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ABSTRACT

This paper outlines the goals, design, implementation and results of a project of the State Education Assessment Center of the Council of Chief State School Officers to develop state indicators of the condition of science and mathematics education in elementary and secondary schools. The goals of the project include: (1) improving the quality and usefulness of data on science and mathematics education to assist state policy-makers and program managers in making more informed decisions; and (2) developing a system of indicators that provides the capacity for state-to-state comparisons of science and mathematics education as well as a national database to assess the condition of education in these subjects. This project calls for a network of state education specialists. The five major steps in the design and implementation of the project are discussed. Also included are the results of the indicator inventory focusing on student outcomes, instructional time/enrollment, curriculum content, school conditions, teachers and resources. Tables include student testing by state, states with data on enrollment in secondary science and mathematics courses, state curriculum frameworks, state data available on teachers' preparation in teaching subject, estimates of teacher supply/demand and type of state data available. (CW)

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Council of Chief State School Officers
State Education Assessment Center

Science/Math Indicators Project

STATE NETWORK FOR INDICATORS OF SCIENCE AND MATHEMATICS EDUCATION*

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STATE NETWORK FOR INDICATORS OF SCIENCE AND MATHEMATICS EDUCATION

INTRODUCTION

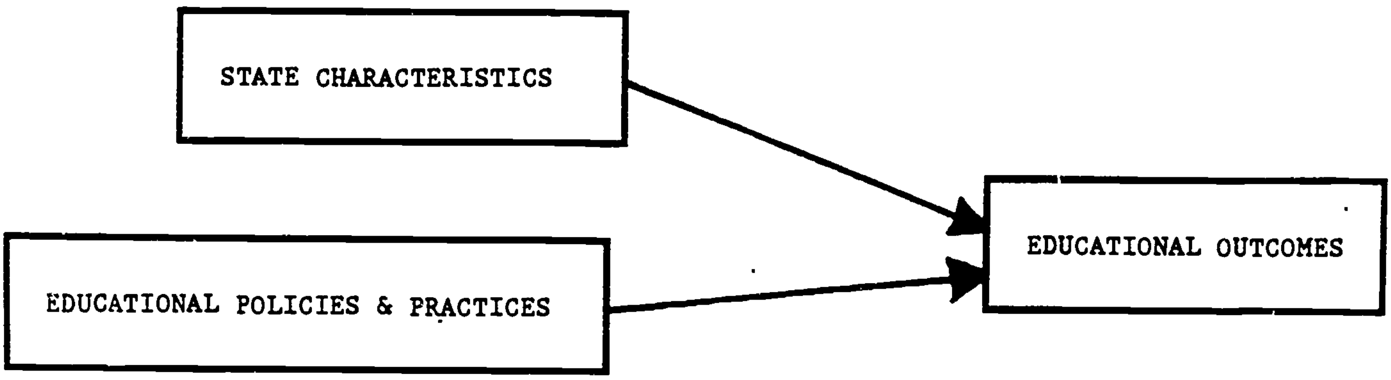
Many states have recently instituted education policy reforms that are aimed at improving science and mathematics education. State commissioners of education and their staffs have been working to implement these reforms as well as to improve information by which the quality of education can be monitored. In 1984, the Council of Chief State School Officers adopted a far-reaching position on the responsibility of the states for leading educational assessment and evaluation, and the following year, CCSSO established the State Education Assessment Center to coordinate the development, analysis, and use of state-level data.

With support of the National Science Foundation, the Center began a project in 1986 to develop state indicators of the condition of science and mathematics education in elementary and secondary schools. The goals of the project are: 1) to improve the quality and usefulness of data on science and mathematics education to assist state policy-makers and program managers in making more informed decisions, and 2) to develop a system of indicators that provides the capacity for state-to-state comparisons of science and mathematics education as well as a national database to assess the condition of education in these subjects.

PROJECT DESIGN

The project was designed to identify and develop indicators of science and mathematics education that would be based on comparable state-by-state data. A network of state education specialists would provide the key link between desired indicators, needs and interests of states, and the capacities of state data systems. There were five major steps in the design and implementation of the project.

1. Developing a Conceptual Framework. In October 1985, the Committee on Coordinating Educational Information and Research (CEIR) of the CCSSO approved a model for state education indicators. The CCSSO model has three components: (a) indicators of educational outcomes, (b) indicators of school policies and practices, and (c) indicators of contextual factors, or "state characteristics," in which the schools operate, such as school-age population, per-capita income, and percent of adults with four years of high school.



The CCSSO program is built around a model of educational indicators in which information about educational program policies and practices is related to educational outcomes, accounting for factors outside the education system that determine, to some extent, what it can accomplish. This gives the indicators explanatory power that they would not have as individual variables, because the scheme is intended to model, based on research, educational inputs and outputs and the relationships between them.

CEIR recommended a core set of indicators for the model, and these recommendations provided an outline for the CCSSO program to develop a system of comparable state data on education. Three criteria were established by CEIR for selecting the core indicators: a) importance/ utility for states, b) technical quality, and c) feasibility; and it was decided that the three criteria should be applied in this order. The recommended indicators formed the basis for CCSSO's proposal to the NSF to develop educational indicators at the subject level, i.e., science and mathematics.

For NSF, this project focusing on state-level indicators and data was consistent with the Science and Engineering Education division's increased involvement in improving the quality of information on science and mathematics education. The need for better data was highlighted in the 1983 recommendations of the National Science Board Commission on Precollege Education in Mathematics, Science, and Technology (1983). NSF has supported major studies by the RAND Corporation and the National Research Council (NRC), and the studies resulted in recommendations on the kinds of indicators (NRC) and data systems (RAND) that are needed to effectively monitor science and mathematics education in elementary and secondary schools (Shavelson, et al, 1987; Murnane & Raizen, 1988).

