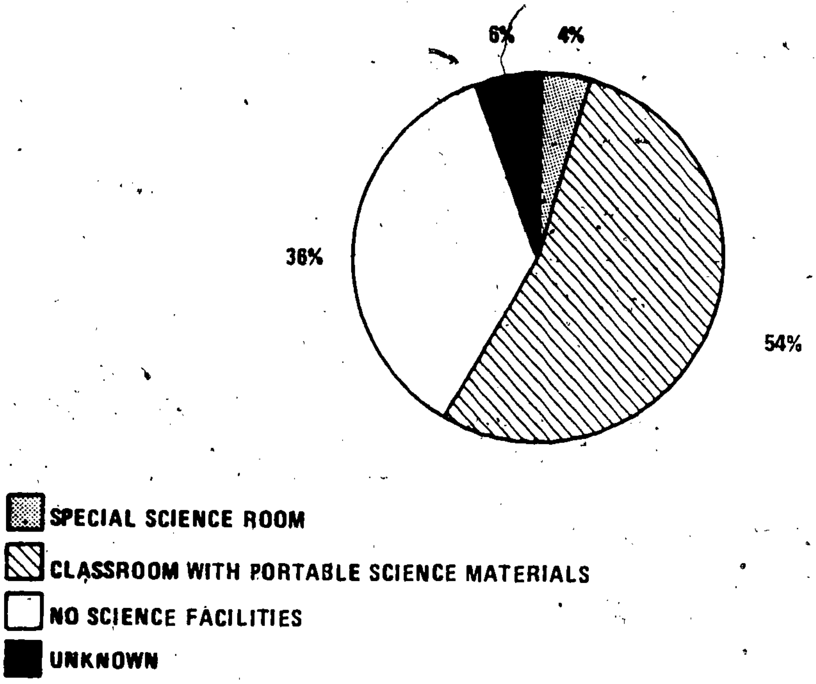

FIGURE 11: TYPES OF CLASSROOMS USED BY K-6 SCIENCE CLASSES

year of social studies. Very few states currently require specific competencies in these subjects, but a number of states are planning to implement such programs. Approximately a third of the states are planning to implement competency programs in mathematics, while 22 percent plan to do so for social studies and 13 percent for science.

Approximately 25 percent of the states and 40 percent of the districts set guidelines for minimum instructional time in one or more of the elementary grades. Relatively few districts set guidelines for kindergarten instruction, and those that do recommend a minimum of only approximately 15 minutes per day each for science, mathematics, and social studies. In grades one through three the recommended minimum time for mathematics is 30 minutes on the average, while the recommended minimums for science and social studies are approximately 20 minutes each per day. In the higher elementary grades the recommended minimum times for the 3 subjects are all in the 30 to 40 minute range, with no major differences between subjects.

In addition to questions about district requirements and curricula, respondents to the district curriculum questionnaires were asked about their professional activities. While allegiance to a particular subject area appears to be stronger at the secondary level than at the elementary level, in no case did as many as a third of the respondents indicate membership in their subject area's professional organizations, e.g., the National Council of Teachers of Mathematics, the National Science Teachers Association and the National Council for the Social Studies. Similarly, fewer than 50 percent of the respondents reported attending a professional meeting in the subject of interest at the state, regional or national level during the 1975-76 school year.

F. Factors Which Affect Instruction in Science, Mathematics, and Social Studies Education

Insufficient funds for purchasing equipment and supplies, and lack of materials for individualizing instruction are serious problems affecting K-12 science, mathematics, and social studies instruction according to all groups queried (teachers, principals, and state and local supervisors). Inadequate facilities are also considered a serious problem in science at all grade levels. Interestingly, all groups except teachers consider inadequate articulation of instruction across grade levels to be a serious problem.

Several problems appear more serious in the elementary grades than in the secondary grades, including lack of teacher planning time in all three subjects. For elementary science and social studies, the belief that these subjects are less important than others and inadequate time to teach these subjects are also considered major problems. It is interesting to note that all groups except the teachers themselves consider inadequate teacher preparation and lack of teacher interest to be major problems in K-6 science instruction.

Two problems are considered serious for science, mathematics and social studies instruction in grades 7-12: inadequate student reading abilities and lack of student interest in the subject.

Surprisingly, difficulty in maintaining discipline was not rated a serious problem for science, mathematics, or social studies instruction by teachers, principals, or state and local supervisors. This result is not consistent with findings of some other recent studies which indicate great concern over discipline-related issues.

FOR MORE INFORMATION:

A more detailed treatment of the results of this survey can be found in the technical report. Copies of the technical report of the 1977 National Survey of Science, Mathematics, and Social Studies Education and additional copies of this Highlights Report may be obtained from the ERIC Document Reproduction Service (EDRS)[1] and from the National Technical Information Service.[2] Copies will also be available from the Government Printing Office.[3] In addition, persons interested in using the survey data to conduct additional analyses may obtain a copy of the Public Release Data Tape and the accompanying User's Manual from the National Technical Information Service.

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CASE STUDIES IN
SCIENCE EDUCATION
EXECUTIVE SUMMARY
(CHAPTER 19)

Robert Stake and Jack Easley

Center for Instructional Research and Curriculum Evaluation
and
Committee on Culture and Cognition
University of Illinois-Urbana-Champaign

January 1978

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The Project

Case Studies in Science Education is a collection of field observations of science teaching and learning in American public schools during the school year 1976-77. The study was undertaken to provide the National Science Foundation with a portrayal of current conditions in K-12 science classrooms to help make the foundation's programs of support for science education consistent with national needs. It was organized by a team of educational researchers at the University of Illinois.

Eleven high schools and their feeder schools were selected to provide a diverse and balanced group of sites: rural and urban; east, west, north and south; racially diverse; economically well-off and impoverished; constructing schools and closing schools; innovative and traditional. They were finally selected so that a researcher with ample relevant field experience could be placed at each. To confirm findings of the ethnographic case studies and to add special information, a national stratified-random-sample of about 4000 teachers, principals, curriculum supervisors, superintendents, parents, and senior class students were surveyed. Survey questions were based on observations at the eleven case-study sites.

The field researchers were instructed to find out what was happening, what was felt important, in science (including mathematics and social science) programs. On site from 4 to 15 weeks they were not required to coordinate their work with observers at other sites. Questions originally indicated important by the NSF or identified early in the field were "networked" by the Illinois team. Efforts to triangulate findings were assisted by reports of site visit teams.

Each observer prepared a case study report which was preserved intact as part of the final collection, and later augmented with cross-site conclusions by the Illinois team. The cost of the study was just under $300,000, taking 18 months actual time and about 6 research-person years to complete.

In the principal findings it was noted that each place was different in important ways, that each teacher made unique contributions. Nationally we found that science education was being given low priority, yielding to increasing emphasis on basic skills (reading and computation). Still, the CSSE-high-school science faculties worked hard to protect courses for the college-bound, with many of these courses kept small by prerequisites and "tough" grading. Only occasional efforts were made to do more than "read about" science topics in most of the elementary schools. Although ninth-grade biology and eighth-grade general science flourished general education aims for science instruction were not felt vital at any level. Seldom was science taught as scientific inquiry--all three subjects were presented as what experts had found to be true. School people and parents were supportive of what was chosen to be taught, complaining occasionally that it was not taught well enough. The textbook usually was seen as the authority on knowledge and the guide to learning. The teacher was seen to be the authority on both social and academic decorum. He or she worked hard to prepare youngsters for tests, subsequent instruction, and the value-orientations of adult life. Though relative free to depart from district syllabus or community expectation, the teacher seldom exercised either freedom.

Each of the above statements is only partly correct. This summary is a drastic oversimplification of the circumstances observed by the field people and portrayed in the case study reports. The picture at each of the sites--seen through the experienced but singular eyes of our observer--is a special picture, greatly influenced by the administrators, the parents, an the students encountered; colored with technical, professional, economic and social problems. Somehow the pictures do not aggregate across sites to be either the picture of national education represented by the popular press (though no less aggrieved) or that presented in the professional education publication (though no less complicated). It is an interesting collection.

Robert E. Stake
Jack A. Easley, Jr.
Codirectors

LIST OF CASE STUDY SITES

	Code Name	Description	Field Observer
1	RIVER ACRES	a suburb of Houston	Terry Denny
2	FALL RIVER	a small city in Colorado	Mary Lee Smith
3	ALTE	a suburb of a large Midwestern city	Louis M. Smith
4	BRT	a consolidated district in rural Illinois	Alan Peshkin
5	URBANVILLE	a metropolitan community of the Pacific Northwest	Wayne W. Welch
6	PINE CITY	a rural community in Alabama	Rob Walker
7	WESTERN CITY	a small city in middle California	Rodolfo G. Serrano
8	COLUMBUS	the Columbus, Ohio, school district	James R. Sanders & Daniel L. Stufflebeam
9	ARCHIPOLIS	an Eastern middle seaboard city	Jacquetta Hill-Burnett
0	VORTEX	a small city in Pennsylvania	Gordon Hoke
1	GREATER BOSTON	an urban section in metropolitan Boston	Rob Walker

CASE STUDIES IN SCIENCE EDUCATION--ROSTER

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Tom Hastings Gordon Hoke Jennifer McCreadie Charles Secolsky
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Jacquetta Hill-Burnett, anthropologist, University of Illinois
Gordon Hoke, specialist in innovation and school-community relations, University of Illinois
Alan Peshkin, comparative education specialist, University of Illinois
James Sanders, education evaluation, Western Michigan University
Rudy Serrano, anthropologist, California State College, Bakersfield
Louis Smith, ethnographer, specialist in case study, Washington University of St. Louis
Mary Lee Smith, educational evaluator, University of Colorado
Daniel Stufflebeam, education evaluation, Western Michigan University
Rob Walker, sociologist, field-study specialist, University of East Anglia
Wayne Welch, science education, University of Minnesota, Minneapolis

Other Site Visitors

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William Dunkum Gary Eichelsdorfer Donald Grogan Arlen Gullickson
Archibald Haller Robert Henderson Kathleen Hotvedt Jennifer James
Bernard Johns Kenneth Landin Howard Levine Susan Meyers
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David Hamilton, education research, Glasgow
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Lawrence Stenhouse, educational research, University of East Anglia
Frances Stevens, curriculum specialist, Leeds University (retired)
Clayton Thomas, educational administration, Illinois State University
Iris Weiss, survey specialist, Research Triangle Institute
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CHAPTER 19

KNOWING AND RESPONDING TO THE NEEDS OF SCIENCE EDUCATION

Chapter 19

KNOWING AND RESPONDING TO THE NEEDS OF SCIENCE EDUCATION

The advantage of a case study project is that it provides a personal and experiential perspective of matters. In the Case Studies of Science Education, teacher perspectives of science, math and social studies have been emphasized, but have been rounded out and confronted by the views of students, administrators, and parents. The energies of daily work have been exposed. Worries have been voiced. Some of the obvious problems of science teaching and learning, and some very subtle ones too, have been described in the eleven case studies and examined in the assimilation chapters of this report.

Perhaps surprisingly the concerns of a nation about test-score declines, desegregation, and equalization of taxation for school financing were seldom reflected in the CSSE classrooms. Such educational issues are seen as pervasive, and indicative of our social values (and worthy of our attention in this review), but having small direct impact upon the quality of science instruction received by a child. Much more influential were the renewed emphases on reading, the provision (or lack) of a classroom atmosphere free from distraction, the presence (or lack) of a teacher with genuine curiosity about natural and social occurrences, and a set of rules reflecting the desire to mold children into well-disciplined, middle-class citizens. These influences on the conduct of daily instruction were not perceived to be more important than the national issues--they were the stuff that made up another side of our concern about American education, and require <u>direct</u> attention in the planning of programs to assist science education.

In this section we will summarize the findings of the CSSE case studies and our other data-gathering efforts. Having already partially mutilated the delicate and complicated portrayals of happenings and feelings as drawn together by our field observers by attempting to sort and aggregate them in our findings chapters, we now further over-simplify by presenting them in grand summary. We urge the reader who is appreciative of the problems and efforts of pre-college education to read the complete case studies. The writing there provides a much more firm basis for knowing and responding to the needs of science education than the abbreviations on these following pages can possibly do. Still, because it may be useful to report our most prominent findings in a single place and to suggest responsibilities and opportunities for the science education directorate of the National Science Foundation, and also because our contract required it, we present this Executive Summary.

SCIENCE EDUCATION FINDINGS FROM CSSE

<u>Teacher is Key</u>. What science education will be for any one child for any one year is most dependent on what that child's teacher believes, knows, and does--and doesn't believe, doesn't know, and doesn't do. For essentially all of the science learned in school, the teacher is the enabler, the inspiration, and the constraint. (See ALTE Booklet III, p 3:90).

A child learns a great deal about science out of school. A few children have science hobbies or reading interests, sometimes finding surrogate teachers, so that they gain substantial understanding of science without the school's help. Most children are unable to do that. For most, systematic science learning will occur only if the teacher can cope with the obstacles and is motivated to teach something of the knowledge and inquiry of the scientific disciplines. For other children such learning is unlikely. A VORTEX principal said:

> *But if you have a person teaching science who really loves it, those kids really have a good science program. On the other hand, I've had to almost force someone to put the science kit in their classes. No one wanted to have anything to do with it. You know how science was treated? They got their minimum time allotments in.*

Decisions as to changing the science curriculum were largely in the hands of teachers--even on major choices they had the primary veto power. They often could not bring about the changes a few would have liked, but they regularly could stop curriculum changes they opposed, either at the district level or in the classroom. They were largely alone in a personal struggle to select and adapt available materials to educate a distressingly reticent student body.

The role that teachers play in setting the purpose and quality of the science program was apparent in all our case studies and reaffirmed in our national survey. Teachers in BRT (p 4:22), ARCHIPOLIS (pp 9:6,7,18,23), GREATER BOSTON (pp 11:33-34), and a comment by observer Lou Smith (p 3:79) typified the influence teachers have on what was taught.

As the student body grows smaller, the faculty grows older. Old solutions seldom fit new problems. Most teachers have trouble teaching at least a few children. (There was a strong tendency to categorize these children as Learning Disability children.) Teachers needed assistance of one kind or another. In most of our sites the inservice program was providing little aid, partly because it was anemic and aimed elsewhere, partly because the teachers paid little heed to it. Like professors in charge of preservice education, the inservice personnel we saw were seldom oriented to helping teachers solve such difficult problems as keeping the lesson going or adapting subject matter to objectives for which it was not originally prepared. The teachers were apparently sometimes more "on their own" than they wanted to be.

The Basic Two--Reading and Arithmetic. The dominant influence toward change in the curriculum today was "back to the basics" thinking. People meant different things by it, but most common was a greatly increased emphasis on two of the three R's, reading and arithmetic.

It was strongly stated, by teachers even more than by parents, that other learnings are unlikely or inefficient until the child has a thorough grounding in "the basics." It was not that people could not see that children learn many ideas, skills and styles of expression without good reading and arithmetic competence. But they seemed not to appreciate the extent to which people do and will learn what they need as the need arises. They knew the regret of many who did not discover early a precious corner of the library, or the library at all. They felt compelled to prescribe learning activities which were work-like and clearly purposive--and most of the reading and arithmetic lessons we saw were both.

Many teachers endorsed the movement toward "the basics" thinking that what they had been teaching as a special skill or subject matter was basic and would be included in the new emphasis. Others who "can't beat 'em, join 'em." The science supervisor in URBANVILLE endorsed the basics only after it was apparent that district support for science would continue to wane unless it was shown to be integrated with the basics and demonstrable on student tests.

In school settings, greater emphasis was given to reading and arithmetic and to the results of minimum competency testing aimed at the basics, less emphasis was being given to science, math, and social science concepts and relationships. Teachers were willing to make this trade-off, saying that youngsters would not understand complex ideas until they could read them. Teachers had been embarrassed far more by student inability to read or compute than by their inability to comprehend ideas, and were anxious to demonstrate that they favor drastic steps to involve children in reading and arithmetic exercises. But the more important fact is: Teachers appeared to be fully convinced that improvement in all of education, including science education, was directly dependent on improvement in reading. (See the advocacy of the teachers from RIVER ACRES, Texas, pp 1:9,18,29; but the same conviction can be found in each of our case studies.)

Science, Mathematics and Social Studies Curricula. As seen by most people in the schools, science education had no more alliance with mathematics education and social studies education than it had with English education. Science was seen by many to be the subject matter of physics, chemistry, and biology, and perhaps astronomy, botany or geology. These were seen as fundamentally different from the things taught by teachers of mathematics or social studies. With perhaps an exception or two in the case of environmental education there were essentially no interdisciplinary efforts in the schools of this study. (See Chapter 13.)

The circumstances varied from place to place depending on teacher personality, parent interest, and many other things. Most high school science departments were offering biology for all students and either chemistry or physics or both for the student going on to college. These latter two courses usually had an algebra prerequisite, which helped to keep the course geared for the "faster" students. Home economics, still largely for girls, and agriculture, largely for boys, included science topics, but were not coordinated with the science offerings. Laboratory work in several sites appeared to be diminishing in importance because of the expense, vandalism and other control problems, and the emphasis on course outcomes that would show up on tests. A general science course was a standard offering in junior high schools almost everywhere--we saw an outstanding one at an open school in VORTEX. Although we found a few elementary teachers with strong interest and understanding of science, the number was insufficient to suggest that even half of the nation's youngsters would have a single elementary school year in which their teacher would give science a substantial share of the curriculum and do a good job of teaching it.

With the national emphasis on "the basics" and on vocational preparation, mathematics was getting increased attention. The result was an almost exclusive concentration on computation, from second grade math to that in senior year. Many schools, such as those in URBANVILLE and WESTERN CITY had a computation test which had to be passed sometime prior to high school graduation. There was little feeling for the importance of mathematical concepts, e.g., sets, prime numbers, proportionality, though they appeared in most textbooks, partly as a legacy of the "new math" efforts. The attitude among many math teachers was that new math was too difficult for youngsters to learn; it allowed them to drop behind in computation skills. The commercial world increasingly required less in the way of computation (e.g., by providing cash register keys with pictures of sandwiches, automated inventory cards, hand calculators), but the belief in the need for computational skills was strong. According to the prevailing social and educational ethic, a disproportionate time should be spent on computation. Much of the remedial teaching in mathematics in the URBANVILLE school and elsewhere was being done by non-mathematics teachers reassigned for various reasons. Some teachers said they needed materials more suited to older students, those slow and little motivated.

The social studies curriculum was primarily about history and government, and to some extent, about current social problems and about understanding oneself. It was rarely about social science, the systematic inquiry into social phenomena. There was little agreement on what subject matter content had to be covered in a social studies course and one saw little articulation across these courses. Where we did find coordination, we found also less concern about contemporary social affairs, such as in an URBANVILLE history course, where even in a few idle moments, no one mentioned Jimmy Carter's election on the morning following it. By and large, we concluded, teachers were so distressed with their students' inability or reluctance to read, write, and get serious about their studies, that they worked on the syllabus lessons as much as they could.

The science curriculum of the schools was--in operation more than by definition--taken to be a set of knowledges and skills, rooted in the academic disciplines. It was to be shared in common by all students who would undertake the study of science. Though it may emphasize conviction in one place and skepticism another, it was to be seen as belonging to the collective wisdom of men, a part of the culture, a property that exists outside the individual learner.

The curriculum was not the arrangement of context and contacts so that the students would have optimum opportunity to extend their own meanings of things, to learn those things that interested, challenged or puzzled them. It was "course" and "skill" centered. It was authoritarian. It was external. A curriculum specialist in GREATER BOSTON suggested that that may be the way it had to be in today's schools.

Students were expected to respect a set of understandings that originated outside themselves, that were validated by processes that they could only crudely approximate, that took on a value that was given by the specialists or in terms of its utility to people at large. The motivation for learning these things also was expected to be external. (Perhaps the principal justification for some lesson topics was simply to familiarize the young with what the older generation had to study--a kind of badge of culture.)

The teachers who teach this curriculum may or may not be authoritarian. Many were. Many were not, establishing a most friendly, or casual, or cooperative relationship with the youngsters. Many did not insist upon being treated as authorities, but honored certain knowledge, certain ideas about how to inquire, certain experience--a curriculum--that was defined by those outside the classroom rather than those within. The administrators and parents and taxpayers we talked to seemed almost unanimous in their support for this definition of curriculum.

Socialization as a Pre-Emptive Aim. Each teacher had a somewhat different set of purposes, but a common and vigorously defended purpose was that of socialization. It impressed upon the student an observance of the mores of the community, submitting personal inclinations to the needs of the community, conforming to the role of "good student," and getting ready for the next rung on the educational ladder. Of course there were great differences in the ways teachers stressed and interpreted socialization. (See Chapter 16.)

After reviewing the objections of certain parents to the teaching of family values in other cultures (MACOS) and evolution of the species (BSCS) at the outset of this project, we expected to encounter occasional battles between parents and teachers regarding offensive topics, that is, between groups having different ideas as to the proper socialization of young men and women. In these most sensitive matters we found no battles. Teachers recognized the potentiality of trouble but none told us of feelings of threat or constraint. (Most steered away from "values" questions.)