As these studies were proceeding, NSF joined with CCSSO in designing this project to improve state-level indicators of science and mathematics education. A capacity to aggregate comparable state data could significantly add to the available national indicators on science and mathematics education (as summarized in NSF's biennial Science Indicators report). The chief state school officers recognized the project as an opportunity to improve their capacity for monitoring education in these subjects, as well as to help fulfill their commitment to meaningful state-by-comparisons of education progress.

A conceptual framework paper for the project (Blank, 1986) analyzed the CCSSO model for educational indicators in relation to recommended science and mathematics indicators, and outlined a rationale for identifying and developing state level indicators.

2. Working with a State Network. A network of representatives from each state department of education is a critical element in the project design for two reasons. First, states already maintain extensive systems to gather and compile educational information, and it was likely that desired indicators of science and mathematics could be produced from analyses of selected portions of the existing state data. Then, national indicators could be developed from state data compiled and reported according to specifications that will yield valid state-to-state comparisons. The CCSSO indicators program is being designed with a view toward balancing the need for a more complete picture of education progress with the constraint of selecting the most useful, valid, and feasible indicators of school policies, practices, and outcomes. At the same time, valid indicators must be based on specific information about current state definitions and practices in collecting data on science and mathematics education, particularly as the project begins to work with individual states

Second, in developing a system of educational indicators, the local, state, or federal "policy context" plays a major role in the selection and implementation of indicators (Oakes, 1986). For the project, the state network of representatives from each agency provided a method of identifying and improving indicators with direct participation of state education professionals who are sensitive to the needs of their states and school districts for policy-relevant indicators.

To firmly establish a working relationship with each state department of education, the chief state school officers were asked to select three program managers as participants in the project network. The participants have three types of expertise and responsibility: a) curriculum specialists in science and mathematics; b) student assessment specialists; and c) information systems specialists. Chiefs in all 50 states, the District of Columbia, and three territories designated network participants.

3. Outlining a Set of Ideal Indicators. To clearly understand what types of science and mathematics indicators would be desirable at the state level, a list of "ideal indicators" was developed. Several sources were used to compile a draft list, including the indicators projects of the National Research Council (Raizen & Jones, 1985; Murnane & Raizen, 1988; Committee on National Statistics, 1987) and the RAND Corporation (1987), the CCSSO model for educational indicators (1985), and reports of the Research Triangle Institute's national survey of science and mathematics (1985), the National Science Board (1983), and the Carnegie Forum on Education and the Economy (1986).

The draft list of ideal indicators was reviewed by the project advisory board, comprised of scientists, mathematicians, state education staff, and education researchers. The advisory board revised the draft list, suggested how information on the proposed indicators should be gathered from the states, and outlined criteria for selecting state-by-state indicators.

4. Identifying Commonalities and Differences in State Indicators and Data. An inventory of current state indicators and data on science and mathematics education was conducted through the state network in the spring of 1987. The inventory included questions on six categories of ideal indicators: Student Outcomes, Instructional Time, Curriculum Content, School Conditions, Teacher Quality, and Resources.

Available state-by-state information on the selected indicators were referenced in the inventory form for each state, to reduce the response burden. For example, results of recent surveys on state education policies by several national-level organizations, such as the Education Commission of the States (1985), National Governors Association (1986), Southern Regional Education Board (1983), and Council of Chief State School Officers (1987), were referenced in the inventory to reduce the reporting of state policy indicators.

The inventory consisted of two phases-- first, state respondents reported on the types of data collected by their state, and interests in indicators; and, then, follow-up questions identified the data source or instrument, and methods of analyzing and reporting the data.* With the inventory results, a cross-state analysis was completed, which showed the commonalities in existing state indicators and the specific differences in how data are collected and reported.

5. Selecting Priority State-by-State Science/Math Indicators.

Indicators that would be given the highest priority in development of state-by-state indicators were selected through a three-step process involving representatives of state education departments. A draft list of 15 potential "priority" indicators was developed, based on data availability across the states, expressed interest of states, and consideration of the ideal indicators. A Task Force comprised of state science and math specialists and state data managers, as well as leading experts on educational indicators experts, assessed the draft list of indicators and assigned priorities. Three criteria were applied: a) importance/utility at state, local, or national levels; b) technical quality of the data; and c) feasibility of obtaining state-by-state data.

The recommendations of the Task Force were then reviewed with the Committee on Evaluation and Information Systems (CEIS) of CCSSO, as well as with the chiefs at their annual meeting. With input from these groups, the most likely sources of data for the priority indicators were determined. Figure 1 shows the priority indicators for science and math education and the data sources. There are three kinds of data sources: a) data collected by states, b) analyses of state data, and 3) data from national surveys that have state-representative samples of students and schools.

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* States were asked whether data on indicators are available on student/teacher gender and race/ethnicity; the project advisory board recommended that indicators be reported by these characteristics.

Figure 1

PRIORITY STATE-BY-STATE INDICATORS OF SCIENCE AND MATHEMATICS*

INDICATOR	DATA SOURCE
__Student Outcomes__	
Assessment of student achievement in science/math	NAEP (1990)
Student attitudes/intentions toward further education in science/math	NAEP (1990)
__Instructional Time/Enrollment__	
Grades 7-12 course enrollment in science/math	State Data
Minutes per week in elementary science and mathematics	Schools/Staffing Survey (ED/CES)
__Curriculum Content__	
Students' "opportunity-to-learn" key topics in science/math	NAEP (1990)
__School Conditions__	
Class size in science/math: mid/junior, high school	State Data (Analysis) (from course enrollment by period/section)
Number of different course preparations per science/math teacher	State Data (Analysis) (from assignments by teacher)
Course offerings in science and mathematics	State Data (Analysis) (from course enrollment by school)

* Priority indicators were recommended by the project Task Force (September, 1987) and reviewed with CEIS (September, 1987) and CCSSO (November, 1987)

INDICATOR	DATA SOURCE
<u>Teachers</u>	
Subject Preparation:	
Courses/credits in science/math and pedagogy for science/math	Schools/Staffing Survey (ED/CES)
Field/subject of certification	State Data
Teaching assignment by course By age	State Data
Teaching positions filled with out-of-field teachers	State Data (Analysis) (from assignment by certification)
<u>Equity</u>	
Gender and race/ethnicity of students/teachers (varies by indicator)	State Data (where available)

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During the second year of the project (starting November 1987), a plan is being developed with the states for compiling and reporting state-by-state data on three indicators shown in the list: a) secondary course enrollment, b) teacher assignments, and c) teacher assignments by certification status. A series of regional meetings were conducted with representatives of the state education departments in February and March 1988 to review a plan for reporting each state's current data according to a common reporting scheme.

STATE DATA AVAILABLE ON SCIENCE/MATH INDICATORS

In the following section of the paper, the results of the inventory are reported on a state-by-state basis for selected indicators in each of the six categories.* These results illustrate the current status of state data collection activities as they relate to science and mathematics. From the analysis it is possible to consider the potential of existing state-level data sources for indicator uses and to assess areas in which states could develop indicators.

For some of the indicators, a large majority of states collect data, and 50-state tables are displayed. For other indicators, only a few states currently collect data, and only those states are listed. In both cases, the source of data is described for each state.

The information presented here is intended as a resource for states that are planning new data collection and for states that want to analyze existing data to produce more useful indicators for science and math education. The information can also be useful to educators, policy makers, and researchers for locating state-level sources of data on science and mathematics education.

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* Previous reports from the inventory results list the number of states with available data on each indicator (CCSSO, August, 1987) and state policies related to science and math (CCSSO, November, 1987).

I. Student Outcomes

Three types of state-level indicators of student outcomes are likely to be useful to states: assessment of student achievement in science and mathematics, student attitudes towards these subjects, and post-high school education in science or mathematics.

Assessment of Student Achievement. The Council of Chief State School Officers has been taking a leadership role in developing plans for a revised National Assessment of Educational Progress (NAEP), to begin in 1990. If fully implemented, NAEP would provide state-by-state assessment information on science and mathematics using a sample of schools in each state and testing at three grade levels (4, 8, 12).

The inventory provided state-by-state information on three types of state tests in science and mathematics--assessment, competency, and course-specific. Table 1 shows that assessment tests in math are in place, or being implemented, in 40 states, and in science, in 29 states. Thirty states have, or will have, competency tests in mathematics, and six states have, or will have, competency tests in science. Nineteen states have, or will have, a testing requirement in mathematics or science for high school graduation. (The Appendix contains tabulations of grade levels tested, types of tests, and testing schedules for state assessment tests in science and mathematics.)

Student Attitudes. The attitudes of students toward science and mathematics are viewed by educators and state program managers as an important indicator of the outcome of teaching. One valuable kind of information is students' intentions for pursuing study in these subjects in high school and in postsecondary education. Several states collect student attitudes data in conjunction with their state assessment programs:

- The CALIFORNIA Assessment Program includes items such as: For grade 6 students, "How much do you like math? (Very much, a little, not at all)"

- The MAINE Assessment Questionnaire has items such as: "How many years of science/math do you think you might take in grades 9-12?"

- Other state instruments that include questions on student attitudes toward science and mathematics:
  CONNECTICUT Assessment of Educational Progress
  MASSACHUSETTS Assessment Student Questionnaire
  PENNSYLVANIA Educational Quality Assessment
  UTAH Statewide Educational Assessment Battery
  WEST VIRGINIA Comprehensive Test of Basic Skills.

- The NAEP science and mathematics assessments for 1986 included items on student attitudes and intentions for further study. Current recommendations for the revised NAEP, beginning in 1990 in math, include continuation of student attitude items relating to intentions for further study.

Postsecondary Education. States currently have available two types of information concerning postsecondary education of students in science and math. First, data on intended college majors of high school seniors can provide states with an indicator of the proportion of graduates who have educational and career interests in science or mathematics. Eleven states reported having data from intended majors student background information collected with the ACT and SAT. ALASKA conducts a survey of their seniors.

ACT	IDAHO, IOWA, NORTH DAKOTA, OHIO, UTAH, WEST VIRGINIA
SAT	CONNECTICUT, MARYLAND, NEW HAMPSHIRE, OREGON, RHODE ISLAND

Five state departments of education reported that they have access to state-level data on declared majors of college students, which are typically collected and maintained by state higher education systems. The states are:

IOWA
MARYLAND
MASSACHUSETTS
SOUTH DAKOTA
WEST VIRGINIA

II. Instructional Time/Enrollment

Two state-level indicators are currently available for monitoring the amount of instruction students receive in science and mathematics: a) number of students enrolled in secondary courses, and b) elementary class time spent on science and mathematics. These indicators are likely to be more useful for assessing state-level trends in science and mathematics education than information on state policies. For example, state graduation requirements are often cited as an indicator of the extent of science and math in high schools; instead, this indicator would provide data on the amount and kinds of science and math that students are actually taking.

Secondary Course Enrollment in Science and Mathematics. Data on student enrollment in science and mathematics at the secondary level are currently available through the information systems of 35 states, as listed in Table 2. Most of these states collect the data at the course level, either through teacher assignment or school report forms.

The secondary course enrollment indicator is being developed by the Science/Math Indicators Project for inclusion in the state-by-state Education Indicators report of CCSSO. This indicator will provide state-to-state comparisons of the extent of secondary science and math course enrollments, but it is not an indicator of differences between states in science and math course content.