It appeared to us that teachers had been carefully selected to fit the community and that teachers were anxious not to put children or parents in anguish. Some occasionally went as "far out" as the community, the parents, and the youngsters expected them to, but seldom further. Of course there was not full agreement on the "boundaries" of academic freedom, but we did not find confrontation. Observable differences among teachers were much more likely to be in areas about which the public was not apprehensive. Perhaps if all teachers were to take the same stand as the most radical or outspoken teacher did there would have been trouble, but the community seemed comfortable with its mix of relatively stern "socializers" and relatively liberal "socializers."

The more stern socializers promoted subordination, discipline, a "Protestant work ethic," cheerfulness, competitiveness, and heavy investment in getting students "prepared." The more liberal socializers, no less concerned about having an impact on the learning and personality of the youngster, promoted skepticism, imagination, individual expression, cheerfulness and cooperation. Of course, most teachers appeared to be trying to do some of both.

An example of an important socialization lesson was: "Merit deserves special privilege." There was little belief among most teachers that anything would be wrong with academic discrimination. In RIVER ACRES, URBANVILLE and elsewhere, denial of learning opportunity was seen as warranted by poor performance. In ALTE, WESTERN CITY and elsewhere, "social promotion" was under attack. Although in this century the high school diploma has not been a certificate of competence, there was strong advocacy for making it one.* The denial of privilege that would accompany the denial of a diploma was not at that time considered a large social cost.

Such socialization in the classroom was pre-emptive in that it seemed to get immediate attention almost whenever an opportunity arose. Other learnings were interrupted or set aside, not always by choice, to take care of: an effort to cheat, an impending daydream, or a willingness to accept a grossly mistaken answer. One observer commented that socialization took precedence over general study skills, general study skills over the specific operations (arithmetic, the chemistry lab), and the specific operations over subject matter. One teacher, or perhaps a thousand, said with a sigh, "I don't know what they're going to do when they get to seventh grade."

Studying a few teachers in depth, CSSE site coordinator Jack Easley, with Frances Stevens and others, (in Chapter 16) found an even greater commitment to socialization. To that end, and also to help the teacher survive daily crises, the new teacher learned how to use subject matter to keep control of the class, what question to ask which boy to head off a prank, what homework to assign to keep the study period quiet, and in many more subtle ways (familiarization, etc.). Although some people were dismayed that so much of the school day goes to administrative routines, few people were protesting the portion that goes to socialization. With subject matter being used to socialize, the distinction was difficult to make. Subject matter that did not fit these aims got rejected, neglected, or changed into "something that worked."

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*The argument for a diploma certifying competence usually was one of assuring employers and colleges of student qualification. But employers and colleges have always relied more on tests than certificates. A better interpretation would be that work of low merit was seen as needing exposure and censure.

Text-bound Teaching. Clearly the predominant method of teaching science was recitation, particularly in the junior high school. In the elementary school the science lesson might call for observing the behavior of caterpillars or reading science fiction, but when there was something "important" to teach, reading and recitation were foremost, and a little testing sometimes followed. In ARCHIPOLIS, observer Jacquetta Hill-Burnett called it: "assign-recite-test-discuss." The high school class was more likely to use some workbook exercises, possibly in groups at the lab tables--but the emphasis was still on recitation, with the teacher in control, adding new information and sometimes demonstrating. The textbook was the key to the information.

> Eight fourth-graders were circled around the teacher for their social studies lesson. Miss Williams asked, "Why is New York City a world city? At the top of page 142, why is New York City a world city?" (No answer) "Terry?" Terry reads, "New York City is one of the great world cities," and looks up questioningly. "No, look on into the paragraph. The headquarters of the United Nations is there and trade with all the countries." (Site visit report)

The following observation by Rob Walker in a classroom in PINE CITY (p 6:34) was rather typical:

- Almost all the questions (which come from the textbook) concern terminology or definitions.

  "What are three characteristics of the nervous system?"

  "What's the difference between a threshold and subthreshold stimulus?"

  "What's the difference between the nervous system of the amoeba and the human?"

- The answers come back in the stylish rhetoric of the textbook. Clearly the essence of the task has been to search the text for the sentence which contains the correct answer. One student who tries to ad lib an answer reveals--in the characteristic hesitations and broken constructions of spoken English--that he has failed to work thoroughly on the text and he is met by a growing murmur of jeers from the class.

As we saw it, teachers relied on, teachers believed in, the textbook. Textbooks and other learning materials were not used to support teaching and learning, they were the instrument of teaching and learning. Learning was a matter of developing skills, of acquiring information. The guide and the source was the textbook.

Information is pretty much what many of the courses are about.

> Seeing nothing but inky black in the beaker they asked, "What's supposed to happen?" The girl at the next table said, "It's supposed to go up and down," so they all wrote, "It went up and down," in their lab reports. (Adapted from p 13:40)

The science teacher explained some points and added personal experience, but spent most of the time asking the students to tell what was in the reading assignment. Reading time during the period was common. Homework was not very common.

The same was true of social studies. Most of the courses were courses in history or government. The social studies teacher had opportunity to digress--into relevent and irrelevant topics. The digression topics were likely to be heard elsewhere around town;

catastrophes, competition (the Miss America contest or the state basketball tourney), crime, etc. In many classrooms a comfortable familiarity existed--as in our GREATER BOSTON and WESTERN CITY sites. Teachers enjoyed "rapping" with the kids. In many classrooms there was an ascendancy of thinking, above the commonplace, and above the level of curriculum syllabus and textbook as well. But the most common scene was not of "liberated" discourse but of the teacher asking questions about the reading assignment, often requiring verbatim responses, stressing the value of good information from reliable sources, particularly the textbook.

In mathematics at all levels the teaching method was usually one of going over the problems assigned, either teacher or students working a few at the chalkboard while others observed, the teacher working out the most difficult problems. They started new assignments together, then worked individually. (PINE CITY, Walker files)

Articulation and Uniformity. Each district's syllabus presented a coordinated sequence of courses capitalizing on the learnings of the previous year. Teachers regularly expressed their dismay that the students did not arrive knowing what they were supposed to have learned previously. Teachers expected considerable leeway for dealing with breakdowns in sequencing, and additional leeway for requiring more and offering more than was prescribed in the syllabus. Most supported the syllabus when they were on the defensive; most treated it lightly when it came to deciding what their classes and individuals within the class should be expected to know.

All in all, there was extremely little articulation in the science, math and social studies curricula among different schools in a district, either between levels (elementary, middle, and secondary) or between school buildings at the same level. There was a little more articulation across classes within a school building, but there too teachers supported the uniqueness of each teacher's approach as long as it did not get them all into trouble. Among the CSSE schools, not surprisingly, the smallest school (BRT), had the best articulation. (See p 4:9-10)* These comments from three different RIVER ACRES teachers illustrate the plight of articulation efforts at many schools:

> *". . . the kids coming into ninth grade are not as well prepared as they should be."*
>
> *"We had the (articulation) meeting. . . . We discussed where our problems lay. And we have heard nothing since then."*
>
> *"I don't have to try to communicate with my elementary colleagues. I sat with them (in courses). I know they don't know mathematics."*

To the extent that one perceives the school as having the responsibility to get each child to master a large common set of tasks, this lack of communication and coordination appeared to have a deleterious effect. To the extent that one perceives education as the development of personal understandings and extending of experience, the lack of articulation appears to have little educational significance. But a large majority of people in and out of school in the sites we visited felt that classes should be more uniform across the city and more articulated up and down the grades.

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*CSSE = Case Studies in Science Education; BRT = code name of one CSSE district.

Low Priority for Science Education. During our visits to the schools we asked many people about the importance of science programs. Their answers differed of course, but a number of people large enough to surprise us said that other things were more important. They were not speaking in favor of diminishing the science programs the schools had then, but neither were they expressing a strong desire to have science programs upgraded. About half of our respondents agreed that "the general public does not put high priority on the teaching of science." About one-third disagreed. In math however, less than 20% of school people (and less than one third of the parents) agreed that "the general public does not put high priority on the teaching of math." Except for students (who split about 50-50) the high majority indicated that the public felt more supportive of mathematics than science. Surely, a perceived need for simple computational skills raised the over-all priority for math (see Chapter 17). Still, the public was not seen by our school officials (including teachers) to be opposed to support for science education.

We asked superintendents, science teachers and parents if they thought the lower priority being given science education would have a serious effect on the growth of technology in our society, on the economy in years ahead, and in the quality of life in this country. The overall response was about 75% saying "yes." Over 80% said that the schools should try to do something to reverse the trend.

We were surprised when we asked about the primary purpose of schools that such a large proportion of our survey respondents did not cite the "knowledge purpose" (see p 14:2 for a fuller description) of the schools, the traditional emphasis on the knowledge of the scholarly disciplines, as the primary purpose for the schools. A majority did, but large numbers cited the human experience purpose and the vocational career purpose too. Among three groups the results were:

The most important task of the school should be:

	the human purpose	the knowledge purpose	the career purpose
among 125 parents responding	12%	34%	53%
among 78 administrators responding	40%	39%	21%
among 175 teachers responding	36%	40%	24%

Earlier in the 1970s there had been some anti-science feeling in the U.S., but we found little of it. Almost everyone wanted a strong science program, but most were quick to add that there were other things that needed bolstering first, things like "reading," "vocational skills," "writing ability" and "remedial courses." Although the dynamics of career choice and manpower development are not well understood, nor are future needs, we did not discover grounds for belief that the "supply" of scientists is threatened by the present circumstances in the schools. The pressing concern seemed to be improvement in the quality of instruction available to the large numbers of American children having difficulty learning ordinary lessons. The schools were concerned about student achievement on the simplest of tasks taught, while science departments were concerned about some of the most difficult.

We visited schools in eleven communities, staying long enough to get acquainted with science teaching and learning, noting the satisfactions and dismays of teachers, students and others. We found each place different, complex, interesting. Each generalization had many exceptions. Sometimes the science program, the mathematics program, or the social studies program was a part of what people were most proud of, or least proud of--but not often. There were too many other critical matters. Many teachers were busy narrowing down to a "basic skills" curriculum; most were teaching pretty much as they always had, on their own, relying on the textbook or workbooks, treating science as something important, but something that could be learned later if not learned now.

OTHER FINDINGS OF THE CSSE PROJECT

The CSSE field observers, scattering out to the original ten sites, were coached to concentrate on science, math and social studies teaching. Not surprisingly, many of the issues they found were general education issues. The schools are highly visible social institutions and much of what happens in schools relates to the general place of youth in today's society. The following findings and interpretations are not immediately indicative of needs for science education or National Science Foundation support for the schools, but should contribute to an understanding of the background that will influence any efforts to upgrade the quality of science teaching and learning in pre-college institutions.

Due Process vs. Ordinary Pedagogy. There was a major but only partly visible confrontation in these schools between due process, particularly equal treatment, derived in part from the 14th Amendment to the Constitution, and ordinary pedagogy, particularly as a teacher manages student learning activities. Efforts to give equal educational opportunity to all children are at times at odds with efforts to protect learning spaces from the distractions and disruptions of students who could not or would not learn the lessons at hand in timely manner. There was a confrontation between a common belief in how-to-teach versus a social-political pressure to combine all students into a single class for instruction. But more than that--

Especially in communities such as ARCHIPOLIS (see p 9:25) and WESTERN CITY (see p 7:27) where many children needed extra teacher attention, where school kindled little spark and where authorities struck little fear in youngsters, teachers were suffering the loss of two traditional control mechanisms: grouping students according to talent and motivation, and isolating the majority from the slow, the diffident, and destructive. It was not that teachers could no longer "track" students--in fact it was apparent they could do so, in ALTE subtly, in RIVER ACRES, and WESTERN CITY openly--but they all had "so many problem children" and little way to help them or even to keep them from having an adverse impact upon classroom activities.

The situation was substantially worsened by the good works of the advocates of equal opportunity of education. By law, court ruling, and by regulation (and by all that is right and moral) no child is to be denied the ordinary classroom experience, the full opportunity to learn amid the youngsters of neighboring subcultures. Accordingly, children are to be "mainstreamed," taught without regard to race, sex, social class, physical disability, psychological impairment--whether or not they are an obstacle to the ordinary pedagogical regimen. In classrooms in three eastern cities we visited (e.g., p 9:13ff) not infrequently the teacher was unable to maintain control. The youngsters disrupted each other, failed to respect the property of individual or institution, and assaulted the teacher both directly and indirectly. In one city those expelled for more severe offenses were returned by the courts to the same classrooms, to be afforded that equal but now diminished opportunity to learn amid disruption.

Teachers and educational leaders at all our sites, proud of the liberal heritage of the American schools, were respectful of the law and reluctant to speak directly against busing, mainstreaming, and open enrollment. They acknowledged that in the past and still, the Blacks, the poor, and other groups had been discriminated against and deprived of full educational opportunity. They were embarrassed by protestors who chant in the streets and by parents who enroll their children in private schools. They did not want to be identified with these groups, so they failed to speak up and even to recognize the directness of the confrontation between the two forces.*

In their own classrooms most teachers treated children as individually different (if they could find time to) recognizing that developmental patterns and basic knowledge would be greatly similar, but recognizing also that each child's education is a continuous extension of personal association of the mind. They had different expectations for different youngsters, sometimes giving marks on the basis of what the child should be doing with his/her skill and background rather than on the basis of what was accomplished. They grouped children in teams, clusters, and tracks, and put them on individual pathways and pacings, in order to move them through assignments expeditiously. They did not do all these things equitably or even wisely. But they did them with a deep conviction that to teach effectively you have to treat individual students in unequal ways. They often did not know what to do about the requirements of government and the rulings of courts to treat children as equals.

It was a hurtful confrontation. The children and parents at hand were benefiting from neither legal redress nor good instruction, with little relief in sight.

Technologizing the Curriculum. On page 19:1 it was said that several national concerns about education were not reflected in the CSSE classrooms. Activities at the state and district levels did reflect more the national issues. In response to poor student performance in tests, to other embarrassments such as nationally publicized lawsuits brought by nonreading graduates, to a belief that technology** could improve the efficiency of instruction, and to a perceived need for more control over the whole teaching-learning system, a nationwide effort

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*We of the CSSE staff think it might have been a better legal confrontation if there had been a Constitutional Amendment guaranteeing the right of each child to an education. Then it might have been acknowledged that in order to learn to read and to begin the innumerable tasks expected of competent adults, the child must learn with fellow learners who are capable of learning, interested in learning, and at least usually unable to entice others away from learning. Even a corps of quiescent but disengaged classmates would not meet that legal requirement, for classmates themselves are the models for what a school person should be. If there had been such a constitutional guarantee we might have had a better legal confrontation. But even that Amendment would probably not have been enough to remedy the distress of those who wanted schools to work.

We think it is not enough for a society to live within the law. The laws do not clarify what is right ultimately, only what is right under the law, only what should be obeyed while the law remains unchanged. When two great "rights" are in confrontation, as they were here, it is the responsibility of the lawmakers, and primarily the citizens before them, to spell out what combination of rights, what compromise, will best serve the larger welfare. Such was the case in 1977 with the confrontation in education between due process and homogeneous grouping for instruction.

**Technology here does not necessarily mean mechanical or automated devices, but any effort to routinize or standardize procedures either for students or teachers. Thus flash cards, workbooks, and formal plans are all instruments of technology.

has been undertaken to make teaching more explicit and more rational and to make learning more uniform and more measurable. Evidence of this effort was apparent in all our sites and confirmed by our national survey. The effort appeared to have some effect on what teachers talk about, and some even on what they did. Many teachers appeared convinced that teaching and learning should be more efficient. They preferred to get efficiency by explication and simplification of what is to be learned. For the most part teachers cooperated with district efforts to improve efficiency through this procedural technology.

The first step usually had been to obtain widely-acceptable statements of school objectives, reducing the number of paramount things to be accomplished, diminishing the differences to be noted between classrooms and between classmates, and drawing community attention to those school purposes that all agree on. The second step usually had been to identify criterion test items appropriate for assessing student accomplishment of the objectives. It was presumed that lack of accomplishment would require additional study or that teachers would know how to modify instruction. This last part was not technologized except in certain "individualized" systems such as IPI (which we encountered in ALTE, p 3:14) and PROJECT PLAN (which we encountered in FALL RIVER, p 2:20).

Administrators at many of our sites spoke highly of these technological efforts. Many teachers spoke highly of the increased manageability of instruction through objectification but objected to instructional time diminished by time taken in testing and were apprehensive about what might be done outside the classroom with the test scores. In districts where objectives have been formalized and tests administered the teachers were less enthusiastic, but many continued to appreciate the order and assurance that such systems brought to teaching. We did not run into any situations where the objectives-based system had in fact changed the achievement levels of the youngsters.

<u>The Management Burden</u>. For various reasons, federal and state offices have assumed a greater responsibility for the conduct of education. The superintendent of the local district had become less the head of an educational system and thus less the community spokesman for science education. He had become more the intermediary between the local schools and federal and state offices and more the spokesman (often reluctantly) for the social bureaucracy of which he was a key member. (See Chapter 17.)

Federal legislation, such as the sweeping new provisions for education of handicapped children (PL 94-142) and state programs appeared to greatly increase the administrative burden in school districts. (We noted it particulary in VORTEX and WESTERN CITY.) Public opposition to school costs fixed sometimes on the total salary costs for administrators (as it did in FALL RIVER), but demands created by new legislation pressed the district to continue to expand its staff. High management skills were needed for properly interpreting and carrying out the regulations. The demands not only added to the expense, they redirected attention of almost all administrators from pedagogical matters to management matters.

In their wording, federal and state regulations continued to allude to local responsibility for the conduct of education. But in fact the formal and informal national pressures were so great that few district curricula had a character of their own, independent of what they had taken on to win special funds. (There continued to be many uniquenesses at the classroom level that were not reflected at the district level.) The obligation to establish "minimums," e.g., for student performance, for teacher teaching-field college credits, for safety--above which schools could be different if they have the resources--was probably a constraint upon unique thrusts. The funds available from categorical programs were essential to the solvency of the district, so the local Board of Education committed the district to those categorical aims in order to win the funding.

According to contemporary wisdom, extra responsibility for the conduct of education cannot be exercised properly at state and federal levels, nor indeed at the local level, without additional information about the performance of students and other details of the curriculum and classroom. Therefore, elaborate information systems have been established. In many places these had been standardized and automated, ostensibly to simplify the burden of gathering and interpreting information. So far, as reported in RIVER ACRES and FALL RIVER and GREATER BOSTON, the systems were cumbersome, expensive, distracting, and apparently of questionable validity for improving the operations of instruction. Their very complexity, plus the complexity of the relationships between local and higher authorities, demanded much administrative attention and talent. Thus it seemed the immediate and ordinary affairs of curriculum and instruction actually got increasingly less administrative attention.

In an effort to diminish burden and constraint, many of the larger districts had decentralized both authority and services. In ARCHIPOLIS, building principals and teachers thus did gain greater autonomy--but district requirements remained, and the result in part had been increased confusion and less help with curricular and pedagogical problems. (See p 9:3)

Classroom teachers did not see superintendents and district personnel as "informed" or sufficiently "concerned about conditions in the classroom." For example, in FALL RIVER (p 2:4):

> Occasionally the talk is about administrators--not the ones in the building, generally respected and considered part of the group--but the ones "downtown." The tone is usually negative. One gets the feeling that "we" and "they" are not playing on the same team.
>
> > *There are guys down there that don't even have a job description. They run around trying to do things to justify their jobs.*
> >
> > *Administrators ought to have to teach one class a year just to keep in touch with reality. They get down in that central office and forget what it's really like. Education professors should have to do the same.*

Actually it appeared that teachers had little information about central administrators, and even building administrators, on which to form such judgments. Both parties had isolated themselves. Most building principals in our CSSE schools were quite well acquainted with what was going on in the classrooms, but took little part in their direction other than to see that regulations were followed. In URBANVILLE our observer perceived the management system and the instructional system operating smoothly--but little engaged with each other, congenial, showing respect for each other's "turf." Both systems appeared to be substantially committed to "Education," and both were invested with the belief that without a smoothly working system, there could not be a high quality instructional program.

The RFP Questions. The following questions were raised by the National Science Foundation staff in the RFP. The proposal and the study itself moved on to other issues, but many answers to the questions are to be found in the case studies and assimilation chapters. Here we give a brief summary answer.

1. What are the perceptions of the role, scope, and function of science education at the local level as identified by students, teachers, parents, administrators, and supervisors?

Science education was seen as an integral part of secondary school education and contributory to its several purposes (indicated rather directly in responses to the questionnaire [see. especially p 18:100]). The most common perception of function was on preparation for later training, but there were also expectations that the student would become knowledgable about the world, would move toward a greater readiness for vocational responsibility, and would increase his or her sensitivity toward human purposes and problems. (See Chapter 12) Natural science was seen mainly as preparation for college (see ALTE), as preparation for work (see PINE CITY), and for increased understanding of the environment (see ALTE and FALL RIVER). Math, particularly computation, was seen as basic to all intellectual pursuit (see Chapter 13), but additionally was widely used as a vehicle for socialization of youth (see Chapter 16). Competence in math was informally used to distinguish between those who should and should not go on for further academic training. The social sciences were seen in more varied roles and functions (see BRT and RIVER ACRES especially).

2. What practices exist in the selection and use of curricular materials?

Selection practices were varied, ranging from accepting state-adopted textbooks (RIVER ACRES) to a complex local review procedure based on teacher skills and styles, student needs and interests, and community preferences (ALTE). Attention was frequently given to articulation (see Chapter 14) both across grades and across schools, but the heterogeneity and mobility of students were obstacles to strict sequential programming. The texts used in math and science were frequently criticized as having too difficult a reading level. Restricted budgets had caused postponement of purchases in many districts, but poor purchasing in the past left many usable materials unused. Textbooks were central to instruction in almost all classes. (ALTE and PINE CITY address the general question.)

3. What roles are played by parents, teachers, students, school board members in the review, selection and use of science curricular materials?

The circumstances vary from place to place. (ARCHIPOLIS and BRT are illustrative.) Usually, the larger the place, the more is decided at the district office, within the choices allowed by the state. But many individual teachers were finding a way to obtain the materials of their choice among those permitted by ordinary expense limits. Parents usually got involved only when something went wrong. (See instances in FALL RIVER, ALTE, and VORTEX.) Students had no role except indirectly as their complaints about texts and other materials are taken seriously by teachers (RIVER ACRES). School boards took the advice of teachers and administrators. The people most interested in curricular choices got involved in "curriculum guides." Many teachers ignored the guides or berated them, but central office personnel often displayed them with a considerable pride.

4. What are the roles of the teacher in the science classroom? How effectively do teachers perform these roles? What are their qualifications?

Teachers were, first of all, managers of instruction (see ALTE) and arbiters of decorum. Secondly, they were questioners and judges of responses. Most information came from teaching materials, but teachers provided a measure of information too. Seldom did they assume the role of fellow learner. Qualifications ranged widely, as did standards set by citizens in each community. Outstanding teachers were easy to find, so were teachers "gone stale" (BRT, ALTE). Among the least qualified teachers for present work are those reassigned out of their area of training because of enrollment shifts or budget cuts. (RIVER ACRES, FALL RIVER, ALTE, and GREATER BOSTON have good descriptions of science teacher roles.)

5. What objective evidence is available about the effectiveness of science education programs as measured by student outcomes?

The effectiveness of science programs is not indicated by the measures of student outcome in any district we visited. Some test performances had declined (see VORTEX); some level performance trendlines were proudly displayed (see ALTE), but it is questionable to attribute either change or no change to the quality of instruction.

6. How and by whom are science teachers and students evaluated?

In each site there was frequent evaluation of student performance by teacher judgment and by formal testing. Outstanding students were "followed-up" by interested teachers. Most teacher evaluation was informal, with formal responsibility assumed by principals. Teacher evaluation was stressed in URBANVILLE, ALTE and ARCHIPOLIS.

7. What laboratory materials were used in connection with science curricula?

Huge variation was found, in amount as well as kind. (ALTE is a portrayal of feast, ARCHIPOLIS and PINE CITY are portrayals of famine.) Variation among schools within a district was also apparent (see WESTERN CITY and VORTEX).

8. What out-of-school resources are used in conjunction with science curricula?

Out-of-school resources were seldom used. Though rare, outdoor experiences were highly valued in ALTE, FALL RIVER, and ARCHIPOLIS. Museums were utilized in GREATER BOSTON and ARCHIPOLIS, but less than they probably should have been. Parents occasionally were asked, and sometimes made noteworthy contributions (see RIVER ACRES). In COLUMBUS, mortuaries, brokerages, poolrooms and churches substituted temporarily for schoolrooms. Emphasis on the basics and preparation for testing created doubt about the value of out-of-school resources.

9. How much time (in comparison with other subjects) is spent on the teaching of science by grade level?

Minimum times are set by districts or states for the lower grades. The elementary schools met these requirements for math and social studies, but sometimes met them in science only in a perfunctory way. Reading about science topics was counted as science instruction. Recorded times are likely to be misleading. In two adjacent classes teaching science for 120 minutes per week, one teacher might be involving students in the key ideas of science, teaching vocabulary, and helping them work on projects for more than that while the teacher next door may do no more than to assign science related readings and encourage those interested to develop their individual interests. Math, social studies, and language arts and physical education got more time; art, music, foreign language and "guidance" got less. (See WESTERN CITY, ALTE, RIVER ACRES, and VORTEX.)

10. How effective are the science education efforts as viewed by students? by parents? by teachers? by administrators?

Almost all members of these groups rated the science education efforts as "satisfactory" or "very good." (See p 18:92)

11. What special efforts are set aside for those students skilled or highly interested in science? for non-reading or unmotivated students?

The main response of the schools is to group students homogeneously for instruction. (See the "levels" in RIVER ACRES, the "prerequisites" in ALTE, the "advanced placement" in VORTEX, and the "tracking" in WESTERN CITY.) Some schools had special labs in math for slow learning children (URBANVILLE, VORTEX). There were signs of new attention to the "gifted child", but in general, attention for ten years had been directed to the "less gifted." Actually, very few special efforts, other than separation and changing-of-pace were noted for either the more able or less able students.

12. In comparison with other subject matter, what budgetary considerations are given to the teaching of science?

Math was getting full support. Science, at the secondary level, was holding its own more than social studies, but both budgets were tight. Optional courses were being reduced. URBANVILLE, WESTERN CITY and VORTEX had experienced sudden tightening of budgets. PINE CITY and ARCHIPOLIS had long experience with monetary problems.

13. What types of local in-service training programs exist? How often are they conducted? by whom? What is the level of participation? How effective are they as perceived by teachers?

Staff meetings, district conferences, and university courses were most common. Most schools had in-service workshop days a couple times a year, organized by and staffed by district personnel and consultants. Participation was high in most places. The teachers found them more valuable for opportunity to talk with other teachers than for the help they got from specialists. In-service leadership by master teachers was sought. NSF institutes were praised. Many teachers had problems they were not getting in-service help for. (See RIVER ACRES, VORTEX, and WESTERN CITY.)

14. What supervisory positions exist for science at the district and school level? What function is served by personnel who fill these positions?

Titles and responsibilities varied greatly from district to district. Curriculum supervisors were found increasingly to be organizing competency lists, defending policies and practices, soliciting special funds, and interpreting government documents. They were little involved in evaluating teachers or helping individual teachers improve their teaching. (See VORTEX, WESTERN CITY, ARCHIPOLIS, URBANVILLE, FALL RIVER.)

15. How are science education programs administered? by whom? What are the administrators' qualifications?

Science education "programs" are administered by central administrators (see ALTE) or by building administrators (see RIVER ACRES). In cases where they carry the title "science coordinator" or other specific designation of science, those administrators have excellent academic-science credentials.

16. What barriers exist to improving science education at the local level as perceived by students, teachers, administrators, school boards, supervisors, parents?

The one largest barrier seen by all groups was: student behavior, particularly student motivation (see FALL RIVER). Financial barriers were often mentioned (see URBANVILLE, WESTERN CITY, ARCHIPOLIS). Complaints of teachers (heard but often misunderstood by supervisors and others in the support system) indicated dissatisfaction with materials that did not conform to their responsibilities for socializing the youngsters. Many students found the courses boring. Across the board, there was not a strong feeling that improving science education was high on the priority list. (See the complaint of a RIVER ACRES teacher who couldn't arrange a bus trip to the capital while "athletic teams could be bused anywhere.")

17. In what ways do the major issues, questions or concerns identified differ by subject matter (science, mathematics, social studies)? by grade level within subject matter?

Most widespread issues and concerns were unrelated to subject matter or level (see student heterogeneity, Chapter 14, for example). Computation skill of students was one of the highest of all concerns found, with great attention at all levels given to the problem of its remedy. In the upper grades preparation for college determined greatly how a course would be offered. At the junior high there was great concern for reading skill and student motivation for schoolwork. Other general concerns, such as for a "back to the basics" curriculum or for "greater articulation from year to year," were seen by almost every science teacher as greatly influencing the quality of science education offered, but were about equally prominent in all three curricular areas and at all the levels of schooling.

Powerlessness and Remedy. We talked to many people in the schools who were proud of what they had, proud of what they had done, yet pointing to things they would like to change: Different people seeing different ailments and suggesting different remedies, of course. Most of the changes were changes that someone else would have to make. Many would require a change in the larger system. The teachers and others felt they had little power to change them.

Some of our sites were in rapidly developing areas such as the Houston area, where new jobs, new families, and new money kept the school system a tumult of growth, where little of tradition and cutback seemed to constrain the curriculum. Other areas such as the Boston area were wrenched with poverty, racial confrontation, and judicial intervention in the management of the schools. But wherever we went, whether or not the people were proud of their schools or ashamed of them, they saw little chance of change, and little more they could do themselves.

> Bill is even more resigned. He doesn't feel that there is much that the schools can do to affect the real nature of the historical process, or perhaps much anyone can do. Like many other teachers in the school, the things that keep him teaching are not the hope of bringing about social change, but the fact that he enjoys what he is doing, likes the kids, and finds himself in a school where (such enjoyments) are still possible (GREATER BOSTON, p 11:19).

At most sites the teacher had a great deal of leeway as to what would be covered in the course of study and as to how time would be spent in class, but always within limits. The expectations of other teachers, of parents, of administrators, of pressure groups, could not be violated without repercussion. Many potential confrontations were avoided at hiring, with applicants for teaching and other positions screened partly on the basis of conformity.

A rural Illinois board member rejected one applicant saying in all seriousness, "But he's not country." Almost every teacher on the RIVER ACRES staff was a Texan. The teachers themselves crushed their own diversity, not necessarily in a cruel way. The limits to which a teacher could venture were seldom explicitly defined, but they were there. Some teachers led us to infer that they felt powerless to take action that would challenge the boundaries. Few wanted to.

Principals and superintendents in our districts seemed to feel the same--though less often with an air of despair. In GREATER BOSTON (p 11:22-23) a black principal felt blacks had finally assumed enough control to get something done, but the job remaining was immense --and that he really did not have much power. In PINE CITY (p 6:9-10) where the desegregation progress linked into everything else, the superintendent was pleased with the numbers of students leaving white academies to return to the public schools, but saw the task of educating these youngsters and all the others as still enormous.

The quality of the schools was seen by some to be high, by others low. Everyone can see problems, almost everyone took pride and comfort in at least a bit of the whole. Though each can muster an abundance of evidence, neither Pollyanna nor Cassandra is a suitable reporter of American education. It was neither uniformly good nor bad, but a collage still of the ordinary and the excessive, of magnificent obsessions and petty schemes, of grand comprehension and adamant stupidity.

The eye for remedy had numerous places on which to focus. The classrooms were often poor learning environments, with students unconcerned or even hostile to the school effort. What was being taught was often simplistic (reading, simple operations, direct quotations from textbooks) and of questionable relevance from a subject-matter point of view. The social concerns of people (desegregation, vocational opportunity, sports, defiance of authority)--though they have a place in most ideas of what education should be--were disruptive and counter-productive to much of the academic program. Yet it is difficult to imagine what sort of change in priorities and overall operations could substantially alter the system.

Most schools--it appeared--were not what most education specialists and critics would call "intellectually stimulating" places. Each had a few teachers and a few occasions during the week that aroused the intellect, some many more, and for different children differently, of course--but that was not the pattern nor the intent. The talk one heard in classrooms was much like the talk in nearby churches, bars, rotary clubs, and laundromats. It seemed about the same with regard to intellectual stimulation, with the classroom slightly more committed to the consideration of evidence and the questioning of old beliefs, but not much. Newspapers, television, comic books, and movies were apparently much more a source of intellectual stimulation than the schools. Most schools were bending to <u>other</u> purposes: strengthening the simplest and most basic reading and computation skills and conforming to the expectations of teachers further up the grades, of parents, and of a society that wanted people easily recognizable as Americans.

There was a "Love It or Leave It" attitude about much of education in 1977, just as there had been during the War in Vietnam. People who had different ideals than the locally prevailing ones, who protested or took steps to reform, were suspect. Many people in and out of school were not happy with the way schools were, but they were disillusioned by reforms, and they had ordered their lives on the basis of having school systems pretty much the way they were (PINE CITY, RIVER ACRES, COLUMBUS). A few teachers could be said to be pioneers, not many. It should be noted that the frontier spirit of the day was not "We're here to build a better world," but "We'll do as we damn please." Perhaps it was always thus.

Still, the future looked not as foreboding as these paragraphs sound. People were not submissive. Filing lawsuits and dropping out, spreading the word and exercising privilege in diverse ways, the people in this society largely and continually were working to improve <u>the lot close at hand</u>. Agencies such as the National Science Foundation could do many things to support the efforts of people to remedy ills, to make their small place a better place to teach, a better place to learn.

IEEDS AS A BASIS FOR POLICY SETTING

This project, Case Studies in Science Education (CSSE) was one of three studies designed o provide status information to the National Science Foundation. By subtracting status rom goal information, according to James Popham* one might indicate present needs. After eflecting on what we in CSSE have learned directly about perceptions of need, and on 'earden's** thorough analysis of need as an educational concept, we felt compelled to sugest an alternative strategy to the NSF for programming future support for science education.

Committing the NSF to Needs Assessment.*** Since the 1950s the National Science Foundaion has depended upon scientists for information and direction. In its early efforts the SF cooperated with colleges and universities and focused on science education programs or teachers who teach science in the secondary schools. In the 1960s the NSF support of urriculum development became a significant role of the Education Directorate. With that hrust came an increasing emphasis on secondary school programs and the training of teachers or curriculum implementation. Still, the effective emphasis was toward education of future cientists--a small minority of all students who take science courses.

The early 1970s saw a broadening of the scope of NSF education activities. Curriculum evelopers widened their scope to include all students. As the focus widened, the scrutiny he NSF received from Congress and the public increased also. Increasing criticism culmiated in cessation of curriculum implementation pending an assessment of activities both ithin the Foundation and without. Dr. Harvey Averch, Assistant Director for Science Eduation, said in his address before the Subcommittee on Science, Research, and Technology of the ommittee on Science and Technology, during authorization hearings in the House of Represenatives (February 10, 1976): "No major new curriculum projects will be funded without a ystematic needs assessment. Needs assessment will take two forms: analytic surveys and nalyses of educational practices and requirements, and public participation and comment n our program designs."

Perhaps most significant of all new awarenesses of persons in the NSF was that no longer ould they depend so predominantly on the advice of scientists in determining educational rograms. It was recognized that if the NSF was to affect science education for children 10 would not enter science professions then the views of persons other than scientists ould have to be included more in planning pre-college science education. The result was decision to do a broad needs-assessment of pre-college science education, especially to apture the input of interested and informed sources outside the traditional scientific ircles. Once that decision was made a host of opportunities and problems arose: What is the eed? Who is best equipped to know? How many should be reached? Who represents the preollege science education efforts? With whom will NSF work in implementing future programs? iat data will reveal the needs and satisfy the broad responsibility pledged by then Assisint Director Averch?

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*W. James Popham, Educational Evaluation (Englewood Cliffs, N.J.: Prentice Hall, Inc., 975), p. 65.

**R. F. Dearden, "Needs in Education," in Education and the Development of Reason, ed. F. Dearden; P. H. Hirst; and R. S. Peters (RKP, 1972).

***Parts of this section were drafted with the assistance of Arlen Gullickson of NSF.

Need. For the Science Education Directorate's purposes, need was originally defined as the difference between what exists (status quo) and what is believed should be taking place in science education (ideal status). Difficulty in implementation of that model arises principally because of the lack of agreement as to what "should be." Dearden remarked that norms may be vague, difficult to state, and difficult to agree upon.

"Should be" may be defined in terms of present uses or practices. The claim can be made that if some science knowledge is required for functioning in daily life, then that science should be taught. In such a case need (remaining amount needed) would be the difference between what is being taught and what is required. It was recognized that there is no single universal requirement or desired status of science education. There will always be healthy disagreements as to what "should be." The suitability of a science program or of a child's competencies is largely dependent on his present and future circumstances. (In practical terms there are not minimum skills for all youngsters--it only helps us to talk about minimum skills in order to give greater emphasis to certain learnings that are widely desired but not now sufficiently attained.)

It is essentially impractical to consider needs by separately considering actual status and desired status. Both should be considered simultaneously, relating both to particular children, particular communities, particular learning tasks, and particular curricula. When one inquires about status (as we have in CSSE) it is difficult not to learn about need directly. Students, teachers, citizens, and others are quick to follow answers about the present status of teaching and learning with information about what the status should be. They speak of problems. They speak directly of needs.*

The Jacobian. The problem is to identify a course of action given status and need information but not given a "destination." One might look to mathematics for a sense of strategy here. When analysts are searching out a maximum point on an unseen but formulated surface [e.g.: $y=f(x,v,u)$] they may use a directional rather than a discrepancy strategy. The slope at the maximum point, such as at the top of a hill, is zero. The surface is horizontal there, there is no slope. By the use of derivatives and the calculus one can learn the slope at a present position, or at any guessed position. Once the slope is known there, it is only logical to move on "up the slope, uphill" toward the searched-for maximum, then to check out the slope again at a closer spot.

Sometimes the mathematician uses a procedure called the "Jacobian." It permits him simultaneously to take readings of slope at nine patterned places, using the information to make a much more considered estimate as to where to check the slope for the next iteration. But with or without the Jacobian, he moves in the direction of improvement until he gets as close as he wants to be to the zero-slope maximum.

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*There is an important political implication here. If it is believed that the perception of need is most effectively expressed by specialists in science and education, then it is important to have raw status information for them to work from. If it is believed that the perception of need is most effectively perceived by teachers, students, parents, and others citizens then it makes more sense to ask directly about need than to speak of need as a discrepancy between an actual state and an ideal state. Neither perception alone is usually sufficient, of course, but preference for one or the other helps to resolve the definition of need to be used.

The key to this strategy is to keep moving in the indicated direction. One does not know where the desired spot is, but only something about the conditions there, specifically that it is higher, (i.e., better) there than any other place around. Of course there is always the risk that the maximum one will find is only a local maximum, that there are higher hills elsewhere, but the local maximum found may be good enough.

In education we identify many situations in which learning is not at the high level we would like it to be. We would like to find conditions that bring about the highest possible learning. But our research efforts have not been able to tell us at all accurately about what conditions, at what locus, the maximum learning occurs. What we can do is to study the present conditions, and head out in the direction of most likely improvement. If that makes things worse, we can retreat--but probably we will find some improvement, and identify a new direction of improvement.

Sometimes we can locate knowledge or experience which enables us to estimate what the learning would be if conditions were changed in some way. Then, as with the Jacobian, we might make simultaneous indications as to the best direction to move.

The critical idea here is that we do not know where we ought to be. In education, as with the Jacobian, it is impossible to say, "Here is where we ought to be, therefore we can merely subtract the distance and move that far." We cannot identify the most important needs by noting the greatest discrepancies between present and ideal status. It doesn't work that way. What we can identify are the greatest distresses. We can recognize our problems and aim our movement, not in the direction of an obscure Utopia, but in the direction of relief. (Almost no one can spell Utopia, but everybody in the country can spell Relief.) The key to need recognition is finding the direction of relief.

Another Round or Two of Studies? At the end of the present round of studies we will know a great deal about need for improvement of pre-college science learning and teaching in the U.S. There will be some issues central to NSF program development which will be unclear, needing further study. There will be some issues that are clear but unresolved, with different directions. There will be other needs still undiscovered, principally because only certain sub-groups of the population were asked this time around. Leaders of industry, economists, teacher trainers, and futurists are some of the many who have additional ideas about what is needed now and what will later be needed.

The choice of this rationale for needs assessment does not deny that Utopian ideas about science education are important. It only claims that the appropriate inputs for the Utopian output are obscure. It rejects the idea of making a single calculation as to what is needed for a once-and-for-all change. It opts for incremental remedy.

Clearly a needs assessment should be accompanied by a study of the options available to alleviate the higher priority needs. Some information on relief possibilities accompanies information on the need, but more systematic study of alternative remedies is usually needed. A second round in the NSF's needs assessment procedure might include one or more studies (probably policy studies) for each need, or cluster of needs, including the following:

(a) to further identify the need;
to examine its interrelation with other needs; and
to examine the conditions under which this need is more or less formed;

and then

(b) to identify possible options for remedy of the need or improvement of conditions; and

to examine the costs, existing constraints, and implications of exercising each option; and especially

(c) to examine carefully the projections of change in conditions so as to know what relief may occur without action, and to know what exacerbation is to be expected.