The Project is recommending that course enrollment be reported by student gender and race/ethnicity due to the expressed need for a capacity to assess differences in course enrollments for different demographic groups. Currently, gender information is available from 10 states and race/ethnicity from three states.

In the inventory, state respondents expressed strong interest in having data on the total number of science and mathematics courses taken by graduating seniors. This indicator, which would require student-level data, may be available from the state-by-state NAEP, beginning in 1990.

Elementary Class Time for Science and Mathematics. In the inventory 22 states reported a state policy or guideline on the amount of time that should be spent on elementary science and mathematics. For tracking local implementation of policies on elementary class time, nine states reported collecting data on the amount of time actually spent on elementary science and mathematics, and 33 states reported interest in having the data available. The nine states, and their data sources, are:

CONNECTICUT	Assessment test
FLORIDA	State database
ILLINOIS	School report card
MAINE	Assessment teacher questionnaire
MASSACHUSETTS	Special state survey
NORTH DAKOTA	Professional personnel record
PUERTO RICO	Circular letter
SOUTH CAROLINA	Personnel/teacher assignment form
TEXAS	Accreditation visits

Information on local policies on the amount of class time time to be spent on elementary science and mathematics is also collected by nine states:

ALASKA	Curriculum status survey
ARKANSAS	Annual elementary/secondary school reports
FLORIDA	State database
MASSACHUSETTS	Special state survey
NEW JERSEY	State science association questionnaire
NEW MEXICO	Accreditation process
PENNSYLVANIA	On-site visitation process
PUERTO RICO	Circular letter
TEXAS	Accreditation visits

III. Curriculum Content

A third area of science and mathematics indicators addressed by the project is the content of the curriculum. The inventory identified states' sources of information about curriculum content in elementary and secondary schools. First, states were asked whether there is a state curriculum framework which establishes goals or standards for instruction in science and/or mathematics. Second, for the states which have a framework, its purposes and uses in the state were identified. Third, states reported on how information is obtained on the content of curriculum in schools and classrooms.

State Curriculum Frameworks. The inventory revealed that 38 states have a curriculum framework for science and 38 states have one for math. Table 3 provides a state-by-state breakdown of three purposes of the state curriculum frameworks (required state curriculum, curriculum goals, instructional objectives) and two state-level uses of the frameworks (selecting or recommending textbooks, developing or selecting state tests).

In twenty-five states the framework sets goals for local science and math; in 16 states the frameworks provide instructional objectives (often for state testing programs); and in 15 states the framework sets a required curriculum to be followed by schools. Twenty states develop or select science tests using curriculum frameworks and they are used for selecting or developing mathematics tests in 28 states.

Information on Curricula in Schools and Classrooms. The states responded to questions on different potential methods of collecting information on the content of science and math actually used in schools. Four methods listed by states that may be useful as a curriculum indicator are: a) review of school-level subject/course outlines or curricula; b) surveys of teachers; c) classroom observation of teachers; and d) questions on students "opportunity-to-learn" key content topics, such as with the state testing program in science and math.

The states using one or more of these methods, and their sources of data, are:

<u>Review of school-level outline/curriculum</u>

ARKANSAS, NEW YORK	Content of new courses
FLORIDA	Curriculum audits
NEW JERSEY	Direct monitoring
PENNSYLVANIA	Compliance visitation
RHODE ISLAND, SOUTH CAROLINA	On-site visits
IDAHO, KENTUCKY, MONTANA, SOUTH DAKOTA, TEXAS	Accreditation process

<u>Survey of Teachers</u>

MAINE	Questionnaire with assessment tests
PUERTO RICO	Teacher questionnaire
IDAHO, KENTUCKY	Accreditation process
RHODE ISLAND	Self-study/on-site visits

<u>Classroom Observation</u>

IDAHO	Accreditation process
KENTUCKY	School effectiveness program
TEXAS	Teacher appraisal system
SOUTH CAROLINA, RHODE ISLAND	On-site visits

<u>Opportunity-to-Learn Questions</u>

MAINE, OREGON	Teacher questionnaire with state test
MICHIGAN, TEXAS	One-time teacher survey
MASSACHUSETTS	Curriculum survey
PENNSYLVANIA	Visitation process
SOUTH CAROLINA	On-site visits

IV. School Conditions

The conditions, or characteristics, of the school in which a teacher works are an important "process" variable affecting instruction. States have several kinds of data available on school conditions.

Average class size is often used as a general indicator of conditions for teaching, with averages sometimes computed at state, district, or school levels. For science and mathematics, the project advisers recommended that the indicator should provide a relevant measure of teacher "work load," specifically one that measures differences by type of course and grade level. Thirty (30) states collect data which allows them to measure class size for high school science and math courses. In most cases, these are the states that collect course and teacher data with a personnel/teacher assignment form (see Table 2).

States that collect data at the teacher level, such as through a personnel/teacher assignment form, also can compute the number of different course preparations of science/math teachers, which is a second recommended indicator of teacher work load. This indicator provides a measure of how much time and attention a teacher can devote to preparing for instruction in any one course.

Three other potential indicators of school conditions for science/math education are available from state data. First, information on the number of elementary science or mathematics specialist teachers is available in 13 states, usually through a personnel/teacher assignment form. This indicator allows states to assess the degree to which elementary schools have hired and/or assigned teachers for these specific subjects. The states with this indicator available are:

ARKANSAS	IOWA	OREGON
DISTRICT OF COLUMBIA	MAINE	PUERTO RICO
IDAHO	MISSISSIPPI	SOUTH CAROLINA
INDIANA	NEW JERSEY	WEST VIRGINIA

Second, some states collect information on magnet schools or other schools with a special curriculum focus. These schools often provide unique school settings for teaching and learning science and math, and the number and types of schools with this designation may be a useful indicator for states. The inventory results showed that nine states currently have data on these kinds of designated schools.