For example, it was our observation and it might be concluded by officials of the NSF, that "teacher support systems" were weak and needed vitalization. The teacher having difficulty carrying out an ordinary science teaching assignment was seen to be without sufficient aid, though many agencies existed for the purpose of providing aid. Teachers told us that their resource people largely did not know the realities of their classroom situations. Potential alleviations were seen via better curricular materials, institutes for teachers, Teacher Centers, and Teacher Networks. The role of the Teacher Association and the intermediate district apparently needed study. Additional "excessing" or "riffing" of teachers in the future means that more nonscience teachers can be expected to get science assignments in the next ten years. These are matters to be studied if the NSF is to alleviate the perceived need for support for teachers having difficulty providing good science instruction.

If the National Science Foundation is to continue to improve its awareness of current conditions of science teaching and learning from time to time, one or more additional studies should be established to look broadly at the needs.

The next studies

(a) might draw on additional information sources, such as:
professional associations, both educational and other;
business and industry, including NASA, DoD, etc.;
college people, administrative officers, teacher trainers; state departments of education;
legislatures, governors, congressmen and staff;
scientists;
specialists in manpower and employment;
and community advisory groups

for the purpose of getting new perspectives on identified issues and for getting additional issues or needs identified;

(b) integrating and validating need-perspectives with various studies, such as those prepared by
The International Education [illegible]ion;
the National Assessment of [illegible]onal Progress;
the Educational Products Info[illegible]on Exchange; and
the National Center for Educational Statistics; and

(c) providing special perspective from distinguished scholars with an orientation to:
the history of the problem;
a comparison across countries;
an economic model or rationale for science education; and
a "socialization" rationale or model for science education.

A third round of work might continue to start new probes of issue clusters and continuations and improvement of overall need-assessments for the NSF. It also should move to a feasibility study and perhaps pilot operation of one or more program options appearing most favorable in the second round. The idea is that changes in NSF activities should be based not only on needs assessment but on policy studies that directly relate to practical constraints under present and future conditions. The focus in this NSF needs assessment would remain on providing a more community-based perception for NSF programming to assist the schools (and other educational media) through regular and continuing support services.*

What is proposed here is that needs be identified directly, not without consideration and documentation of present conditions and desires for the present and future, but that needs not be operationally defined as a discrepancy between the two. What people can often agree upon is the direction in which to move to improve conditions. Needs will not be entirely eliminated by any one program, but they can be alleviated best--it is claimed--by direct attack upon the problems. When problems and constraints are sufficiently reduced, the nation's educational system, following the dictates of the individual communities, can be counted on to provide a proper science education program of quality.

A Hierarchy of Needs. The behavior of an individual at a particular moment is largely determined by his/her strongest need. This seems to be true for teachers, and it may be true for school systems, and for national efforts. The "behavior" of educational programs and teachers in classrooms at any particular time seems not generously directed to the highest and most complex of needs, but more often at the lowest and most immediate.

Abraham Maslow once offered an interesting framework to explain the hierarchy of responses to human needs. According to Maslow, physiological and safety needs are strongest until they become at least considerably fulfilled. If survival is not threatened then the individual can attend to social and self-esteem needs. And finally, when comfortable among peers and with one's self, one then may move on to "self-actualization," attempting to satisfy the need to be the "best" that one can become.**

It is interesting to note how in some ways a hierarchy of needs fits the behavior of school officials and entire bodies of government. When survival is threatened, when the budget is about to be cut, when asked in new ways to be accountable, or even when the illusion of such "jeopardy" arises, it seems very difficult for the teacher or superintendent or director or commissioner to work cooperatively with other agencies. And only when the institution is respected among others and by itself is there real effort for it to become the self-sacrificing, altruistic "best" it can become. Or so it often seems.

There is a need for excellence in teaching, in learning, in administering, in providing support. As the educator is charged with failure or threatened with transfer, as the agency is embarrassed at hearings and asked to justify its actions, there may be an all-absorbing effort to protect the enclave, to survive. The more there is indignation about the absence of excellence, the more there are charges of a lack of excellence and clamor for it, the less likely persons and institutions can mobilize to attain it. This is not a plea to quiet the clamor nor to ignore the shortcomings of educators and educational institutions, but a plea for understanding the response. It is a plea for letting up on a singular emphasis on needs. The more needs are subdivided and specified, the more defensive many educators and institutions become, and the less rational may be the response. We have to move to gain relief even before we know enough about our needs.

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*This action on the part of the NSF would be consistent with the historical pattern of social reform in America, according to Harry Passow in "The Future of the High School," Teachers College Record 79 (September 1977): 15-31.

**Abraham H. Maslow, Motivation and Personality (New York: Harper & Row Publishers, 1954).

POSSIBLE ACTION FOR THE NSF SCIENCE EDUCATION DIRECTORATE

In an internal document for NSF staff planning (dated 6/11/77) Howard Levine wrote:

> Since the Directorate is concerned with the interface between science and education, it must begin any analysis by determining the current status and future prospects of both of these entities. It must then synthesize the information at the interface to discover what the pressing problems are at the interface. Finally, it must propose programs to rectify those problems.

There is reason to question the avowed and widespread reliance on information for program planning, but information is certainly an important ingredient. For example, sensitivity to a co-worker's perspectives is dependent on information, but needs more than information alone. The information provided by these case studies tells of current statuses of some schools with a strong sense of expectation for the future. It of course provides little information about science itself. The interface between the two is more important for college, graduate and post-graduate education than for pre-college, but the sense of intersection is an important one at all levels.

Following our research plan, we reviewed previous NSF program efforts and attempted to anticipate prospective and potential headings. In this section of the CSSE final report we comment on the desirability of support for those headings in the immediate future--considering of course the many points of view expressed in our case studies.

Curriculum Development

As long as knowledge and pedagogy change there will be need for curriculum development. But right now is not a time of much change. In the schools we visited we found renewed attention to a traditional curriculum and only occasionally a need for text materials not currently available. We did hear some requests for basic or remedial arithmetic materials for high school age students. Teachers in all subjects continued to look for supplementary materials, something beyond the syllabus that was inexpensive and motivating. There was some feeling that teachers should have help in developing materials which could be shared with other teachers, as is done in the Vancouver Environmental Education Project at the University of British Columbia. Testing appeared to be too strong an influence on curriculum development. Curriculum developers should probably give less attention to the analysis of skills, more to the contextual utility of skills.

Teacher Institutes, Centers, Networks

There was substantial need for pedagogical support for teachers. Many of the good ideas of supplementary centers, intermediate districts, and teacher centers had not caught on--for reasons we did not understand. But the need was well recognized out there. There continued to be a very good feeling about the NSF teacher training institutes, and many teachers and administrators told us the "course content" institutes should be extended to the many teachers who have not had a chance to benefit from them. Institutes based on the use of expensive materials or new departures for teachers were less likely to succeed at this time because local funds and innovativeness have ebbed. As a group, the teachers we became acquainted with in these studies wanted to extend their continuing professional education. Many expressed need for better ways for teachers to share experience and get help with problems.

Scientific Literacy

Overall, in the sites at which we observed classes, science was seen as having rather limited value to the education of all students. Numerous districts had general science goals for students of the elementary grades and junior high school, but these goals did not get high priority attention. Many a district's teachers were satisfying their obligation to teach science by using reading materials that had a scientific topic and by observing the development of plants and animals, important activities but falling short of usual definitions of a science education program.

The claim that a deeper level of understanding of science is necessary for mature thought is a provocative idea, but one that lacks empirical substantiation. What constituted minimum competency in science or any area of skill or knowledge was highly dependent on local circumstances and value patterns; therefore, scientific literacy was not something "testable" with a single standard on a universal scale. But the idea of a better place for science education in general education is worthy of further study.

School-Arranged Opportunities to Learn Science Out-of-School

Programs of outdoor education, with strong science components, were found in several of our sites, particularly the ALTE, FALL RIVER, and ARCHIPOLIS schools. Students there testified to some happiest and most memorable learnings in outdoor programs. Combination school and work programs, presently a priority planning topic with the U.S. Department of Labor, could be much more than a credit-for-work-experience plan if curricular structure were integrated into the arrangements. The opportunities to provide valuable science education experiences in such high-motivation programs were numerous. It needs to be realized that many schools found the arrangements for such out-of-school experiences problematic, exhausting, and of no lasting value, as we learned from the Columbus, Ohio, School-Without-Schools observations. The National Science Foundation could assist the schools in making these difficult logistic arrangements and contribute a bonus to the local science curriculum at the same time.

In an article entitled "More Youth Than Jobs," educational sociologist Robert Havighurst said:*

> The contemporary youth crisis calls for leadership and action by educators working at the high school and college levels. However, they will have to think and act outside of their accustomed routines. Youth need practical, maturity-promoting experience in the adult world, together with vision and perspective on the future of the society for which they will soon become responsible.

He proposed an Education for the Future program along these lines with emphasis on the liberal arts but taking place in the work and learning settings of adults. He suggested a joint curriculum commission funded by the National Endowment for the Humanities and the National Science Foundation. The findings of these case studies largely support the need and good sense of this proposal.

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*Robert Havighurst. "More Youth than Jobs," The Center Magazine 9 (May, 1976): 16-19.

Science Education Through Non-School Institutions

The public schools appeared to us to have a full load of work and to be moving away from science education more than toward it, with the exception of computational arithmetic. It was our conclusion, even though our study did not extend to non-school media for science education, that more programming could be purchased non-school than through schools, for the same investment. The problem is that the children who would benefit most from most non-school programs are the youngsters who already have the best of it, the ones who already are traveling, going to museums of technology and natural history, who are guided to the Cousteau television programs and have a chance to look at an occasional Scientific American. Special programs might be developed through Title I of ESEA for students whose parents are economically disadvantaged and who do not subscribe to the local school objectives or are not served well by them. Special television programming in the science areas is probably undersubscribed at the present time, and much more could be done with local park districts. We noted in particular the changing role of the 4-H clubs in America (page 15:54).

Adult and Continuing Education

There is one small science education void that NSF might try to fill, but it would take major planning and development. There are people of various ages, mostly those out of school (we encountered an interesting mother-son business team prospect) who are thinking and working at the developing edge of some technical area, such as verticalization of pork production and merchandising, technologization of warehousing and inventory control, repair of hi-fi equipment, use of polling techniques by local newspapers and advocacy groups. There are far too few such people in most communities to support formal coursework or even informal learning groups. But in a region of perhaps 90 minutes travel time there may be several who are interested in the same thing, and whose interaction would facilitate their learning. These people could be assisted considerably by an extension program oriented to scientific support for self-initiated learning.

This is an area that university-based extension services have considered their responsibility, but even with large transformation in recent years, they have not developed networks or study groups on the basis of the indiviual learner, but rather on the basis of the subject matter areas that the college (usually a college of agriculture or professional school) has developed. A drawing in of unusual contributions from scientific fields has not characterized these efforts. Clubs, such as 4-H, and industrial organizations, have tried to do some of this, but have been limited either by commonness of interest within a community or by the limited ideational horizon of the sponsor. It probably would be found that existing extension networks and clubs should be the operating platform for an NSF program designed to increase the science education opportunities for isolated individuals but moving beyond the instructional offerings of even the more advanced institutions.

Research on Science Education

The National Science Foundation has for the first time become engaged in the responsibility to conduct research on education. It would seem that a review of the millions spent on research by other agencies of the federal government would show millions spent without apparently moving us substantially further in the direction of understanding education or providing a better base for development than we had previously. Now it could be that the NSF could organize its studies better, find better researchers, or probe areas with higher potential--but the NSF planners cannot be without trepidation at the prospects.

It was our conviction before we started this study, and we became even more persuaded during the doing, that research on the context of instruction rather than research on the learner is more likely to yield insights into the ways of improving the quality of education that is offered. What research on the learner tells us is the vast number of ways people differ, and how greater experience increases those differences. What research on the pedagogical processes, the administrative processes, and the social-political background tells us are the obstacles to learning and the obstacles to changing the opportunity for learning. The cognitive-personal obstacles to learning are formidable, and also not much amenable to school control. The social-political obstacles are also formidable, and also not much amenable to school control, but somewhat more.

Research on the Support System. One of the most attractive topics of research appears to us to be the study of the support system for teaching and learning, including the role of the principal, the department, the curriculum supervisors, the in-service training program, the informal teacher networks, the professional associations and unions, the continuing ties with colleges of education, the PTA's, the textbook publishers, and more. It might be presumed, with the schools having become more technically-oriented, that a support system would exist to diminish the non-teaching burden on the teacher, to bolster those teaching areas in which the teacher is not strong, and to maximize the use of the teacher's talents. It was apparent that many support systems were not accomplishing these purposes.

Research on the Curriculum Supervisor. One part of the support system that should be singled out for particular research attention is the office of the curriculum supervisor or coordinator. Handled in quite different ways in different school systems, the role was apparently undergoing new changes. Partly because of district decentralization, budget cuts, and greater involvement of central offices in state and federal programs, the offices of curriculum specialists now appeared to be busy reviewing new regulations and preparing proposals for new or renewal programs. Work strictly on curriculum and pedagogy problems appeared to have diminished. This may have been an improvement--we do not know. Our CSSE experience was that there were few science curriculum specialists available to help teachers with course content problems and few district officials speaking comprehensively about science education generally. A research study might show that these functions are amply being taken care of by teachers, might show that the present coordinators are doing the new jobs as well as the old, might show that if increased these offices would be staffed mostly by "excessed" administrators or might show that the National Science Foundation should undertake programs to help upgrade the role and the responsibility.

There is another aspect of the curriculum supervisor that bears investigation. A huge investment was being made in the nation's schools in management information systems, many of them mandated by the states. There was an assumption made that resources existed at the district level for interpreting the data so that correction or replacement of curricula would be soundly based. Many supervisors would tell us that they did not have that kind of expertise; about the best they could do is to get some of the testing people and some of the teachers together and to go over the data and see what sense they could make of it. These reviews may be good or bad, no one apparently knows. Just what the curriculum people can best do in these situations, alone or as part of review committees, is another important research aim.

Research on Scientific Knowledgability. Although the amount of testing of student knowledge and skill has increased it was difficult for us to see how it has improved science education, including mathematics education. Supposedly we are moving to a time when teachers will know how much the child knows and how much the child does not know--at least within a prescription of objectives. Many teachers and administrators expressed a belief that they were making progress in this direction. We remained skeptical.

But one thing clearly was happening. The curriculum was becoming more oriented to general skills (adding, reading, observing, looking up information) and less oriented to subject matter content. This was partly because a skill item appeared to be more basic and universal than a content item and therefore "relevant" to a larger stretch of the instruction and more likely to be good preparation for later courses. Perhaps research and development in the science content areas might help to return some of the attention of both instruction and testing to the subject matter of the sciences. (See Chapter 15)

It is noteworthy that we have not been able to provide standardized testing instruments which are focused enough to note when a teacher has spent an extra two weeks on a topic, but not so narrow as the present lesson-specific criterion referenced tests. There are many problems with testing, and developing more tests may add to the burden of instruction and the risk of further imbalance to educational opportunity, but the present negligence of testing for subject matter sophistication seems to call for reserach attention.

Research on Use of Science Instruction for Socialization. The uses teachers made of science subject-matter and instructional materials for socialization, that is, the inculcation of values as described in Chapter 16, were subtle and pervasive and often perplexing. It appeared to some to be a means-ends reversal, at least to those of the rational world of science, where scientific inquiry can stand as an end in itself. However, from the point of view of sociology and anthropology, educational institutions function primarily in the transmission and preservation of societal values. Thus the context of the general educational programs, including ritualistic activities, served primarily to establish the attitudes and habits of behavior in youth which become the admission passes to membership in adult society.

In a technological age, when vocational training becomes more and more specialized, there is a possibility that general education in scientific knowledge may function more and more as a behavioral badge of eligibility for employment, further educational opportunity, and various privileges of the society. The strong suggestion in Chapter 16 that teachers recognized this function and wanted help in adapting newer instructional materials to these ends needs further study. If such socializing functions block the effective adoption of educational innovations, as they appeared in this study to do, they need to be more thoroughly understood than they are now.

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This section obviously did not outline a major educational research program. We of the CSSE staff know that there are many fascinating problems to be explored, and we feel that a society that does not pursue its grand doubts and curiosities can have little hope of coping with its immediate problems, but we did not agree on the value of further basic research in education. As it was, our responsibility in this project was not to plan "the" major works. Our attention was directed to the present status of science teaching and learning, with particular concern for those needs that rather immediately deserve programmatic support from the National Science Foundation. We were not well acquainted with prospective NSF action so our recommendations will not serve that aim as well as perhaps they should. The four areas of applied research mentioned above are, we believe, the most relevant and worthy of exploration.

SCIENCE EDUCATION STRENGTHS, PROBLEMS, AND NON-PROBLEMS

In the foregoing sections of the Executive Summary we have summarized our findings and commented as to how we saw them relating to National Science Foundation programming for pre-college education. Although we benefited from conversations with staff members of the Foundation we feel that we do not have sufficient information about courses of action and merits and costs thereof to justify making recommendations. What we do in the following section is to identify what we saw to be strengths that need to be protected, problems that need attention, and problems often identified which we feel do not merit NSF programming attention. In preparing this list we went well beyond the findings of this case study project to include other experience we have had as researchers and teachers, along with findings from various other research studies.

STRENGTHS

The most substantial STRENGTHS we have seen in science programs in the schools are the following. It is believed by the staff of the CSSE project that NSF planning should give priority to programs which would sustain and protect these strengths.

1. The large responsibility given the individual teacher to decide what will be taught and how it will be taught. Many teachers do not have as much leeway as they would like but other teachers want more of the choices to be determined by the district or state. It is possible that an adjustment could improve things. But the reliance on the individual teacher to make the critical decisions as to what science education will be is compatible with both the workings of science and the requirement of personal responsibility for decisions in a democratic society.

2. The respect shown our faculties of science and mathematics by the general public. A lesser respect, but still substantial regard, is shown for the teachers of social studies in the high school and for elementary school teachers. The militancy of teacher organizations in some places might erode the respect for teachers collectively. The regard shown individual teachers continues to be a strong basis for maintaining and improving school programs.

3. The sincere regard teachers have for the well-being of students, both personally and academically. The teachers have somewhat less concern for parents and taxpayers generally, but still, as a group, have a high sense of social responsibility. Neither child nor adult always appreciates the concern; sometimes the benevolence is greatly disguised; but by and large the empathy is there. Paradoxically, a teacher's efforts in the direction of personal development for students is often little appreciated by subject matter experts and parents, and least of all by the students themselves.

4. The NSF institutes for inservice training. These institutes provide one of the best opportunities available anywhere for upgrading the scholarly understandings and to some extent the professional skills of science and math teachers. They are not entirely suitable for teachers who are struggling with their classroom teaching responsibilities, but are valuable in refreshing the knowledge base for teaching and establishing networks of teachers to tackle common problems.

5. The complex and sophisticated epistemology developed by the modern youngster. While much of the knowledge a child has may itself be simplistic, the intuitive understanding of knowledge is formidable. They understand that "truth" changes and that we are never going to reach a full and satisfactory explanation of many phenomena, that from different points of view you arrive at different conclusions, that truth will be used selectively to further one's beliefs. They are questioning authority. They are more tentative than children of most cultures and than children previously in this culture, but are not immobilized by their skepticism.

6. The material and episodic <u>learning resources</u> of a scientific nature. The array of materials available to American schools for teaching science is vast, though cost or regulation may limit the choice terribly. The opportunity for most children to encounter science on television, in museums, during travels, etc. is immense.

7. The math wars are over. The contentiousness of the new-curriculum advocates and the traditionalists has largely disappeared from the schools. Scientists are less frequently portrayed now as "mad bombers" and technicians as "polluters." In most places there has been a mellowing of <u>faculty attitude</u> toward science and technology. The attitude is, as Kenneth Komoski of EPIE put it, to move "forward to the basics." The preference now of the mass of elementary teachers is for teaching science as part of reading and reading as part of science, but the time is propitious for reconsideration of claims as to what are the primary ideas and student competences in science that the schools should emphasize.

PROBLEMS

Next are what we of the CSSE project saw to be the most serious problems in science teaching and learning in the American schools. These are problems that are part of larger problems, unlikely to be "solvable" by anything NSF might do--but contributions to solutions, or even ameliorations, are believed to be within the capability of NSF programming. Note again that these observations are not drawn from our CSSE experience alone.

1. The proportion of school <u>funding spent for instruction is diminishing</u> at a distressing rate. District budgets show largest increases for teacher salaries; this is true but misleading. More and more administrative costs, such as those associated with enrollments, planning, program development, evaluation, and coordination are being listed as instructional costs--but contributing very little to the teaching and learning. Much of the increased expenditure is at the federal and state level, but the districts and even individual schools have allocated more money when they could to the administrative costs of instructional systems and less to actual instruction. Additional time for administrative duties is required of teachers (testing, discipline). Costed out for instruction, even considering rising teacher salaries, the funding for teaching is diminishing proportionately.