ARKANSAS, PUERTO RICO, WYOMING	School report
DIST.OF COLUMBIA, HAWAII, LOUISIANA, OREGON	Designation process
MISSOURI	School directory
TEXAS	Special exemption requests

Finally, five states have conducted surveys of teacher attitudes, and this information could provide a valuable indicator of conditions in schools. These surveys have typically been conducted in conjunction with larger special studies, and some have been conducted with a sample of schools and teachers.

KANSAS	Survey of science/math teachers (ratings of adequacy of resources and administrative support)
PENNSYLVANIA	Assessment questionnaire (includes school leadership, involvement in planning, initiatives, environment)
MAINE, MASSACHUSETTS	Assessment teacher questionnaires
HAWAII	Climate survey

V. Teachers

Two types of indicators of teachers in science and mathematics were recommended for the project: a) indicators of teacher quality, such as subject knowledge and preparation; and b) indicators of teacher supply/demand. The inventory addressed potential indicators for each purpose, as well as state data on current teacher assignments and demographic characteristics.

Subject Knowledge/Preparation. The project advisory board recommended several indicators of teachers' subject knowledge and preparation. First, the number of courses or credits in the assigned field or subject of teaching would be a valid, useful state-by-state indicator, but hardly any states have the data available on an automated system (only in transcript files). As displayed in Table 4, almost 40 states have data on teachers' academic major and field/subject of certification. The table also shows that 50 states and other jurisdictions have data available on current teacher assignments by course or subject. Assignment data at the state level can be a useful indicator for tracking teacher allocation over time and for analyzing teacher demographic characteristics. (Teacher assignments by teacher gender, race/ethnicity and age, and, assignments by certification status are being developed by the Project for reporting on a state-by-state basis. Over 40 states currently have data available for each of these indicators.)

Tests of teacher knowledge in science and mathematics are being used or developed in 26 states. Twenty states currently require a passing score on a subject knowledge test for a new teacher certification. Six states are developing teacher tests as of Spring, 1987. Basic information on state teacher tests was obtained through the inventory, but more detailed state-by-state analyses of teacher tests are available in and in CCSSO's first annual report on state education indicators (1987). (An analysis of state teacher testing programs is currently being completed by the U.S. Department of Education.)

The extent of professional development and continuing education beyond an academic degree has been strongly recommended as an indicator of teacher quality in science and mathematics. According to science and math educators and the scientific professional societies, professional development should be specific to the field or subject of teaching. An indicator that identifies teachers' professional development by their teaching assignment would significantly add to a state's capacity to assess teacher qualifications in science and math. The inventory showed that eight states maintain information on inservice/staff development programs, and six states collect data on continuing education courses/credits. (It might be noted that the information on state policies in the inventory showed that 37 states have continuing education requirements for recertification of teachers.)

	Inservice/staff development programs	Continuing education in field of assignment
GEORGIA	X	X
IOWA		X
MAINE	X	X
MARYLAND		X
MISSISSIPPI	X	
NEW JERSEY	X	
PENNSYLVANIA	X	
PUERTO RICO	X	
RHODE ISLAND		X
SOUTH CAROLINA	X	X
WEST VIRGINIA	X	

Positions filled with teachers out-of-field or emergency/provisional certified teachers. These data provide states with a basic indicator of the shortage of qualified teachers in science and math, as well as an indicator of how many teachers are below the state standard on subject preparation. Forty-two states have the capacity to analyze teacher assignments by certification status to determine the extent of assignments filled with teachers not certified in the field/subject they are assigned (see Table 4).

Status of new science/math teachers after two years. Recent studies on science and mathematics indicators advocate tracking teachers over the first two years of their career. These years are critical for both development of skills and decisions about leaving teaching for another career. Nine states report having data on this indicator; however, for many states that have automated personnel files it would appear that follow-up analyses of data on new teachers would provide the indicator.

State estimates of teacher shortage or supply/demand. In the inventory, each state's respondents were asked to provide information on their department's current efforts to develop estimates of teacher supply and demand. They were asked how often estimates were made, whether estimates were for specific teaching subjects/fields, and what kinds of data related to supply and demand are available in the state. Table 5 shows that 34 states have developed estimates, and most of these states produce annual estimates. Twenty-nine of the states make their estimates by teaching field/subject.

The state responses on the kinds of data used to produce estimates of teacher shortage or supply/demand showed a wide degree of variation. A list of recommended types of data, or variables, for teacher supply/demand estimates was compiled from a recent report of the National Research Council (Committee on National Statistics, 1987), and Table 6 shows the number of states that collect data on the recommended variables.

VI. Resources

Two types of resource indicators for science and math were recommended for the project: teacher salaries and classroom resources.

State level data on <u>teacher salaries</u> are not typically reported or analyzed by subject area, mainly because the vast majority of teacher contracts are written to disallow salary differentiation by field. However, states may want to compare the average salaries of an age cohort of science and math teachers with average salaries of a comparable cohort of college graduates in the state, such as college majors in science and math who are not in teaching. Seven state departments of education reported having access to data on salaries of state college graduates by academic major.

The question of the quantity and quality of <u>classroom resources</u> for science and math, such as textbooks, computers, and laboratory facilities is an indicator of high interest for science and mathematics. Twelve states reported having information on these kinds of classroom resources. However, the main source of information in these states is the qualitative reports submitted in a school accreditation process. A useful state-level indicator would require a careful survey of science/math teachers in a sample of schools in the state to obtain their judgements about the adequacy of classroom resources.

SUMMARY

This project offers an opportunity to begin systematically building a national program of educational indicators for science and mathematics that would provide for state-to-state comparisons. The indicators effort is building on the role states are assuming for leadership and oversight in educational programs, and on the recognition that sound indicators are crucial tools in such a leadership function.

The project of the Chief-State School Officers is addressing needs that have been clearly expressed at the national level to monitor the dimensions and quality of mathematics and science education is also generally needed at the state level, and it is also working to build a system of indicators that will address the needs of state education departments in their role in monitoring, planning, and program development with local schools.

By working with states to develop better data that can be used by them and that can also be compared and aggregated for national analysis, one program of indicators can be built that serves the needs of both levels of government. Finally, the project has been developed within the framework and plan for educational indicators established by the Council of Chief State School Officers. The capacity and commitment of this organization for developing indicators is likely to greatly improve the probability that useful, meaningful science and math indicators can be established.

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Table 1

Student Testing By States in Science and Mathematics

(as of June, 1987, unless specified)

	Assessment Test		Competency Test	
	Grades in Science	Grades in Math	Grades in Science	Grades in Math
ALABAMA	2, 5, 8, 10	2, 5, 8, 10		3, 6, 9, 11 (R)
ALASKA				
ARIZONA		1 - 12		
ARKANSAS		4, 7, 10	6, 8	3, 6, 8
CALIFORNIA	8	3, 6, 8, 12		Age 16 (R)*
COLORADO	3, 6, 9, 11	3, 6, 9, 11		
CONNECTICUT	4, 8, 11	4, 8, 11		4, 6, 8
DELAWARE	11	1 - 8, 11		(R)*
DIST. OF COLUMBIA	1 - 6	3, 6, 8, 9, 11	10 (R)	10 (R)
FLORIDA			3,5(88)8,10	3, 5, 8, 10(R)
GEORGIA	2, 4, 7, 9	2, 4, 7, 9		1, 3, 6, 8,10(R)
GUAM				
HAWAII		3, 6, 8, 10		3, 9 - 12 (R)
IDAHO	8, 11	8, 11		
ILLINOIS	3,6,8(90)10(92)	3,6,8(89)10(91)		
INDIANA	3,6,8,11 (88)	1, 2, 3,6,8,9,11		
IOWA				
KANSAS				2, 4, 6, 8, 10
KENTUCKY				K - 12
LOUISIANA	4, 6, 9		11	3,5,7,11(88)(R 91)
MAINE	4, 8, 11	4, 8, 11		
MARYLAND		3, 5, 8		7, 9 (R)
MASSACHUSETTS	3, 7, 11	3, 7, 11		3, 6, 9
MICHIGAN	4, 7, 10(Sample)	4, 7, 10		
MINNESOTA	4, 8, 11	4, 8, 11		
MISSISSIPPI		3, 5, 8, 11		11 (R 89)
MISSOURI	3 - 10	2 - 10		8
MONTANA				
NEBRASKA				5

(R) Passing score on state test required for graduation.
(R)* Passing score on local competency test, based on state standards, required for graduation.

	Assessment Test		Competency Test	
	Grades in Science	Grades in Math	Grades in Science	Grades in Math
NEVADA				3, 6, 9, 11 (R)
NEW HAMPSHIRE	4, 8, 10	4, 8, 10		
NEW MEXICO	3,5,8,10 (R)*	3,5,8,10 (R)*		
NEW JERSEY		9		9 (R)
NEW YORK		3, 6		9
NORTH CAROLINA	3, 6, 8	1, 2, 3, 6, 8		10 (R)
NORTH DAKOTA	5, 7, 9, 11	3, 5, 7, 9, 11		
OHIO				9 (94)
OKLAHOMA	3, 7, 10	3, 7, 10		
OREGON		8		
PENNSYLVANIA	4, 6, 7, 9,11	4, 6, 7, 9, 11		3, 5, 8
PUERTO RICO		12		4, 6, 9
RHODE ISLAND		3, 6, 8, 10		
SOUTH CAROLINA	4, 5, 7, 9, 11	4, 5, 7, 9, 11	3, 6, 8	1,2,3,6,8,10(R)
SOUTH DAKOTA	4, 8, 11	4, 8, 11		
TENNESSEE	2, 5, 7, 9, 12	2,3,5,6,7,8,9,12		9 (R)
TEXAS				1,3,5,7,9,11(R)
UTAH		5, 11		
VERMONT				8 (R 89)
VIRGINIA	4, 8, 11	4, 8, 11		10 (R)
VIRGIN ISLANDS				
WASHINGTON	4, 8, 10, 11	4, 8, 10, 11		
WEST VIRGINIA	3, 6, 9, 11	3, 6, 9, 11	3, 9	3, 9
WISCONSIN		4, 8, 11		
WYOMING	3, 7, 11	3, 7, 11		

Notes:

Assessment test: State assessment program which is intended to describe a range of knowledge and ability of students in certain curricular areas (CCSSO, 1984).

Competency test: Minimum competency testing program which is intended to demonstrate individual student's ability to meet predefined criteria or standards of performance (CCSSO, 1984).

Course-specific test: New York--State Regents Examinations; North Carolina--End of course tests in science and mathematics.