2. There is a <u>diminished concern for scientific ideas</u>, such as Newton's laws and homeostasis, as central to instruction in science. Replacing the emphasis on fundamental relationships are: topics of a scientific or technological aspect, such as environmental pollution, animal behavior, and space exploration. But even those are giving way to emphasis on fundamental learning skills, such as reading, arithmetic, and spelling. In spite of the fact that there is little evidence that these fundamental skills should be (or even can be) mastered before substantial time is taken to develop an acquaintance with the basic ideas of science, the pressure in the schools is to set the ideas aside for a later time that for most students never will come.

3. The <u>pedagogical support for teachers</u> is poor in relevance and small in quantity. Though they do not complain much, teachers have few resources for assistance in teaching difficult subject matter or in teaching children who have trouble learning. The present response is to have teachers teach them something simpler. The assistance in in-service sessions after school tends to be acquainting teachers with new regulations and new opportunities--which are important, but not useful for the difficult pedagogical problems. More experienced teachers are helpful, but help is personal and on a "favor" basis. College courses and special institutes help a teacher with new conceptualizations, but not much with old problems.

4. Opportunities to learn science <u>out-of-school</u> are not <u>sufficiently supported</u> by teaching in the schools. Many teachers, for example, do have children watch National Geographic television shows, purchase hand calculators, and visit local industries, but many do not. There is little official reward to the teacher who encourages youngsters to incorporate into their formal education learnings from the rich environment around,

5. The emphasis throughout the school program, from kindergarten through the twelfth grade is on preparation, not on utilization. Almost everything is learned because it is to be useful somewhere else. When the student gets sometimes to a point where specific learning was supposed to be useful, the next teacher complains that it was not learned well enough. The opportunities for utilizing one's "preparation" are too infrequently built into the curriculum--so that the child gets all too little experience in school as a user of organized knowledge.

6. The schools are no longer providing a spokesman for science. It used to be that the superintendent was a man of learning, a professor, a voice for the importance of knowing why things are what they are. Now, though just as intelligent, the superintendent is a specialist in management of a complex institution, an expert in community relations, and a liaison with federal and state agencies. The curriculum coordinator is doing important things but not speaking out about the importance of science.

NON-PROBLEMS

There is an additional list of problems to be considered, a happier list--for these are problems that get substantial attention but more than is justified. In other words, the following problems have not been seen to be as serious by us of the CSSE staff as they have been by many people in many places. We do feel that anything that is seen by large numbers of people as problematic deserves attention--but it may be more in the matter of helping the concerned people to see the condition as perhaps more tolerable than they have been seeing it.

1. Among teachers and among citizens there are great differences in perception of the objectives of our schools. Our formal statements of purpose are overly general so that no one will disagree or are overly specific so that each bit appears to be small and not likely to take up too much time. A healthy society needs no agreement as to what the schools should do. In fact diverse and even contradictory purposes can be (and regularly are) simultaneously pursued. Agreement as to purpose does not serve as a prerequisite for successful instruction--if it did we would never have successful instruction.

2. The quality of reading and other "basic" performances of students is too low. The fact is that we are not a literate people, not as it seems the Japanese or Swedish are. Perhaps we need to accept ourselves more as what we are rather than as what some of us would like us to be. Of course we should aspire to improvements in reading, but we should also realize that totalitarianism is based on trying to make people what they are not. These children are not the possessions of the schools nor of the government. Even if we knew how to we would not have the right to make all of them "good readers." Parent aspirations and student aspirations should of course be honored, their sincerity in wanting strong backgrounds in basic skills should be respected, but they should not be encouraged to think that without such skills a youngster will not "survive" or that students are better off doing nothing but skill work early in a program. They should not be encouraged to think that failure of the political-economic system to provide jobs is something the schools can alleviate by better reading instruction. Skills that show up on tests are important, but not as important as they are now believed to be. The important thing is to educate young people, not to impose minimal standards for diverse persons in diverse circumstances; to give youngsters the educational opportunities they want, their parents want for them and that fit with traditional ideas of what an education is--and to resist the revision of programs to fit the technology of instruction perceived in administrative offices and governmental agencies. "Reading" is a problem, but not as great a problem as the nation thinks.

3. There is little articulation regarding instruction across classrooms within a building, across buildings, and across levels of instruction, from elementary to high school. But there are very few subject matters for which the teaching actually depends on a high degree of articulation. Science education and even a great deal of mathematics education depend on personal experience and associative meanings. The curriculum which does not develop these individual comprehensions is mechanistic and in danger of being sterile. Sequencing of lessons is important. It depends now on use of syllabi, textbooks and tests. Additional articulation is seldom needed. It really does not help very much to know in detail what other teachers are doing or what later teachers are going to be doing.

4. Science and the social sciences are seldom being taught in an interdisciplinary fashion. Perhaps they are too hard to teach that way. To a person who is "up-to-date" in several of the disciplines the absence of an interdisciplinary approach is dismaying, for so many good learning opportunities are missed with the present approach, and the likelihood of missing more by having teachers teach what they are unaccustomed to teaching or hostile to teaching is high. It is apparent that human beings are amazingly able to tie together things from different conceptual realms across distant experiences. We could do much better in our instruction than we do, but over-attention to disciplinary boundaries is just not a major problem.

5. The level of work in our schools is highly dependent on competition. Winning is just as important for many teachers as it is for athletic coaches. Course marks (grades) are greatly over-emphasized. Competition succeeds in ge[illegible] more ground covered and keeping youngsters more alert than they would be otherwise. Bu[illegible] cost is one of subordinating the learning to an outside motivation, one which is often unavailable for out-of-school learning. The problem however, is a cultural problem, not one that the school now knows how to do much about.

6. There is a diminishing regard for authority. This has direct relevance for the learning of science, as well as indirect. Not only are students as a whole less willing to do their assignments, but they are less willing to believe that their assignments are worth doing. They have been well taught that scientific learning is fluid, ever-changing, and they are not very willing to memorize something that sooner or later is going to be outdated. This is a mature response, one fostered by a number of the curricular reform projects fifteen years ago. It is disappointing when we see it generalized to a devaluation of all learning and a disregard for the learning opportunity of others. Of course, a student will study things of interest to him and his classmates regardless of how authoritative its aura.

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These "strengths, problems and non-problems" summarize our speculative ruminations after some eighteen months of work on the Case Studies in Science Education. We believe they may be useful for NSF program planning but of course urge more careful attention to the project findings stated earlier.

SAMPLE PAGES FROM CASE STUDIES

Readers of the Executive Summary will find frequent citation of pages in the case studies. The following sample pages are provided for those readers who do not have access to the eleven case studies. The sample pages are intended to give readers a sample of the several writing styles of the authors and examples of treatment of certain key issues.

The authors were experienced researchers, educational evaluators and ethnographers. As our field observers, they were encouraged to approach the site in their own way, to select what to observe and whom to interview, to use their own methods and writing styles. As a result, the narratives they have produced represent a broad range within the general rubric of case study research. The studies read like short stories, novelettes, essays, summary reports, or ethnographies. Some are laden with raw data, judgmental interpretations, vignettes, and exerpts from observers' field notes. One gives more stress to reporting or analysis, another lets the people at the site speak for themselves. The sample pages are intended to invite the reader to get and read each case study in its entirety.

These sample pages illustrate several of the most important issues raised in the case studies. The work of the study was originally structured by the science teaching-and-learning questions raised in the RFP and by primary science education issues found in the literature and the field. From these "foreshadowed problems" emerged the general issues of the study. Each field observer raised issues relevant to the site. The process of focusing on these emerging issues and validating them with site visitations gave emphasis to problems both unique to the site and universal to the study. What was important in one case was validated, subsumed, diminished or absent in another. The within-site variation of issues often overwhelmed the between-site aggregation of issues. The sample pages give a flavor of the kinds of issues that emerged as relevant to science, math, and social sciences in each case--open space, excellence, grouping, preparation, articulation, alternatives, back to basics, socialization, testing, disruptive behavior, school finances, teacher militance, desegration.

Sample Page
CSSE Case Study I
SOME STILL DO: RIVER ACRES, TEXAS
by Terry Denny

An elementary school teacher who was trying to cover fifty years in a coffee break told me the thing I . . .

> . . . *had to learn most about our schools is that change comes very slowly to RIVER ACRES. We had it good and knew it before all this started to happen. The old time Houston farmer made sure there were twelve good years of public school for his kids. Those who couldn't cut it didn't deserve to. They have always had a good college-bound curriculum. Then they sent their children to the best schools to get away from the dust, the oil and the cattle. That won't do anymore. Some may yearn for it but it just won't do. All kids need to get their chance.*

The Administration of RIVER ACRES sees architectural change as providing opportunity for more children "to get their chance." But open-space education, now a few years old in RIVER ACRES, came from the "top down" and is embraced by few of the junior high and nearly none of the senior high school faculty. . . .

In the RIVER ACRES school district I found an easy-going administrative style that accompanied the helter-skelter day-to-day problems of rampant growth. The citizens by their absence at school board meetings are saying "things are all right." Simultaneously a group within the district is working toward municipal secession from the district, a maneuver encouraged by Texas law. The easy-going administrative style masks an informed concern. They are aware of what is going on behind the scenes. One parent said the superintendent had more news sources than Deep Throat.

One of the storms that reccurs regularly for the administration is the practice of grouping. How many levels; what criteria to use; and what are its effects? The conventional representations are made. There are calls for more instructional levels, for as many as seven in each grade in each subject. There is a top administrator who wants fewer instructional levels, "two would be about right."

Others feel the administration is caught in a responsive rather than a leadership mode. They assert that the pace of change in RIVER ACRES is more than it can handle. "Who could handle it?" I asked. "A young, sensitive Texan who could make us proud of what we are--and who ate hurricanes for breakfast."

about professional matters, how to improve their teaching or their subject matter knowledge, or of ever ("God forbid") ascending to an administrative position. There is that same feeling of regularity and sameness, as if the lounge patterns were laid down years ago. It's a comfortable, friendly place for those who fall into the patterns. Not all the teachers do. Some deliberately avoid the lounge and don't share the interests and values of those who abide there. If a department has a headquarters, there is opportunity for other sub-groups to form and pursue their interests. One of these is the math-science room, crowded with desks, supplies, and equipment. The teachers use the quiet to study, prepare for their courses, and exchange ideas and feelings about teaching.

The academic life at the high school (speaking only for science, math, and social studies) appears to be confined to the classroom. Even there, academic business is in almost constant danger of being overwhelmed by the student society. What takes place in the classroom is the province of the individual teacher. The building administrators occasionally observe and evaluate, but teachers rarely intrude on one another. If a teacher chooses to lecture, run discussion groups, or confine himself to showing films, an unwritten rule seems to hold that others will say nothing about it. Curriculum--the coverage of a single course or the relationships among courses--is discussed and agreed upon in informal department meetings. Incursion into this system by central administrators or committees is likely to be resented, sabotaged, or passively "waited out."

The students appear to accept the primacy and authority of the teacher, for the hour they sit there. There is rarely an outburst in class; one never sees the student flouting the authority of the teacher. Truancy is the only serious discipline problem in the school. Classroom problems that exist are problems of acquiescence and passive non-involvement. Many teachers express concern about conducting discussions. It is difficult for the observer to pick out the best students in any class. They are as quiet as the others. They don't seem to provide that spark that can help a teacher strike a lively pace and maintain a taut intellectual tone.

The academic life in a classroom is maintained only so long as student attention is directed at some specific activity--a lecture or problem to be done on the spot. When this condition is not met (e.g., when class time is made available for student study), students relax at once; attention is directed immediately to each other. Social processes are so much more compelling than school business. Work can always be postponed until those lonely hours at home; ~~during~~ class there are more important things on students' minds than bookwork.

> [*Observation of an advanced science class.*] *The teacher had assured me that he would start a new unit today, but the students had performed poorly on the unit test and he had agreed to review and retest them. During the review the students quietly and diligently took notes. Then he asked for individual students to approach him with problems while the others reviewed their tests. Immediately what had just been one class broke into several conversation groups. The noise increased. One student went back to the lab to perform an experiment he had missed. The banter started with usual game of "wha'ja get?" but talk about science was soon replaced with talk of girls, dates, cars, the latest track meet, the injuries suffered in Friday's game. Although the teacher tried to bring the class back to science, the hour was lost. Two girls from the hall opened the door and beckoned to a boy to leave class early. Several students sat staring, waiting for the hour to be over.*

The High School Science Program

The high school science program consists of eighteen courses. Despite lenient graduation requirements, enrollments are high. The courses are staffed with an impressive

Among the report's conclusions, two bear upon the issues of curriculum.

> Elementary social studies continues to be an area in which we find the least agreement on what we should be doing and the most difficulty in fully implementing.
>
> In general, however, the record of what is being done is dramatically improved over last year's assessment. Then, recommended programs could be found in about one-third of the classrooms in the district. Now, at least one of the recommended programs can be found in three out of every four classrooms. Of course, how well they are being used is a judgment the principal must make. And it cannot be denied that some teachers may be doing an excellent job with other than the recommended programs. It would seem, however, that almost every teacher needs a good set of materials from which to start social studies instruction and it also seems that she should feel free to take off from these materials whenever appropriate.

Careful reading of those paragraphs suggests a number of potent but implicit aspects of curriculum in Alte.

The formal curriculum at the elementary school illustrates vividly one of the most central problems in a theory of education as a theory of action--dilemmas, trade offs, and decisions. In this instance, one might draw extreme cases of a prescribed curriculum for all schools and classes in science, math, and social science on the one hand, and a curriculum totally left to each individual teacher on the other hand.[14] In between steps on such a continuum might be the introduction of some commonality within each individual building, which does occur presently in Alte. Another variation between the extremes is to provide a prescription, as is also now in place in Alte, that half of the math time is IPI and half the science time is ESS.

The logic of the alternatives seems to be an accent on motivation, creativity, and interest on the one hand; and orderly, organized, and sequenced teaching and learning on the other hand. At its best, one is back with the former to the "project" and "activity" curriculums of Kilpatrick and perhaps Bruner. With the latter, at its best, one is back to Herbert and perhaps more recently to Ausubel. Complex aptitude X treatment interactions exist at the teacher level: that is, who can do what with each orientation.

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[14] An even more extreme possibility would be to have the curriculum determined by the children. See Anatomy of Educational Innovation (Smith and Keith 1971) for an account of attempts in this direction.

that often. You know you're never going to get a whole class at the same time asking a lot of questions, not feeling this inhibition about 'she's a teacher, I can't ask a question,' but just interested in learning for the sake of learning and not because of next week's test. That may be too much to expect. Still, you have students who maybe go do something in science, who do well and enjoy it, and you have the feeling that you had something to do with that. Those are the longer term kicks. From day to day, the labs are more enjoyable than classroom work. I think the kids get more out of them. I think I like most interacting with the individual kid. There's students who'll tell you in class they don't know, when they do know the answer. In lab, they'll talk to you.

"All in all, this is a good place to teach. Basically I feel I can be the kind of teacher I want to be. I don't really feel pressured from any direction. There's no PTA. The school board is generous. I haven't asked for big things, so maybe it's been easy for them to agree to my requests. I don't know of any comment they've ever made about my teaching. And it's the same with the churches. Some places have had controversies over sex education. We teach it in health, and in biology when I go over the reproductive system I discuss contraception and venereal disease. We feel it's necessary for kids to know these things. We give it simply on an information basis. Most of the parents prefer that the kids get it here because a lot of them don't know much of this stuff. As long as you don't get into the moral aspect. The only time any of that came up was on the idea of abortion and I don't believe in it either. That's what I told the class, but at the same time it's there, it's available, and you should know what it is. Beyond that, you make the decision based on your family and your religious beliefs.

"Evolution has never come up as an issue. I don't know. My personal view is probably close to safe because I don't see any divergence between the theory of evolution and a religious viewpoint. I suppose I'm not really radical. Maybe that's the reason I haven't had any feedback. If I were an atheist, I suppose that might present a problem. And the students don't make it a problematic discussion either. Never had anyone do that. Here again, our students are pretty much of one mind. They're pretty closed in the ideas they have. I've hardly had any feedback from the community."

High School Science Classes

Chemistry I

Mrs. N. shows a girl how to get the area of a rectangle:

$$(10.0\ \text{cm})(15.0\ \text{cm}) = 150\ \text{cm}^2.$$

S:[5] *Do we have to do the problem that way? (she asks, referring to the parentheses and the units).*

T: *Yes. And don't forget that you get squared centimeters. What about the significant digits? (She and the class count up the number of significant digits on both sides of the equal sign, Mrs. N. emphasizing they must place a line over the zero in the answer. She reminds the class several times about significant numbers. She reinforces certain procedures, trying to*

[5] In this and all other classroom scenes, S is student and T is teacher.

crosses your face as you watch their unbounded enthusiasm and curiosity. Sometimes this energy competes against the rules and order desired by the teachers.

Elementary teachers seemed happier in their job than did their secondary counterparts. There were more smiles and fewer complaints in the teachers' lounge. The battle lines between students and teachers are not so clearly drawn and learning seems more of a joy than a conflict.

Reading and language arts dominate the curriculum, even at the upper levels. Mathematics is a distant second but it is considerably ahead of anything else. Principals rank the relative emphasis at the elementary level this way:

1. Reading
2. Mathematics
3. Social studies
4. Physical education
5. Health/science
6. Music
7. Art

A reported schedule of a sixth grade teacher also illustrates the situation.

9:00 - 10:00	Language arts
10:00 - 10:10	Recess
10:10 - 11:00	Math
11:00 - 11:40	Social studies
11:40 - 12:30	Lunch-recess
12:30 - 12:45	Spelling
12:45 - 1:20	Language arts or math again, depending on problems
1:20 - 1:30	Recess
1:30 - 2:30	P.E., science, art, music, health

This schedule, or one like it, is typical of all the elementary schools. Science competes with art, music, health (sometimes considered science by teachers), P.E., and whatever else may impinge on the end of a school day, e.g., parent conferences scheduled for two weeks. And science is losing the battle. It receives very little attention.

The curriculum guide for the district, which is seldom used by teachers, recommends about ninety minutes a day for language arts (including reading), about forty minutes per day for math, and thirty each for science and social studies. Other subjects are recommended lesser amounts. Greater influences on teacher decisions are principal pressure, or encouragement, and current district priorities. The latter currently are on such things as minimum competencies in reading and math, desegregation, accountability, and public relations in the community. Science and social studies are being largely ignored.

Probably the most important observation for the purposes of this study at the elementary level is the small amount of science that is being taught. Only an occasional teacher or principal who is interested in the area generates interest that may spread throughout the building. Otherwise, one is most likely not to see any science at the elementary level.

Social studies is given more attention, but even this is diminishing as the move for competency (with its increased time requirements) and other demands grow. Teachers seem to be willing to teach social studies more than science, but less and less time is available.

In one community every curriculum decision had its ties with desegregation:

In the eyes of everyone in Pecan County integration is the key issue, perhaps particularly in the schools, but much of what is focused on education pervades the community as a whole. . . .

For those pressing more directly for integration there are still significant barriers ahead. The banks, medicine, pharmacy and the law are still exclusively white as are most public offices. Yet there is a feeling amongst those in leadership positions in the school system that it is only a matter of time before these areas too become integrated.

This mood of optimism, almost of crusade, seems to be what holds the school system together. Paradoxically even those teachers who do not share the conviction for integration seem carried along by it, almost despite themselves. I found it quite common for white teachers, who seemed to have no hint of prejudice in school, to return to the conventional racial prejudices and stereotypes out of school, albeit in a muted and oblique form. . . .

I confessed to one black girl that I didn't know how to react when teachers, who in school seemed intent on making integration work, out of school expressed prejudice. Should I admire their professionalism or condemn their hypocrisy? She admitted it was often confusing for black students:

> *There are teachers who will be real nice to you in school, but then you'll meet them in town walking along the street, and because they have their wives or their husbands with them, they'll just act like they don't know you.*

Of course teachers often genuinely fail to recognize their students out of context. This girl merely reports <u>her</u> feelings in the situation.

The superintendent is seen by most people as being in a key position on the integration issue. . . . In steering his way through the rocks and shoals of public concern and established attitudes he has had to develop a sensitivity for situations not unlike that previously cultivated by blacks. The anecdote that best captures this concerns the mural painted on the Primary School under the direction of (an) artist-in-residence. It just happened, she explained, that the black children wanted to paint people, while the white children wanted to paint houses, buses, trees and flowers. The result was a colorful landscape peopled by black figures. The mural is in a prominent position readily visible to visitors to the schools and the school board office, and as it neared completion the superintendent walked across from his office to take a look. "Very <u>colorful</u>," was his pointed comment. If you look now, you can see that there are some white faces too, roughly in the proportion they are in the schools (but they still have brown bodies).

To the outside visitor it begins to look like a success story. The schools seem to be working smoothly and integration appears to be accepted, even those who don't like it seem prepared to accept that the process is irreversible . . .

the students went right to work. Other students worked on puzzles and similar type games. All during the science session a variety of behaviors were noted, but my overall impression was that the students were interested and appeared to be having fun (Field Notes, 1977).

In this school where the S-APA program is used the most "extensively," they also have the problems of time allocation for the various curricular offerings. The reading program, the multicultural components of the early childhood program, and the numerous interruptions due to testing evidently do not interfere with the inclusion of elementary science at this one school. The school populations are slightly different, but the time schedules are basically the same. It would seem, then, that other schools should be able to follow this lead.

Mathematics and Social Science

Mathematics at the elementary level varies from school to school. Some schools use packaged programs such as the C.D.A. (Curriculum Development Associates), while others rely primarily on work problems on dittoed sheets. A large number of teachers prefer to "scramble and choose" those materials they think would be most beneficial for their students. As a consequence, unless the teacher has a few years of experience, a good amount of time is spent hunting for appropriate materials for the students.

From the state level, testing is required of all students. In some cases testing of the students is performed two and three times a year, particularly at the fourth, fifth, and sixth grade level, and this again is very time consuming:

The students have to be prepared before the test, well in advance. None of the schools want to come out with low scores. Low scores would mean that we have not been doing our job (Teacher's Comment, 1977).

The pressure for high score attainment is real in the W.C.S.D. The schools in our sample reflected this pressure; yet there was little, if anything, the teachers could do to eliminate this undue pressure for higher scores that would indicate high achievement in mathematics.

Yet achievement is not high; at least, not consistently so. Of the three main ethnic groups in the W.C.S.D., the Chicanos are the ethnic group that exemplifies the loss of mathematics achievement. By the end of the sixth grade, the Chicano group is reading almost two years behind grade level and is over one year behind grade level in mathematics. Whether this is due primarily to language difficulty is not known, but there is some evidence that indicates part of the problem:

. . . just arrived from Mexico. We have him sit over there because no one can understand him. He hasn't learned to speak English yet. When he gets to the point where he can understand English, we will start him on math and some of the other areas . . . (Teacher's Comment, 1977).

While variation exists from school to school in mathematics instruction, the situation for social studies is even more pronounced. In social studies there appears to be no commonality of subject matter content utilized in any of the schools. The materials used vary with every teacher. When asked about this particular area, most teachers responded that this is one area that is dealt with only tangentially. They are not concerned with this area of science per se because their concern is more with reading, writing, spelling, arithmetic, and art.

instruction, using the newspaper school supplement (Classroom Extra), contacting teachers by telephone, and going on field trips. Elementary teachers found their small group contacts to be quite productive. Teachers working with small groups of children in places outside the school discovered they were becoming better acquainted with their children and were teaching more material than would have been possible in the regular classroom. This was so because of the small groups of students teachers had formed. This was much different from the large group instruction most engaged in during the regular program. Some said their small group contacts were more successful than their one day in school contact. One first grade teacher found that two children who she thought were possible retentions had made so much progress during School Without Schools as a result of small group work and parental help that they would probably not be retained this year.

Transporting one's own materials or borrowing those in a host school were a particular problem that the elementary teachers faced during School Without Schools. One teacher said she had to haul three boxes of materials into the school just to teach reading, spelling, and math. Organizing for the one day in school and organizing all the material for the out-of-school assignments was found by many elementary school teachers to be a formidable task.

Subject areas being emphasized by classroom teachers at the elementary level during School Without Schools were reading, spelling, and mathematics. Teachers reported that they had been requested by central administrators to concentrate on these basic skill areas. Some history and social studies topics were being taught, but there was very little attention given to science.

The science curriculum, especially at the elementary level, was revealed to be weak in both the School Without Schools Program and the regular school program. Science is a little-taught subject by many teachers at the elementary level.

Those at the elementary level who did teach science mainly followed a textbook. A second grade teacher said she had attended grade level science workshops for Columbus teachers and had been given all the science supplies she needed. She said all teachers had the opportunity to attend these workshops. The obvious inference was that teachers could get assistance to teach science; but that for whatever reasons, they resisted and did not use such assistance. Reasons given for not teaching science in the regular or School Without Schools Programs at the elementary level were: dislike of the textbook, dislike of a textbook approach, lack of equipment, lack of knowledge to teach science, lack of time, the need to share textbooks, and the fact that science was graded every other six weeks. The generality of these reasons cannot be judged, but it is suggested that they could be pursued as hypotheses concerning why there seems to be so little science being taught in the elementary grades of the Columbus Public Schools. Other than science-related field trips, few teachers planned science lessons for their classes. One teacher took her class to her home to learn how to care for and feed horses. Another teacher related that she had had the children play a science game patterned after a Columbus television program called "In the Know," in which students from two schools compete by demonstrating their knowledge of various topics. This teacher's questions for her "In the Know" game were based on an "out of school" science assignment.

The use of field trips was highly variable both in terms of teachers' employment of them and in terms of the purposes for which they were used. Reasons given by teachers for taking field trips were: to supplement a social studies or science lesson that had been taught before school closed, to extend science concepts, to enrich children's experiences, and to serve as motivation for discussion when school resumed. For example, one sixth grade teacher with a predominantly black class did not meet with her children for instruction outside school; but she did take small groups of students to the Center of Science and Industry, the Ohio State School for the Blind, the Black Cultural Center, the Lincoln LeVeque Tower, and the TGI Friday, a mod restaurant in Columbus, for enrichment experiences. Some

> *He's not a bad boy, and his family does care. I think the three of them just got into something. . . Anyway, I told him I was sorry it had happened, too, and I was glad about the apology; but I could only accept it if he offered in front of the whole class, because in a way he had insulted them, too. So he did do that and I gladly accepted the apology. It is so hard, though! They aren't bad children.*

In the junior high schools the salient issue was "mainstreaming": not so much random mixing of abilities, but the mainstreaming of youngsters with behavioral problems, "juvenile delinquents" as they were sometimes referred to. This was no small concern. Children were being returned to the schools, and to the same classrooms, by the court. A federal court decree assured these children the right to re-enter those classrooms. Following this legal mandate of the courts, the teachers of one of the junior high schools submitted a petition to the teachers' union to initiate a "class action suit" on their behalf.

The stress ran deep. One day I entered the teachers' lounge with Ms. Odom during her free period. I saw an older man with close-cropped hair sitting at the end of the table nervously smoking a cigarette. He held his head with one hand, stroking back across his hair from time to time as if to relieve it of pain. Whe introduced to me as Mr. Thomas, math teacher, he asked if I were there to introduce a new curriculum. I said "No, not this time." I was there to find out what was happening now in science teaching and what teachers thought of it, good and bad. He said:

> *You get kids and they don't know what they should know to do the work. Since they can't do the work, they act up. They don't want kids to call 'em dumb, so they act up to cover up the fact they can't do the work. . . They can't subtract and multiply. They know theory and sets but can't subtract. . . .New math seems to have done that; the paper says high school grade can't even read!*
>
> *Q.: Do you want to go all the way back?*
>
> *Mr. T.: No, not all the way, but some. . . . Oh, I got a headache just looking at this school this morning. . .A kid said to me. . .pardon me. . .he said to me, "Kiss my ass!" Teachers have no rights anymore, only kids. (He rubbed his aching head and drew deep drags from his cigarette.) Kids are all mixed up now.*
>
> *Q.: Is it the size of the classes?*
>
> *Mr. T.: No, size isn't it. You can have fifty who want to learn and still have a good class. We're not allowed to group kids homogeneously. You'll have kids in a grade who can do the work, but some who are two or three grades behind in reading; you have to individualize or group. You can't teach otherwise. But you're just a security guard. (Then). . .Come to my second period class. I'll show you what good kids can do.*

PARENTS

Parents I found have strong sympathy and support for teachers in this matter. At the end of an interview with one parent, I quoted from the petition being composed by the junior high school teachers in the school her children attended.

> *The teachers of Roosevelt Junior High School request a class action suit to protect the rights of our serious students. The quality of education has been severely eroded by the behavior of a few students who make life miserable [illegible]. The noise, the commotion in the halls created by class [illegible] distracts students from their work. Teachers are being verbally*

Although attempts were made to visit a large number of classrooms throughout the cluster of study sites, few recorded interviews were conducted with instructors other than those in social studies. Instead, I made arrangements for local teachers of mathematics and physical science to hold exchanges with members of our site study team. We had an opportunity to execute a comprehensive visitation in Vortex, and it seemed wise to capitalize on this good fortune.[4] Our intent, though, met opposition from the weather: we lost one day of the site study period to "the effects of one of the worst storms to strike [this] area in many years." It was a fitting climax, for Pennsylvania was one of the states hardest hit by the severe winter of 1976-77.

A pair of "mini-portrayals" are included in this report. They build on the foundation outlined above and feature the areas of secondary physics and remedial mathematics in the primary and elementary grades.

THREE PRINCIPAL QUESTIONS

"The total CSSE project has three principal questions to answer," wrote Bob Stake in October 1976. The trio included:

Question No. 1 - "What is the status of precollege science teaching and learning today?"

Question No. 2 - "What are the conceptualizations of science held by teachers and students?"

Question No. 3 - "What happenings in school and community are affecting the science curriculum?"

Responses offered by Vortex teachers, administrators, students, and parents should be interpreted against the background sketched below.

In December 1950, the superintendent prepared a document entitled <u>Proposed Curriculum Changes and Revisions</u> for the Board of School Directors. It stressed:

Science education which only a few years ago was largely optional and integrated in the lower grades has now become a major responsibility of the school. . . . Today, if the teacher is to meet her responsibility she must help the children, in ways appropriate to their maturity, to understand causal relationships and systematic approaches to the observation of phenomena. Moreover, even the young child must become more informed about the place of science and technology as major factors in modern life.

A decade later, his successor--who served the district for almost thirty-five years as a teacher and administrator--wrote:

It has been frequently stated that the primary function of the schools is the cultivation of the mind, especially as regards the basic mental skills. . . .

[4] Two of our team members were mathematics professors at the local university. Both were natives of the area and well acquainted with its schools. In truth, they were part of the Vortex "family."

[illegible] writes on the board: "Conclusion. Air is all around."

Air is all around and occupies space. ("Those are the key words," David comments.) The drinking glass contains air. ("I'm going to do something different this semester, I'm going to collect in your notebooks, and those who take the notes will get credit for doing it.") The water pushes against the air, but can't enter unless the drinking glass is held at an angle to permit some of the air to escape.

David next demonstrates the second experiment, which is to float a cork on water and then press it under water with an inverted, air-filled drinking glass.

"Describe where the cork is," David asks.

"Below the water."

"Right," says David. "The pressure of air presses it down. Air occupies space. Air has weight. If I tilt the glass, air escapes and the cork will rise. I'm going to put the answer I want on the board."

He writes: "Conclusion. Air is a substance ('Just like solids and liquids'). Air is a real substance and takes up space just as do liquids and solids. The air presses down on the cork, forcing it down. Since the drinking glass is full of air, no water can get in unless we first let some air escape." He reads it out loud and waits for the class to write it down.

You may think these are things you knew all along (he says), but I want you to get used to putting it down in this form. Let me give you a word of advice. I'm going to be giving you some notes each day; if you miss a class, make sure you make up on the notes. You won't always be able to catch up on the experiments, but make sure you get the notes. For homework, I want you to find out what gases compose a volume of dry air.

With ten minutes of the lesson left, he begins a class discussion:

"Where does our atmosphere begin?"

"At the ground."

"Where does it end? How high? (pause) Is a thousand miles too much?"

"No."

"Actually it's nearer two thousand miles. But most of it is concentrated in the first thirty to fifty-five miles. Has anyone ever climbed a mountain?"

(Some yeses)

"If you ever climb a mountain, or go to Denver, you know that the air gets thinner. Denver is at 6000 feet, and that high the air is thinner than it is here near sea level. So most of the air is in a thin layer around the world, and it's in that layer that we get weather. Can you give me a definition of the layer?"

"Earth's atmosphere."

"Remember the definition I gave you the first week?"

He writes on the board: "The great ocean of air that extends thousands of miles above the surface of the earth and gradually thins into outer space."

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SUBJECT INDEX

THE STATUS OF PRE-COLLEGE SCIENCE, MATHEMATICS, AND SOCIAL SCIENCE EDUCATION: 1955-1975 (A Literature Review)

EXECUTIVE SUMMARY

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Table of Contents

GENERAL EXECUTIVE SUMMARY

This study is one of three funded by the National Science Foundation in the summer of 1976 to assess practices in pre-college education and to provide baseline information on needs so that the Foundation can target its future programs in science, mathematics, and social science education to meet documented national concerns. One of the studies, the National Survey of Science Education Curriculum Usage, conducted by Research Triangle Institute, used questionnaires to obtain information on such topics as course offerings, curriculum materials usage, equipment and facilities, instructional techniques and inservice education. The second, Case Studies in Science Education, conducted by staff at the University of Illinois, involved a series of in-depth investigations of current conceptualizations, practices, and problems having impact on science education.

The third study is the one summarized here, a review and analysis of the literature related to the status of (1) existing practices in schools and in teacher education for the period 1955 through 1975, and (2) needs assessment efforts that have focused on local and national concerns. It was conducted by the Center for Science and Mathematics Education at The Ohio State University and the Social Science Education Consortium, Inc., Boulder. An archival search of the literature was conducted using such data bases as ERIC, reports to federal educational agencies, Dissertation Abstracts International, Education Index, state department of education reports, summary data from governmental and professional studies, professional journals and scholarly works, summary data from various accrediting agencies, and other available documents.

The literature was searched and reviewed following parallel strategies for the two areas of practices and needs. Both descriptive literature on existing practices and the research/evaluation literature on effectiveness and efficiency of practices were included. Documents of particular significance were sought on completed needs assessment efforts to determine both goals and progress. The compiled literature was analyzed, evaluated, and summarized. These summaries are status reports of trends or patterns in the preparation of teachers, teaching practices, facilities, curriculum materials, achievement and attitudes of students, and needs expressed during the period as they were reflected in the literature. The outcome of this project is three separate reports, synthesizing the findings from the literature for science education, mathematics education and social science education, respectively.

Some summary highlights from each of the reports are presented along with page numbers for the section in the appropriate report from which each statement was drawn.

Highlights from the Science Education Report

- Enrollments have been increasing but are beginning to decline, with elementary enrollments declining earlier than secondary. (7)

- The effect of enrollment change may be heightened by emigration of students. (7)

- Just as increasing enrollments had an impact on schools, decreasing enrollments will impact on schools, particularly financially. (7)

- Stated objectives for elementary school science have not changed significantly since 1955. (16)

- Objectives for secondary school appear to be in transition; the importance of science in the general education program is receiving less emphasis. (21)

- The percentage of students enrolled in science has increased until 1973-74 and since has remained relatively stable. (21)

- Class sizes have been reduced between 1955 and 1975. (30)

- Perceived barriers to effective science teaching have not changed appreciably over the past 20 years. (30)

- The individual classroom teacher is still the primary mode of instruction in most classrooms. Less than 10% of the schools have used innovative practices such as modular scheduling, television, or computer assisted instruction in any consistent manner. (30)

- Since 1955 there has been an increase in student-centered and hands-on instruction but a substantial percentage of students are not involved with such procedures. (34)

- There are far more alternatives for instructional materials currently than in 1955. Relatively few of these are designed for use in an articulated program. (34)

- The variables for effective teaching are generally agreed upon and the most important, with the current mode of instruction, is the teacher. (34)

- About 50% of the students take no science after grade ten. (34)

- State certification criteria still do not reflect those proposed by professional associations in that the professional organizations call for an increase in science content. (43)

- Over the years the guidelines proposed by professional organizations have broadened their focus from science content to include such things as interpersonal relations and ability to deal with societal problems. Guidelines related to content areas are the most likely to be implemented, however. (43)

- Preservice programs in science education reflect increased field experiences and, in general, increased time in the education component. (50)

- While NSF and OE did offer intensive institutes in the late 1960's and early 1970's, the majority of teachers currently teaching have not participated in these. (70)

- The bulk of the science instruction for the secondary program is in the junior high school (nearly 50% of the students take no science after tenth grade); this level has the teachers with the least adequate content preparation, poorest facilities, and fewest certification programs available. (70)

- Even though more science is being taught at the elementary level, elementary school teachers are most comfortable when science consultants are available. (80)

- Although secondary school science teachers are currently younger and better educated than in the 1950's, there is still a critical need for inservice education, both as perceived by the teachers and as indicated by research. (80)

- The average tenure for teaching was about eight years in the late 1960's and early 1970's; it is currently increasing. This has implications for inservice education since it appears that the more recent graduates are those more likely to go back to school. (89)

- There is a critical need for preservice and inservice science education to be viewed and dealt with as a continuous program rather than as discrete entities handled by two different sets of people. (96)

- Teachers are being impacted upon by the press for accountability, the back to basics movement and textbook controversies, but these are rarely the kinds of issues dealt with in their preparation. (105)

- The influence of state governments on science education has increased markedly since 1955. (119)

- There is extreme variation in state control and influence, but regional patterns do exist. (119)

- Some examples of areas in which considerable state control is exerted are school organization, school curriculum, teacher certification and financial support for schools. Science education has been impacted both negatively and positively by state influences. (119)

- The percentage of financial support for the schools from federal and state sources has increased since 1955; the percentage of financial support from local sources has decreased since 1955. (133)

- Federal support for science education has declined since the late 1960's. (133)

- Since state support tends to follow federal trends, state support for science education has also declined and is likely to continue to do so. (133)

- The greatest single need facing education is an improved program of financial support. (148)

- There is increasing emphasis on basic skills; knowledge of science is rarely considered basic. (149)

- An important and complex need is for equal educational opportunity. (151)

- Pressure for accountability has increased markedly within the past ten years. (152)

- Science education is rarely included in state needs statements. When it is included, it increasingly reflects concern for life skills and work skills. (152)

- Nearly all states have some form of accountability or assessment procedure. (152)

- The major objectives in science education have not changed markedly over the past 20 years. The emphasis is beginning to shift, however, at the secondary school level. (170)

- Continuing research in science teaching-learning is vitally needed. However, the results of that research which has already been done needs to be better communicated and applied. (184)

Highlights from the Mathematics Education Report

- Roles of federal agencies changed as they assumed varying degrees of responsiblity for the cost of curriculum development and teacher retraining. (13)

- An explosion was apparent in research as well as development efforts. (13)

- Concern was apparent for the mathematically able, especially at the secondary level, and for the disadvantaged, especially at the elementary level. (13)

- The self-contained classroom at the elementary level and the fixed-period schedule of the secondary school remain the predominant organizational patterns. (28)

- As reflected in print, the content of school mathematics curricula changed. The number and variety of courses offered at the secondary level increased, but the inclusion of "new math" content in the elementary school may be illusory. (32)

- Knowledge of what goes on in schools is limited; few studies have described the actual classroom situation (50)

- Classrooms have changed little over the past 20 years, despite the innovations advocated. Predominant patterns continue to be: instruction with total-class groups; tell-and-show followed by seatwork at the elementary-school level, and homework-lecture-new-homework at the secondary-school level. (50)

- It appears that no one mode of instruction can be considered best for mathematics, nor is there any <u>one</u> organizational pattern which will increase student achievement in mathematics. (50)

- Few variables consistently make a difference in mathematics performance. (50)

- The needs of the talented, especially those in small schools, are not being well-served in the 1970's. (50)

- Standardized tests have assumed increasing importance, as has recognition that scores from tests are being misused. (78)

- Attitudes toward mathematics are generally positive in the elementary school and appear to peak at approximately age 12. (84)

- Socioeconomic factors appear to account for much of the variance in mathematical achievement. (84)

- The textbook is the primary determinant of mathematics curricula, and many teachers use no instructional materials except textbook and chalkboard. (98)

- The amount of money devoted to mathematics instruction is difficult to determine; 18% to 20% seems plausible but cannot be verified from available data. (116)

- The amount of money spent per pupil has not been found in most studies to be significantly related to mathematical achievement. (116)

- The mathematical background of students completing preservice programs increased significantly. (128)

- Leadership for in-service education at the local school level can appreciably change its character and teachers' perception of its worth. (128)

- Competence of teachers, when assessed in terms of promoting mathematical growth of students, is apparently related to a complex interaction of factors. (128)

- The most significant trend in preservice teacher education is the move toward incorporating pre-student-teaching field experiences. (128)

- Many needs have been repeatedly stated during the 20-year period. (180)

- Discrepancy in the selection or ranking of goals is common. (180)

- Relatively little attention has been given in most states to documenting the history, status, or needs of mathematics education. (194)

- Where needs assessments specific to mathematics have been conducted, both "knowledge of basic skills" and "applications of skills to real-life problems" have been high on the list of needs. (194)

- Discrepancy among concerned groups is apparent in the priorities assigned to mathematical goals. (194)

- A comparison of data on computational skills indicated that these skills are not acquired on the basis of initial instruction, but performance tends to stabilize during junior high school. (199)

- State progress assessments vary greatly in scope of objectives, type of test, and reporting procedures. (209)

- Content areas in which weaknesses have been identified by assessments are ones which have long been known to be difficult; fractions, division, and subtraction with regrouping head the list. (209)

- Three sources of failure in the process of policy formation for mathematics education are apparent: (218)
    (1) Educational policy is frequently determined without collecting enough information to allow the process to be rational.
    (2) Educational policy is frequently constructed without using information that is readily available.
    (3) The point at which values enter into policy formation and the effects of the differences in the various groups concerned with the schools are frequently not recognized in determining priorities.