Table 2

STATES WITH DATA ON STUDENT ENROLLMENT IN SECONDARY SCIENCE AND MATHEMATICS COURSES

STATE	DATA SOURCE
ALABAMA	Personnel/teacher assignment form
ALASKA	
ARIZONA	
ARKANSAS	Personnel/teacher assignment form
CALIFORNIA	Personnel/teacher assignment form
COLORADO	
CONNECTICUT	Curriculum report (every 5 years)
DELAWARE	
DIST. OF COLUMBIA	Student schedule database
FLORIDA	Course data survey
GEORGIA	
GUAM	
HAWAII	Student enrollment form
IDAHO	Accreditation process
ILLINOIS	School report (science/math subject area only)
INDIANA	School report
IOWA	Curriculum report (school)
KANSAS	One-time math/science teacher survey
KENTUCKY	Personnel/teacher assignment form
LOUISIANA	School report
MAINE	
MARYLAND	
MASSACHUSETTS	One-time EESA survey
MICHIGAN	District report (science/math subject areas)
MINNESOTA	Personnel/teacher assignment form

STATE	DATA SOURCE
MISSISSIPPI	Personnel/teacher assignment form
MISSOURI	Personnel/teacher assignment form
MONTANA	School class schedules
NEBRASKA	Curriculum report (school)
NEVADA	
NEW HAMPSHIRE	
NEW MEXICO	Personnel/teacher assignment form
NEW JERSEY	School report
NEW YORK	Personnel/teacher assignment form
NORTH CAROLINA	Personnel/teacher assignment form
NORTH DAKOTA	Personnel/teacher assignment form
OHIO	Personnel/teacher assignment form
OKLAHOMA	Accreditation process (school)
OREGON	School report
PENNSYLVANIA	School report
PUERTO RICO	Personnel/teacher assignment form
RHODE ISLAND	
SOUTH CAROLINA	Personnel/teacher assignment form
SOUTH DAKOTA	School report
TENNESSEE	Personnel/teacher assignment form
TEXAS	
UTAH	High school senior survey
VERMONT	
VIRGINIA	Personnel/teacher assignment form
VIRGIN ISLANDS	
WASHINGTON	School report
WEST VIRGINIA	Personnel/teacher assignment form
WISCONSIN	Curriculum report (every 3 years)
WYOMING	Curriculum report (school)

Table 3

STATE CURRICULUM FRAMEWORKS IN SCIENCE/MATHEMATICS

	PURPOSE			USE	
	Required State Curriculum	Curriculum Goals	Instruction Objectives	Select/ Reccomend Textbooks	Develop/ Select State Tests
ALABAMA	SM	SM	M	SM	SM
ALASKA	No State Framework				
ARIZONA	SM	SM		SM	M
ARKANSAS				SM	SM
CALIFORNIA		SM		SM	SM
COLORADO	No State Framework				
CONNECTICUT		SM	SM		SM
DELAWARE					SM
DIST. OF COLUMBIA	SM	SM	SM	SM	SM
FLORIDA			SM	SM	SM
GEORGIA	SM		M	SM	M
GUAM	No State Framework				
HAWAII	SM	SM	SM	SM	
IDAHO	S	S	M		
ILLINOIS		SM			
INDIANA	No State Framework				
IOWA	SM				
KANSAS*					
KENTUCKY		SM	M	SM	M
LOUISIANA	SM	SM	SM	SM	SM
MAINE	No State Framework				
MARYLAND		SM	M		
MASSACHUSETTS	No State Framework				
MICHIGAN		SM	SM		
MINNESOTA	Planning				
MISSISSIPPI	SM	SM	SM	SM	SM
MISSOURI		SM	SM		SM
MONTANA	Planning				

	PURPOSE			USE	
	Required State Curriculum	Curriculum Goals	Instruction Objectives	Select/ Reccomend Textbooks	Develop/ Select State Tests
NEBRASKA	No State Framework				
NEVADA	SM	SM	SM		M
NEW HAMPSHIRE		SM	M		
NEW MEXICO			SM	SM	SM
NEW JERSEY**					
NEW YORK		SM	SM		SM
NORTH CAROLINA	SM	SM	SM	SM	SM
NORTH DAKOTA*					
OHIO	No State Framework				
OKLAHOMA		SM	SM	SM	SM
OREGON	Planning				
PENNSYLVANIA		SM			SM
PUERTO RICO	SM				SM
RHODE ISLAND	No State Framework				
SOUTH CAROLINA			SM	SM	M
SOUTH DAKOTA		SM		SM	
TENNESSEE	SM	SM		SM	SM
TEXAS	SM	SM	M	SM	M
UTAH	SM		SM	SM	SM
VERMONT**					
VIRGINIA		SM	SM	SM	SM
VIRGIN ISLANDS	M			M	M
WASHINGTON				SM	
WEST VIRGINIA	SM	SM		SM	SM
WISCONSIN		SM			M
WYOMING	No State Framework				

* State has curriculum framework or standards but has not indicated purpose or use.

** Framework used for advice and assistance to local districts/schools.

Table 4

STATE DATA AVAILABLE ON TEACHERS' PREPARATION IN TEACHING SUBJECT

State	Academic Major	Teacher Assignment by Course/Subject Area	Teacher Assignment by Certification Field/Subject*
ALABAMA	yes	course	yes
ALASKA	yes	subject area	no
ARIZONA	no	subject area	no
ARKANSAS	yes	course	yes
CALIFORNIA	no	course	yes
COLORADO	no	subject area	yes
CONNECTICUT	no	subject area	yes
DELAWARE	no	subject area	planning
DIST. OF COLUMBIA	yes	course	yes
FLORIDA	yes	course	yes
GEORGIA	yes	no	no
HAWAII	yes	course	no
IDAHO	yes	course**	no
ILLINOIS	yes	course	no
INDIANA	no	course	planning
IOWA	yes	course	yes
KANSAS	yes	subject area	yes
KENTUCKY	yes	course	yes
LOUISIANA	yes	course	yes
MAINE	yes	course	yes
MARYLAND	yes	subject area	yes
MASSACHUSETTS	no	subject area***	no
MICHIGAN	yes	subject area	yes
MINNESOTA	yes	course	yes
MISSISSIPPI	no	course	yes
MISSOURI	yes	course	yes
MONTANA	yes	subject area	yes
NEBRASKA	yes	course	yes