- Amazingly, progress has been made without systematic information collection about existing practices. (218)

- Efficiency in promoting change is the real problem to be faced. (218)

Highlights from the Social Science Education Report

- Although there have been a number of studies examining the state of social studies practices over the past two decades, many aspects of practice remain unclear. (12)

- The scope and sequence of the social studies curriculum has remained relatively stable in general outline over the past 20-year period; there have been a few noticeable shifts within that framework such as the infusion of concepts and methodologies from the scientifically oriented social science disciplines. (21)

- Studies of use of various social studies classroom practices are limited; those that do exist indicate that, contrary to popular belief, the lecture method may not have been so pervasive in the 1950's and 1960's as has been claimed; a sizeable proportion of teachers employed multiple instructional techniques. (48)

- Aspects of curriculum materials most frequently analyzed are their treatment of (a) social science content and methods, (b) specific concepts and themes (such as violence, communism, social change), and (c) minority groups; most analysts conclude that there are inadequacies in treatment of the social sciences by textbooks. (80)

- There appear to be major deficiencies in the social science course work of social studies teachers; there is evidence of a slight trend away from the dominance of history and toward inclusion of more social science courses in teacher training programs, however, no such pattern is apparent in state certification requirements. (120)

- Social studies educators have not been much interested in or affected by research; there is a lack of a cummulative research base in the field. (148)

- Little or no research has focused on questions about about the relative merits of different kinds of content in achieving the goals of the social studies. (167)

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- A large proportion of the effectiveness under the heading of research on instructional methods and focuses on methods labeled "critical thinking," "inquiry," and the like. Most of the research has shown no significant differences between critical thinking methods and the so-called traditional methods; however, weaknesses in design and in interpreting the results may be concealing real differences in effectiveness. (170)

- There has been little research on the effect of curriculum materials and even less effort directed toward interpreting what little research there is in this area. (194)

- Research on the effects of various learner variables (such as student attitudes, interests, abilities, and socioeconomic backgrounds) on learning in the social sciences is spotty. There have been a few research conclusions drawn with respect to how children's developmental abilities affect learning, but these have apparently not been put into practice by curriculum developers and teachers. (198)

- No attempts have been made to draw conclusions from the body of research surrounding the development of the "new social studies" project materials. (206)

- National achievement testing programs have produced trend data on social studies achievement at the lower cognitive levels which indicate that students' knowledge of so-called basic information in the social disciplines, particularly history, is declining. (209)

- Assessment efforts in social studies and citizenship have produced results in a wider variety of areas, including attitudinal outcomes of schooling; however, because these are recent efforts, trend data are not yet available. (209)

- The testing programs and assessments do not generally attempt to tie test results to possible causal variables in test-takers' backgrounds. (209)

- Cummulative research findings related to social studies teacher education are few and suggest that, even though a variety of teacher training practices produce changes in teacher behavior, student behavior is not affected by changed teacher behavior. (251)

- Combining teacher training in academic content and instructional methods may hold the best promise for affecting student outcomes. (251)

- Because the question of the purposes and boundaries of the field of social studies remains unsettled, needs in social studies education are difficult to pinpoint; all manner of needs, including some contradictory ones, have been claimed for the social studies. (263)

- There is high agreement that academic freedom and the difficulties of dealing with controversial issues in the classroom pose a problem of particularly strong significance for social studies teachers. (263)

- During the 1960's, social scientists exercised a particularly strong influence on the social studies, attempting to infuse more and better social science content and methods into the curriculum. (263)

- The influences of laypersons on the social studies has waxed and waned over the past two decades; there has been no consistent pattern displayed in the demands of the laypersons over this time period. (263)

- There are many different perceptions of what the characteristics of the "new social studies" are, although there appears to be general agreement on seven "core" characteristics. (263)

- At least ten different categories of criticisms have been advanced against the "new social studies" over the past decade. (291)

- Some data on the impact of the "new social studies" are available; these show that the materials have not been widely adopted by school systems, but they do not shed light on other possible modes of influence, such as impact on the kinds of materials being developed by commercial publishers. (291)

Some Generalizations from the Three Reports

- There have been few assessments which dealt with the specific needs of any of the three discipline areas of science, mathematics, or social science education.

- Discrepancy in the identification of needs, the selection of goals, and the ranking of goals is apparent.

- Emphasis on accountability has increased markedly over the past ten years; nearly all states have some form of accountability or assessment procedure, with the two procedures often intertwined.

- Patterns of classroom organization have remained relatively stable over the past two decades.

- There is no one best mode of instruction; the individual classroom teacher is the center of instruction in most classrooms.

- There was great expansion in curriculum development activity during the past twenty years; activity peaked during the mid-to-late 1960's.

- Textbooks remain the predominant determinants of curricula and reflect the influence of state guidelines.

- Teachers currently have greater academic preparation than did those of twenty years ago; new approaches to inservice education are needed to meet the needs of these teachers.

- Research has increased markedly over the past twenty years; however, the results of research are not effectively translated into classroom practice.

- An improved program for financial support of education related to priority-determined programs, rather than the simple infusion of more funds, is a critical need.

EXECUTIVE SUMMARY: SCIENCE EDUCATION

I. Introduction

The time period from 1955 to 1975 was unparalleled in the degree of activity in science education. Millions of dollars were devoted to the cooperative involvement of scientists, educators, and learning theorists in the development of science curriculum materials. Extensive programs were conducted to upgrade and update the science content background of teachers and to train them in the use of the new curricula.

The Elementary and Secondary Education Act initiated programs to deal with special groups within the educational community. Concern for the educational needs of students, especially the disadvantaged and the deprived, and for program effectiveness was specifically mandated by this Act.

The focus of this project was a status report on the impact of such activity in curriculum development, teacher education, instruction and needs assessment. Specifically, the purpose of this project was to:

1. review, analyze, and summarize the appropriate literature related to pre-college science instruction, to science teacher education, and to needs assessment; and

2: identify trends and patterns in the preparation of science teachers, teaching practices, curriculum materials, and needs assessments in science education

during the period, 1955-1975.

II. Methodology

Because this was an archival study, the procedures focused on identifying, retrieving, and analyzing existing literature rather than on generating new information. Major sources of information included the ERIC data base, Education Index, Reader's Guide to Periodical Literature, Dissertation Abstracts International, published books and journals, federal agencies' files and collections, state department of education archives, and reports from conferences and committees. Selection of documents for review was based upon (1) generalizability of results based upon size of population, sampling techniques, and methods of analysis; (2) summarization of data or research reports (e.g., reviews of research); (3) importance or significance as indicated by publication in a refereed journal or as a committee report; and (4) representativeness of a type or kind of document (e.g., curriculum guides).

The report is organized around four major considerations:

1. Existing Practices and Procedures in Schools--enrollment, school organization, curricular and instructional patterns, facilities and equipment.

2. Science Teacher Education--preservice education guidelines, certification, programs, and research; inservice education certification, programs and practices, and research; science teaching today, curriculum reform, supply and demand, professionalism and responsibility, pressures and politics, and implications for science teaching.

3. Controlling and Financing Education--control and financing of schools; cost effectiveness of science instruction.

4. Needs Assessment Efforts--general education needs and science education needs.

A section of the report corresponds to each of the major areas. Within each section summary statements are presented for the major subsections followed by the documentation from which each was derived. A final section presents a summary and trends of needs and practices. Because of space limitations and redundancy of information, documentation is selective rather than an exhaustive listing of applicable citations. It should be noted that many of the documents are from the last half of the twenty-year period rather than the first half. This stems partly from the ephemeral nature of much of the literature, but more importantly from two other considerations. First, the emergence of results, trends, and patterns is better reflected in the more recent literature since these are not instantaneous apparitions. Second, the recent literature indicates the existing conditions from which decision makers must determine factors affecting educational policies. If a historical review is to assist science education, the policy implications of past events must be considered for the future.

III. Findings

Selected summary statements are presented for each major section. The column of page numbers indicates the section in the report from which the findings were drawn.

Practices and Procedures

- Enrollments have been increasing but are beginning to decline, with elementary enrollments declining earlier than secondary. (7)
- The effect of enrollment change may be heightened by emigration of students. (7)
- Just as increasing enrollments had an impact on schools, decreasing enrollments will impact on schools, particularly financially. (7)

- Stated objectives for elementary school science have not changed significantly since 1955. (16)

- Objectives for secondary school appear to be in transition; the importance of science in the general education program is receiving less emphasis. (21)

- The percentage of students enrolled in science has increased until 1973-74 and since has remained relatively stable. (21)

- Class sizes have been reduced between 1955 and 1975. (30)

- Perceived barriers to effective science teaching have not changed appreciably over the past 20 years. (30)

- The individual classroom teacher is still the primary mode of instruction in most classrooms. Less than 10% of the schools have used innovative practices such as modular scheduling, television, or computer assisted instruction in any consistent manner. (30)

- Since 1955 there has been an increase in student-centered and hands-on instruction but a substantial percentage of students are not involved with such procedures. (34)

- There are far more alternatives for instructional materials currently than in 1955. Relatively few of these are designed for use in an articulated program. (34)

- The variables for effective teaching are generally agreed upon and the most important, with the current mode of instruction, is the teacher. (34)

- About 50% of the students take no science after grade ten. (34)

Science Teacher Education

- State certification criteria still do not reflect those proposed by professional associations in that the professional organizations call for an increase in science content. (43)

- Over the years the guidelines proposed by professional organizations have broadened their focus from science content to include such things as interpersonal relations and ability to deal with societal problems. Guidelines related to content areas are the most likely to be implemented, however. (43)

- Preservice programs in science education reflect increased field experiences and, in general, increased time in the education component. (50)

- While NSF and OE did offer intensive institutes in the late 1960's and early 1970's, the majority of teachers currently teaching have not participated in these. (70)

- The bulk of the science instruction for the secondary program is in the junior high school (nearly 50% of the students take no science after tenth grade); this level has the teachers with the least adequate content preparation, poorest facilities, and fewest certification programs available. (70)

- Even though more science is being taught at the elementary level, elementary school teachers are most comfortable when science consultants are available. (80)

- Although secondary school science teachers are currently younger and better educated than in the 1950's, there is still a critical need for inservice education, both as perceived by the teachers and as indicated by research. (80)

- The average tenure for teaching was about eight years in the late 1960's and early 1970's; it is currently increasing. This has implications for inservice education since it appears that the more recent graduates are those more likely to go back to school. (89)

- There is a critical need for preservice and inservice science education to be viewed and dealt with as a continuous program rather than as discrete entities handled by two different sets of people. (96)

- Teachers are being impacted upon by the press for accountability, the back to basics movement and textbook controversies, but these are rarely the kinds of issues dealt with in their preparation. (105)

Controlling and Financing Education

- The influence of state governments on science education has increased markedly since 1955. (119)

- There is extreme variation in state control and influence, but regional patterns do exist. (119)

- Some examples of areas in which considerable state control is exerted are school organization, school curriculum, teacher certification and financial support for schools. Science education has been impacted both negatively and positively by state influences. (119)

- The percentage of financial support for the schools from federal and state sources has increased since 1955; the percentage of financial support from local sources has decreased since 1955. (133)

- Federal support for science education has declined since the late 1960's. (133)

- Since state support tends to follow federal trends, state support for science education has also declined and is likely to continue to do so. (133)

Needs Assessment Efforts

- The greatest single need facing education is an improved program of financial support. (148)

- There is increasing emphasis on basic skills; knowledge of science is rarely considered basic. (149)

- An important and complex need is for equal educational opportunity. (151)

- Pressure for accountability has increased markedly within the past ten years. (152)

- Science education is rarely included in state needs statements. When it is included, it increasingly reflects concern for life skills and work skills. (152)

- Nearly all states have some form of accountability or assessment procedure. (152)

- The major objectives in science education have not changed markedly over the past 20 years. The emphasis is beginning to shift, however, at the secondary school level. (170)

- Continuing research in science teaching-learning is vitally needed. However, the results of that research which has already been done needs to be better communicated and applied. (184)

EXECUTIVE SUMMARY: MATHEMATICS EDUCATION

I. Introduction

This historical study provides evidence on the status of mathematics education in the 20-year period beginning in 1955, in order to ascertain causes and effects of educational policy formation. Since this time period witnessed dramatic attempts to reorient the mathematics curriculum, instructional practice, and teacher education, the process and outcomes are traced in the hope that events of the past can be used to provide guidance for making future decision-making more rational.

The following questions are addressed:

(1) What were existing practices in mathematics education for curriculum, instruction, teacher education, learner performance, and needs assessments?

(2) Was the information about practices used or ignored in decision-making concerning policy in education?

II. The Research Approach

Since this is a historical study, the procedures focused on obtaining, searching, and analyzing the literature of the period. New information was not generated; rather, existing documents were collected and examined carefully. In particular, published articles, committee reports, and influential books were studied; pertinent documents from the ERIC data base, state educational archives, and other institutional archives were collected; and research reported in journals, monographs, dissertations, and other sources was considered. Documents were selected in terms of (1) evidence of significance, (2) validity and generalizability of conclusions from data, and (3) perception of the quality of the work.

Three major themes are treated:

(1) The schools -- organizational, instructional, and curricular patterns; student characteristics, evaluation, materials, and costs.

(2) The teachers -- preservice and in-service education, background, competence, and behaviors.

(3) Needs assessments -- planning documents and assessment results at national and state levels.

A section of the report corresponds to each of these themes. Summaries highlight major conclusions derived from the historical record. A concluding section attempts to integrate major findings and to anticipate trends for the immediate future. The task of determining goals for future activity in mathematics education exceeds the scope of this historical record, although information is provided about the determination, implementation, and rationality of educational policy.

III. Findings

Selected highlights from each section provide a brief summary.

The Schools. Evidence describing practices in mathematics education is presented, with an attempt to trace patterns and the mode of decision-making for seven areas of concern. For most areas, no discernible patterns could be found; needs and the basis for decisions were only rarely documented. The factors which influence practices are varied and complex; change is not linear.

A. Overview, 1955-1975 page 27

- The 20-year period witnessed:
  - continuing curriculum reform
  - extensive federal funding, with federal policy increasingly affecting curriculum development
  - changing roles for federal agencies as they assumed varying degrees of responsibility for the cost of curriculum development and teacher retraining

- an explosion in research as well as development efforts
- concern for the mathematically able, especially at the secondary level, and for the disadvantaged, especially at the elementary level

- The need for curriculum reform was generated by:
  - 1955 - public dissatisfaction with existing curricular outcomes: concern from mathematicians and mathematics educators
  - 1965 - concern for the economically and educationally disadvantaged; reassessment of the need for mathematical rigor
  - 1975 - patterns of declining achievement scores; especially at the college-entrance level; pressures for accountability

B. Organizational Patterns page 31

- There appears to be no <u>one</u> organizational pattern which will increase student achievement in mathematics.
- The self-contained classroom at the elementary level and the fixed-period schedule of the secondary school remain the predominant organizational patterns.

C. Curriculum and Content page 48

- "New math" was not a single phenomenon, but a two-decade series of developments that evolved and changed continously.
- Initially, curriculum reform focused on the college-bound student at the secondary level, while most early elementary projects developed supplementary materials. Changes in intent accompanied changing needs.
- As reflected in print, the content of school mathematics curricula changed. The number and variety of courses offered at the secondary level increased, but inclusion of "new math" content in the elementary school may be illusory.
- Curriculum guides vary in format and emphases, but have little variance in content. Behaviorally stated objectives distinguish many 1965-1975 guides from earlier guides.
- Enrollment increased in secondary mathematics courses, especially in advanced courses. A large percentage of students have used materials from one or another of the curriculum development projects.

- Enrollment patterns seem relatively stable in the 1970s, with continued small increases in advanced courses and in basic or remedial mathematics.

D. What Goes On in Classrooms page 76

- Knowledge of what goes on in schools is limited; few studies have described the actual classroom situation. However, it appears that:

  - Approximately 20% of the elementary-school day is allocated to mathematics, with the number of minutes increasing as grade level increases. At the secondary-school level, approximately 200-300 minutes per week are allocated to mathematics.

  - A large proportion of time is taken up by non-instructional activities; thus, how time is used may be of more importance than how much time is available.

- Classrooms have changed little over the past 20 years, despite the innovations advocated. Predominant patterns continue to be:

  - Instruction with total-class groups

  - Tell-and-show followed by seatwork at the elementary-school level, and homework-lecture-new homework at the secondary-school level

  - It appears that no one mode of instruction can be considered best.

  - Few variables consistently make a difference in school performance

  - Teachers frequently do not differentiate instruction. They tend to gear instruction to skills already achieved by their students.

  - There is little evidence that self-paced programs for individualized instruction are any more effective than "traditional" instruction, but they cost much more than traditional instruction costs.

  - The disadvantaged student can profit from special attention, but such students differ individually more than as a group.

  - The needs of the talented are not being well-served in the 1970s. Enrichment programs are especially needed for those in small schools.

- Advanced Placement serves the needs of those using mathematics better than of those majoring in mathematics.

E. Evaluation of Achievement page 83

- The scope and role of evaluation has been greatly expanded during the 20-year period. Evaluation information is now expected to provide guidance for programmatic decision.
- Standardized tests have assumed increasing importance. Recognition that scores form tests are being misused has also increased.
- The greatest change in testing has been the increasing use of objective-or criterion-referenced tests.
- Instructional objectives and test items compare favorably on content involving computation, but not geometry, measurement, and other topics.

F. Student Characteristics page 96

- The range of mathematics achievement scores increases as grade level increases.
- Attitudes toward mathematics are generally positive in the elementary school and appear to peak at approximately age 12.
- While mathematics educators and teachers believe that attitudes toward mathematics are related to achievement in mathematics, there appears to be no meaningful or significant relationship between the two.
- Sex-related differences are not universal across the factors related to mathematical ability differences in aptitude and achievement vary more with individuals than by sex.
    - Girls and boys at the early elementary level do not differ significantly in mathematical achievement. In upper elementary and junior high school year, differences are not always apparent; when they do occur, they likely favor boys on high-level tasks and girls on computation.
    - No conclusions regarding sex differences can be reached concerning secondary students; fewer girls take mathematics, however.
- Socioeconomic factors appear to account for much of the variance in mathematical achievement.

G. Instructional Materials page 114

- The textbook is the primary determinant of mathematics curricula, and many teachers use no instructional materials except textbook and chalkboard.

- About half the states have mandated textbook adoption lists, with more listing multiple texts; however, a single text is used in most classrooms.

- Variance across textbooks at the elementary level is largely in terms of amount of space allocated to a topic, approach, and design. At the secondary level, wider variance is obvious as the type of course varies.

- Teachers tend to follow the textbook closely with regard to content selection and sequencing, though components which they do not consider essential may be ignored.

- Use of manipulative materials decreases as grade level increases; however, use of such materials appears to be effective at all age levels and with all types of students.

- Computers are used more widely in mathematics classes than in any other subject-matter field. The problem solving mode is most often used.

- The hand-held calculator has the potential to change the curricular focus on computation.

H. Costs of Instruction page 127

- For at least 15 years, education has been the largest item in the budgets of most state and local governments; the amount of federal funding for education has increased dramatically.

- The amount of money devoted to mathematics instruction is difficult to determine; 18% to 20% seems plausible but cannot be verified from available data.

- The amount of money spent per pupil has not been found in most studies to be significantly related to mathematical achievement.

- Since 1968, increased emphasis has been placed on evaluation of federally funded projects. Evaluation from outside reviewers rarely indicates the degree of success that those involved in a project declare.

I. The Teachers page 178

Dramatic changes in the nature and quality of preservice and in-service education transpired during the 20-year period.

- The mathematical background of students completing pre-service programs increased significantly.

- Teachers are acquiring a second professional degree in greater percentages and at an earlier age than ever before.

- Teachers want in-service education and prefer that it be related to programmatic and instructional needs, and be neither purely mathematical nor purely methodological.

- Leadership for in-service education at the local school level can appreciably change its character and teachers' perception of its worth.

- Research provides little supportive evidence that participation in in-service education improves the effectiveness of teachers.

- Competence of teachers, when assessed in terms of promoting mathematical growth of students, is apparently related to a complex interaction of an assortment of factors. Teachers' mathematical background and attitudes do not account for a substantial amount of the variance in their students' performance.

- Competency-based teacher education (CBTE) does not appear to be a significant factor of sustained impact on teacher education programs.

- Computer literacy and the background to use the computer in teaching mathematics is not a component of certification requirements in most states or in the institutions that train teachers.

- The most significant trend in preservice teacher education is the move toward incorporating pre-student-teaching field experiences.

- There is a significant trend toward including laboratory or activity learning emphases in both the mathematical and methodological phases of preservice elementary teacher education.

- The teacher shortage characteristic of the 1950s and 1960s has given way to oversupply in the 1970s, but evidence suggests that an undersupply of secondary teachers in particular may occur in the near future.