State	Academic Major	Teacher Assignment (Course/Subject Area)	Teacher Assignment by Certification Field/Subject*
NEVADA	yes	subject area	yes
NEW HAMPSHIRE	yes	subject area	planning
NEW JERSEY	no	course	yes
NEW MEXICO	yes	course	yes
NEW YORK	yes	course	yes
NORTH CAROLINA	yes	course	yes
NORTH DAKOTA	yes	course	yes
OHIO	yes	course	yes
OKLAHOMA	no	course	yes
OREGON	yes	subject area	yes
PENNSYLVANIA	no	subject area	yes
PUERTO RICO	yes	course	yes
RHODE ISLAND	yes	subject area	yes
SOUTH CAROLINA	no	course	yes
SOUTH DAKOTA	yes	course	yes
TENNESSEE	no	course	yes
TEXAS	yes	course	yes
UTAH	yes	course	yes
VERMONT	yes	subject area	no
VIRGINIA	yes	course	yes
VIRGIN ISLANDS			
WASHINGTON	yes	no	no
WEST VIRGINIA	yes	course	yes
WISCONSIN	no	subject area	yes
WYOMING	yes	course**	yes
TOTAL	Yes = 38	Course or Subject area = 50	Yes = 40

* State can conduct automated analysis or check of teacher assignments against the teacher's field/subject(s) of certification or endorsement.

** Not automated.

*** District summary information: number of teachers teaching subject area.

Table 5

STATE ESTIMATES OF TEACHER SHORTAGE
OR SUPPLY/DEMAND

State	How often made/reported	Estimates by field/subject
ALABAMA		
ALASKA	annual	yes
ARIZONA	one time	yes
ARKANSAS	periodic	
CALIFORNIA		
COLORADO	annual	yes
CONNECTICUT		
DELAWARE	annual	yes
DIST. OF COLUMBIA		
FLORIDA	annual	
GEORGIA	annual	yes
HAWAII	annual	yes
IDAHO	annual	yes
ILLINOIS	annual	yes
INDIANA	annual	yes
IOWA	annual	yes
KANSAS	annual	yes
KENTUCKY		
LOUISIANA	annual	yes
MAINE	annual	yes
MARYLAND	annual	yes
MASSACHUSETTS	periodic	no
MICHIGAN	as needed	
MINNESOTA		
MISSISSIPPI		
MISSOURI		
MONTANA		
NEBRASKA		

State	How often made/reported	Estimates by field/subject
NEVADA		
NEW HAMPSHIRE	annual	yes
NEW JERSEY	annual	yes
NEW MEXICO		
NEW YORK	periodic	yes
NORTH CAROLINA	every 2 years	yes
NORTH DAKOTA		
OHIO	annual	yes
OKLAHOMA		
OREGON	annual	yes
PENNSYLVANIA		
PUERTO RICO	annual	yes
RHODE ISLAND		
SOUTH CAROLINA	annual	yes
SOUTH DAKOTA		
TENNESSEE	periodic	no
TEXAS	annual	yes
UTAH	annual	yes
VERMONT		
VIRGINIA	annual	yes
VIRGIN ISLANDS		
WASHINGTON	annual	yes
WEST VIRGINIA	annual	yes
WISCONSIN	annual	yes
WYOMING	one time	yes
TOTAL: Estimates made/reported=	34	Yes= 29

Blank after state = No estimates made by state, based on inventory responses.

Table 6

TYPES OF STATE DATA AVAILABLE ON TEACHER SUPPLY/DEMAND

Types of Data	Number of States
Supply of Teachers:	
New college graduates in education	27
Graduates with non-education majors (and teaching credential)	13
Entrants from other occupations	12
Re-entrants into teaching	19
Current teachers in new field	15
In-migration of teachers into state	23
Continuing teachers with regular or standard certification	29
Demand for Teachers:	
Pupil-teacher ratio	36
Pupil-teacher ratio by subject/field	17
Enrollment projections	26
Teachers retiring	31
Teacher attrition	28
Emergency/provisional certificates	31
Positions vacant, filled with out-of-field teacher or substitute, or withdrawn	24

Appendix
(to Table 1)

CHARACTERISTICS OF STATE ASSESSMENT TESTS IN SCIENCE & MATHEMATICS

Grade Levels Tested	States	
	Science	Math
Grade 2	3	5
Grade 3	7	15
Grade 4	10	13
Grade 5	4	8
Grade 6	5	11
Grade 7	9	11
Grade 8	11	18
Grade 9	7	10
Grade 10	5	9
Grade 11	13	16
Grade 12	1	4

Type of Assessment Test	States
State Test	11
SAT	5
ITBS	5
MAT	3
CAT	3
SRA	2
CTBS-U	4
PEP (New York)	1
NAEP	1
CAEP (Connecticut)	1
College Board	1

Time of Year for State Assessment Tests

Fall	Winter	Spring
Connecticut (5 yr cycle)	Maine (Gr 4)	Alabama
Maine (Gr 8)	Minnesota (Gr 4, 4 yr cycle)	Arizona
Maryland	Oregon (2 yr cycle)	Arkansas
Michigan	Tennessee (Gr 12)	California
Minnesota (Gr 8, 4 yr cycle)		Colorado (3 yr cycle)
New Hampshire		Hawaii
North Dakota		Idaho
Puerto Rico		Illinois
Tennessee (Gr 9,11)		Maine (Gr 11)
West Virginia (Gr 9,11)		Massachusetts (2 yr cycle)
Wyoming		Minnesota (Gr 11, 4 yr cycle)
		New Jersey
		New York
		North Carolina
		Oklahoma
		Pennsylvania
		Rhode Island
		South Carolina
		South Dakota
		Tennessee (Gr 2,3,5,6,7,8)
		Utah (3 yr cycle)
		Virginia
		West Virginia (Gr 3,6)
		Wisconsin