J. Needs Assessments

Reflections of needs are evident in a variety of sources. Most involve goals; this type is the one to which the term "needs assessment" is applied. The term "progress assessment" is used in referring to achievement and other status test data.

1. National Concerns page 193

Repeatedly discussed and cited are the need to:

- examine mathematical goals in relation to societal needs
- examine implications of technology
- establish minimal competencies
- increase attention to applications, statistics and probability, problem solving, the metric system, and basic mathematical skills
- provide for individual needs, particularly of less-able pupils and the talented
- improve articulation of mathematics with other subjects and across grades
- conduct research on the learning of mathematics, link research and curriculum development, and improve the implementation of research
- improve pre- and in-service teacher education, to strengthen teacher competency both in knowledge of content and methods of teaching
- develop better evaluation techniques

improve cooperation between mathematics educators in universities and schools

- Discrepancy in the selection or ranking of goals -- between educators and public, college personnel and classroom teachers, students and teachers -- is common.
- Increasingly, federal and state legislation has been encroaching on local control of schools.

2. Needs Assessments in the States page 198

- Relatively little attention has been given in most states to documenting the history, status, or needs of mathematics education.
- Mathematics education per se is seldom cited in state goals; it is most frequently one aspect of a "competency in basic skills" goal.

- Where needs assessments specific to mathematics have been conducted, both "knowledge of basic skills" and "applications of skills to real-life problems" have been high on the list of needs.

- Discrepancy among concerned groups is apparent in the priorities assigned to mathematical goals.

3. Progress Assessment at the National Level page 208

- National Assessment of Educational Progress (NAEP) data indicate specific strengths and weaknesses, although the real function of NAEP is to provide longitudinal information on the status of mathematical achievement.

- A comparison of data on computational skills indicated that these skills are not acquired on the basis of initial instruction, but performance tends to stabilize during junior high school.

- College-entrance and some other standardized test scores indicate declines in achievement across years, with more extensive decreases for verbal than for mathematical portions of the tests.

4. Progress Assessments in the States page 217

- As of April 1977, eight states had minimal competency legislation, 10 had state board of education rulings, and legislation was pending in 10 states.

- As of June 1974, thirty states had some type of accountability legislation.

- State progress assessments vary greatly in scope of objectives, type of test, and reporting procedures.

- Content areas in which weaknesses have been identified by assessments are ones which have long been known to be difficult; fractions, division, and subtraction with regrouping head the list.

V. Synthesis and Conclusions

The purpose of the study is to describe the evidence that bears on the rationality of making policy decisions in mathematics education. The evidence shows that progress and change have resulted form federal intervention. Some claim that the federal investment in mathematics education has been the vital margin in determining whether a change would be realized or not. We see little evidence that the future will be otherwise. Thus, thoughtful policy formulation at the federal level is critical since it guides the investment of dollars for mathematics education.

It is not sufficient simply to recommend increasing the magnitude of the investment in mathematics education to make desired changes. More money must be invested wisely in order to accomplish change expeditiously and efficiently in the areas of greatest need in mathematics education. Recognition of deficiencies in policy formation processes is an important first step toward improving the payoff of the investment toward improving the learning and the teaching of mathematics in the schools.

Three sources of failure in the process of policy formation for mathematics education are apparent:

(1) Educational policy is frequently determined without collecting enough information to allow the process to be rational.

(2) Educational policy is frequently constructed without using information that is readily available.

(3) The point at which values enter into policy formation and the effects of the differences in the values held by various groups concerned with the schools are frequently not recognized in determining priorities.

Documented in the report are numerous examples of the first type of failure. Regarding practices in the schools:

- Too little is known about what happens in the typical classroom.

- Too little is known about the extent to which teachers differentiate instruction.

- Too little is known about the extent and nature of teachers' use of instructional materials and tools.

- The extent of teachers' dependence on drill-and-practice teaching strategies in not known.

Regarding teacher education practices:

- Data concerning supply and demand of secondary mathematics teachers are only conjectural.
- Too little is known about the characteristics of teachers not participating in in-service activities.
- Too little is known about how much, what kind, and when early field experience is best or how it actually contributed to helping the prospective teacher become competent.
- The characteristics of teachers that contribute to the effective learning of mathematics by students are neither well-described nor verified.

The sections on existing practices describe many other blank spots in the knowledge base for effective policy formation. A major difficulty is that these missing segments are not used to define priorities for information collection or for deciding what research to support and fund.

Failures of the second type -- formulation of policy without using available knowledge -- are also readily apparent. Often the collection of information confirms what has been known previously. Some aspects of schools and schooling have an inherent stability and resistance to change. The formulation of policy frequently has not recognized this reality, and both energy and resources have been wasted in addressing the wrong concerns.

Shifts in interest and in funding levels in a variety of areas in mathematics education indicated shifting priorities. However, it often appears that these shifts have been based on little evidence about existing practices. Needs assessments confirmed existing problems and issues rather than being fadlike in character, is at stake.

The third type of failure -- not recognizing the point at which the values of various groups enter into policy formation -- is similarly evident. Policy making was described in terms of operation at two levels, one incorporating professional judgments based upon information and the other that is political and reactive to prevailing societal attitudes and values. Change results only when there is significant agreement across the two levels. Needs assessments must systematically garner information not only relative to the schools and their performance, but also on the prevailing societal ethos that is a necessary condition for acceptance and support of change. Accurate and meaningful information must also be disseminated to develop broad bases of support and to improve rational decision-making. The gaps between expectancies and priorities of various groups need to be narrowed.

Policy formulation at the federal level typically has ignored existing practices in the schools except as mirrored in the disquietude of society. Information was collected after-the-fact of policy decision to confirm the actions taken. The amazing, significant conclusion indicated by this study is that progress has been made without systematic information collection about existing practices. Apparently, the societal/political ethos is sensitive enough to the goals, aims, and objectives of education to provide substantial direction. Thus efficiency in promoting change is the real problem to be faced. The inplication is that not only must appropriate kinds of information concerning practice in the schools be collected: sound application of this information must be made.

EXECUTIVE SUMMARY: SOCIAL SCIENCE EDUCATION

In the spring of 1976, the National Science Foundation contracted with the Center for Science and Mathematics Education (CSME) at The Ohio State University to conduct a survey of the literature on needs and practices in precollege science, mathematics, and social science education for the period 1955 through 1975. The Center subcontracted the social science portion of the project to the Social Science Education Consortium (SSEC).

SSEC's task was to identify, analyze, and summarize the literature produced between 1955 and 1975 concerning:

1) the state of and trends in practices in precollege social science education;
2) the effectiveness and efficiency of practices in precollege social science education; and
3) the state of and trends in perceptions of needs in precollege social science education.

The project was to take one year, from July 1976 through June 1977.

Procedures

Four procedural questions loomed large during the project:

1) whether to distinguish between social studies education and social science education, and if so, how;
2) what specific topics to consider within the broad three-point outline given above;
3) how to search the literature in order to identify all relevant documents; and

4) how to select specific documents for analysis or mention in the report.

Social Studies/Social Science. The definition of the field of social studies education has been a central and continuing problem for the profession. One of the major questions within this issue has been the estent to which precollege social studies education should be governed by or limited to the boundaries of the academic disciplines of the social sciences. (A lengthier discussion of the nature of the definitional controversy may be found in the early part of Section 4.0 of this report.)

Because this issue has been so important in the field, it was decided that this report must reflect the controversy. Hence, rather than limiting our review only to the literature dealing with social studies defined as social science education, we have taken a broad approach and dealt n social studies from multiple perspectives.

However, we have, where possible and appropriate, focused special attention on literature dealing with the social science aspects of social studies education. For instance, in Section 1.4, we have devoted extensive discussion to studies of the treatment of social science content and methods in social studies curriculum materials.

Specific Topics. The detailed working outline for the report has gone through numerous revisions in the course of the project. The rough outline developed at the very beginning of the rpoject contained over 150 questions that we thought might be answered through our review of the literature. Examples of questions included on this initial "wish list" of things we would like to find out were: What are representative social studies program objectives? What is the relative emphasis on history and social science in the curriculum? What are the dominant instructional strategies in use? What sorts of "fads" have there been in social studies over the years? How well tested are social studies materials prior to publication? What curriculum packages are most commonly used? How well financed is social studies in comparison to other areas of the curriculum? What are typical course patterns for social studies teacher training? What kinds of instructional methods are most effective? Most efficient? What kinds of poeple have been most active in making demands on the social studies curriculum? What kinds of administrative support and inservice training are typically provided by school districts for social studies teachers?

As we progressed through the review, a number of these initial questions were dropped on the grounds that they were trivial or only of tangential interest. Others were dropped because there was not literature dealing with them. (Sometimes these latter questions were, however, mentioned in the report in order to point out the absence of information on significant questions.) The major areas of concern that remained intact throughout the review and writing process were:

1) social studies curriculum scope and sequence
2) social studies instructional methods
3) social studies curriculum materials
4) social studies teacher education

We sought and found information on practices, effectiveness, and needs in all these areas.

Search Strategy. At the beginning of the project, a number of extensive, systematic searches were conducted on several data bases. As the project progressed and specific gaps within particular topics were identified, highly focused, systematic searches were conducted as needed. Also, as the project progressed--and especially near the end of the project--less systematic means were used to "pinch hit" where systematic searches had not turned up documentation we thought might be available. For instance, we would follow up references in footnotes or phone someone considered to be an expert on a particular topic for suggestions of sources.

The extensive, systematic searches consisted of the following:

1) Computer search of the ERIC data base (includes Resources in Education and Current Index to Journals in Education)

2) Computer search of Dissertation Abstracts

3) Computer search of Psychological Abstracts

4) Computer search of Sociological Abstracts

5) Manual search of Education Index

6) Manual search of all comprehensive reviews of research in social studies education

7) Manual search of all compilations of abstracts of dissertations in social studies education

8) Manual search of the journal Social Education

For a complete list of the search terms used in the four computer searches, see the appendix at the end of this report, beginning on page 538. Education Index was searched under all terms beginning with the words "social studies." Since the comprehensive reviews, the dissertation compilations and Social Education focused specifically on social studies documents, all items mentioned in them were considered relevant initially. (For a detailed listing of the reviews and the compilations, please see the discussion of sources in Section 2.2 of this report.)

The special-focus, systematic searches conducted as need arose during the project consisted of both computer and manual searches of the ERIC data base; manual searches of various handbooks, encyclopedias, and state-of-the-art monographs; and manual searches of the SSEC's collection of curriculum materials and background couments in its Resource and Demonstration Center and archives.

A total of 1,038 usable items were produced by the initial extensive computer search of the ERIC data base. (Culling of duplications and irrelevant items from the initial printout reduced the original 1,677 to the 1,038 figure.) The computer search of Psychological Abstracts produced a total of 265 items, of which 155 were usable; of Sociological Abstracts, 81 items, of which 15 were usable; and of Dissertation Abstracts (which was searched only from 1973, since the compilations covered the previous period), 186, of which 85 were usable. Exact numbers of citations from the comprehensive reviews and the dissertation compilations are given in Section 2.2 of this report. We did not keep track of the numbers of items turned up in the more limited systematic searches and the unsystematic searches. Although the exact size of the total pool of documents identified cannot be determined, dut to overlap among data bases and other problems, we would estimate that the total pool was four to five times the number of documents actually cited in the report; that is, the total pool would be approximately 2,000 to 2,500 documents.

Selection of Documents for Inclusion. We have attempted to indicate in each section of the report what types of documents were selected for mention in that section and what guidelines were used in choosing those documents and rejecting others.

In some sections, we have attempted to be exhaustive and mention all pertinent documents. For instance, in Section 1.4, we felt this report an appropriate occasion for compiling as complete a list as possible of all the textbook content analyses that had been done in the last 20 years. In Section 2.0, we deemed it absolutely necessary to include all comprehensive and special-focus reviews of research in social studies education from the last

20 years. And, in Section 4.0, it was considered important to identify all of the studies of the impact of "new social studies" materials. There have been so few studies of impact that every little bit of inforamtion available becomes important.

In other sections, we have attempted to present only representative documents. In most cases, this is due to the fact that there is simply too much literature to discuss or even mention each document separately. This is particularly true of the section on perceptions of needs in the social studies (Section 3.0).

One guideline that has been applied throughout this report is that the documents mentioned must be accessible. Readers must be able to obtain copies through a commercial publisher, ERIC, or some other ongoing agency. In a few cases we ran across "fugitive" documents that we put into ERIC; ERIC order numbers (ED numbers) are given for these and the documents that were already in ERIC in the entires in the reference list at the end of this report. In a couple of cases, fugitive documents that we wished to use could not be put into ERIC; in those cases, we have noted in the entry in the reference list how readers may obtain photoduplications of the documents.

Organization of This Report

This report is organized into four major sections. Section 1.0 describes the literature that surveys the state of actual practices in social studies education and changes in those patterns over the 20-year period. This section focuses on the "status" literature, as distinguished from the "research" literature-that is, studies attempting to discern relationships among variables. Section 2.0 takes up these questions of relationships, by examining research on the effectiveness and efficiency of social studies practices. Section 3.0 then examines the problem of identifying needs in the social studies. And, finally, Section 4.0 takes a look at certain aspects of the "new social studies," whcih can be considered the major trend or movement influenceing the field during the last 20 years. More specific information on the contents of each of these four major sections can be obtained from the detailed table of contents provided for this report.

In addition to the four major sections, there is a lengthy reference list containing full bibliographic information on each document mentioned in this report. There is also an appendix at the end of the report describing the search terms used in the computer searches.

Summary of Findings

One hundred fifteen "summary observations" have been listed at various points throughout this report. These comments are intended to present, in capsule form, a description of what the literature on precollege social studies education from 1955 to 1975 tells us. They are grouped at the end of each major section or subsection of the report, immediately following the narrative discussing and documenting them. The table of contents indicates the specific pages on which these summary observations may be found. Some readers may wish to read through the summary observations before (or instead of) reading the full report or specific sections.

Since 115 summary observations, each of one sentence or more, is still alot of reading, we have attempted here to distill them further yet, in order to give the reader a preview of what is contained in this review of 20 years of social studies literature. The paragraphs below present the barest essentials only, for, while we have gained conciseness by this introductory summary, we have lost a certain amount of preciseness. It is highly recommended that readers at least examine the end-of-section summary observations in addition to this brief overview of findings.

Summary of Literature on the STATE of Social Studies Practices

1) State of the Status Literature

Although there have been a fair number of studies examining the state of social studies practices at various times during the last two decades, we do not obtain a very clear picture of many aspects of practice from these studies. Probably the clearest status picture available is that concerning curriculum materials; numerous analyses of the content of materials have been done. We have a less clear picture of patterns of actual classroom practice and how they may or may not have changed over the 20-year period. And surveys of the state of teacher education practices give us very little information at all.

2) Curriculum Content

Although the scope and sequence of the social studies curriculum has remained basically stable in general outline over the 20-year period from 1955 through 1975, there have been a few noticeable shifts within that framework. Particularly noticeable has been the infusion of concepts and methodologies from the scientifically oriented social science disciplines. (See Section 1.2 for a more detailed set of findings and documentation.)

3) Instructional Practices

Studies of the extent of use of various kinds of social studies classroom practices at various points in time are rather limited. The studies that do exist indicate that, contrary to popular belief, the lecture method may not have been nearly so pervasive in the fifties and sixties as has been claimed; a sizeable proportion of teachers employed multiple instructional techniques. Recent studies do not indicate clearly whether patterns of instructional methods have changed as a result of the "new social studies" and other educational innovations. (See Section 1.3 for a more detailed set of findings and documentation.)

4) Curriculum Materials

A substantial number of studies have analyzed social studies curriculum materials. The aspects of materials that have been analyzed most frequently are (a) their treatment of social science content and methods; (b) their treatment of specific concepts and themes (such as communism, violence, social change); and (c) their treatment of minority groups. Almost without exception, analysts of social science content and methods in social studies curriculum materials have concluded that there are inadequacies in treatment of the social sciences by textbooks. (See Section 1.4 for a more detailed set of findings and documentation).

5) Teacher Education

Most studies of the academic preparation of social studies teachers have concluded that there are major deficiencies in their social science coursework. (Studies cited in Section 2.0, on effectiveness, however, call into question the value of additional coursework in the social sciences.) Surveys of course requirements in teacher training institutions indicate a slight trend away from the dominance of history and toward the inclusion of more social science courses; however, no such pattern is apparent in surveys of state certification requirements. (See Section 1.5 for a more detailed set of findings and documentation.)

Summary of Literature on the EFFECTIVENESS of Social Studies Practices

1) State of Research on Effectiveness

Social studies educators have not been very much interested in or affected by research. Only recently has research in the field begun to blossom. There are many complaints about the lack of a cumulative research base in the field. (See Section 2.2 for a more detailed set of findings and documentation.)

2) Curriculum Content

Little or no empirical research has focused on questions about the relative merits of different kinds of content in achieving the goals of the social studies. (See Section 2.3 for a more detailed set of findings and documentation.)

3) Instructional Methods

A large proportion of the effectiveness research conducted in the social studies falls under the heading of research on instructional methods and much of this focuses on various methods labeled "critical thinking," "inquiry," and the like. Most of this research shown no significant differences between critical thinking methods and so-called traditional methods; however, weaknesses in research design and weaknesses in attempts at interpreting existing research may well be hiding real differences in effectiveness. Some telling results in regard to carefully and narrowly defined techniques have been obtained from research. (See Section 2.4 for a more detailed set of findings and documentation.)

4) Curriculum Materials

There has not been a great deal of research on the effects of curriculum materials and there has been even less effort directed toward interpreting what little research there is in this area. (See Section 2.5 for a more detailed set of findings and documentation.)

5) Learner Variables

Research on the effects of various learner variables (such as student attitudes, interests, abilities, and socioeconomic backgrounds) on learning in the social studies is rather spotty. There has been an interest in how children's developmental abilities affect learning in the social studies and a few researchers have been able to draw conclusions from this body of research; however, their findings have apparently not been put into practice by curriculum developers and teachers, as yet. (See Section 2.6 for a more detailed set of findings and documentation.)

6) "New Social Studies"

No attempts have been made to draw conclusions from the body of research surrounding the development of the "new social studies" project materials. (See Section 2.7 for documentation.)

7) Outcomes of Schooling

National achievement testing programs have produced trend data on social studies achievement at lower cognitive levels. These data indicate that students' knowledge of so-called basic information in the social disciplines, particularly history, is declining. National and state assessments efforts in social studies and citizenship have produced results in a wider variety of areas, including attitudinal outcomes of schooling; however, because assessment efforts are recent developments, trend data are not available here. The testing programs and assessments do not generally attempt to tie test results to possible causal variables in test-takers' backgrounds. However, a few studies have attempted to make such linkages and have generally found that gross variables, such as number of credit hours taken in social studies. (See Section 2.8 for a more detailed set of findings and documentation.)

4) Teacher Education

Social studies teacher education has become an important research interest only within the last decade. Cumulative findings in this area are few and suggest that, even though a variety of teacher training practices produce changes in teacher behavior, student behavior is not affected by the changed teacher behavior. Combining teacher training in academic content and instructional methods may hold the best promise for affecting student outcomes. (See Section 2.9 for a more detailed set of findings and documentation.)

Summary of Literature on NEEDS in Social Studies Education

1) Definition of Social Studies

Because the question of the purposes and boundaries of the field of social studies remains unsettled, it is difficult to pinpoint needs in any precise sense. All manner of needs--including some contradictory ones--have been claimed for the social studies.

2) Academic Freedom

One of the few things on which social studies educators seem to have been able to agree is that academic freedom and the difficulties of dealing with controversial issues in the classroom pose a problem of particularly strong significance for social studies teachers, due to the inherently "hot" nature of the subject matter.

3) Social Scientists' Perceptions of Needs

During the sixties, social scientists exercised a particularly strong influence on the social studies, attempting to infuse more and better social science content and methods into the curriculum.

4) Layperson's Perceptions of Needs

The influence of laypersons (people who are neither social scientists nor professional social studies educators) on the social studies has waxed and waned over the 20-year period from 1955 to 1975 and the demands of laypersons have displayed no consistent pattern from one period to the next.

(See Section 3.0 for a more detailed set of findings and documentation for all of the above conclusions.)

Summary of Literature on NEW SOCIAL STUDIES

1) Characteristics of the "New Social Studies"

There are many differing perceptions of what the characteristics of the "new social studies" are, although at least seven "core" characteristics seem to be generally agreed upon. (For a list of these characteristics and documentation, see Section 4.0.)

2) Criticisms of the "New Social Studies"

At least ten different categories of criticisms have been advanced against the "new social studies" over the last decade. (For a list of these categories and documentation, see Section 4.0.)

3) Impact of the "New Social Studies"

Some data on the impact of the "new social studies" are available. These show that the national project mateirals have not been widely adopted by school systems, but they do not shed light on other possible modes of influence, such as impact on the kinds of materials being developed by commerical publishers. (See Section 4.0 for additional discussion and documentation on impact.)

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