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ABSTRACT

The process of developing a state education indicators system using the model proposed by the Council of Chief State School Officers (CCSSO) is described. The CCSSO model has three components--indicators of educational outcomes; indicators of school policies and practices; and indicators of contextual factors, or state characteristics. The goal is to relate educational outcomes to state program policies and practices, accounting for factors outside the education system that affect what schools can accomplish. Two projects are examined to demonstrate how comparative state indicators can be developed: (1) the design and implementation of the State Science/Math Indicators Project--an effort to develop indicators for monitoring and reporting on states' progress in improving science and mathematics education; and (2) the National Assessment Planning Project--an effort by a consortium of 18 national organizations to prepare for expanding the National Assessment of Educational Progress to produce state-by-state comparisons of student achievement. Examination of these two projects demonstrates that the indicators are based on the analysis of what information is important to collect about educational progress in specific subject areas and how this information should be reported. Ten figures and four tables provide information about the implementation of these two projects. (SLD)

Council of Chief State School Officers
State Education Assessment Center

DEVELOPMENT OF A 50-STATE SYSTEM OF EDUCATION INDICATORS: ISSUES OF DESIGN, IMPLEMENTATION, AND USE

Rolf K. Blank

Paper prepared for the annual meeting of the American Educational Research Association, March 1989.

This paper includes data collected by state departments of education that was obtained through the cooperation of the State Network on Science/Mathematics Indicators, comprised of professional staff in each state department of education. Research support was provided through a grant from the National Science Foundation, Office of Studies and Program Assessment, Science and Engineering Education.

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DEVELOPMENT OF A 50-STATE SYSTEM OF EDUCATION INDICATORS: ISSUES OF DESIGN, IMPLEMENTATION, AND USE

Local school districts, state departments of education, and federal agencies, such as the Department of Education and the National Science Foundation, have been active in trying to improve the quality and usefulness of data and information on education. Many of these efforts have been aimed at developing and implementing a system of educational indicators that would regularly inform policy-makers, the public, educators, and researchers about the extent of progress in improving education in our schools (Oakes, 1986; National Science Board, 1987; National Center for Education Statistics, 1987; Phi Delta Kappan, 1988; National Governors' Association, 1986; Council of Chief State School Officers, 1988).

States have become very active in developing and improving indicators of school performance due to the wide range of state education reforms in the 1980's. States have instituted policy changes in the 1980's to increase graduation requirements, revise elementary and secondary curricula, upgrade teacher certification, attract and retain teachers, and develop new state assessment programs (Blank & Espenshade, 1988). The state superintendents and their staffs have been working to track the effects of these reforms and to ensure that methods are available for reporting on the progress of states in improving education. In 1984, the Council of Chief State School Officers (CCSSO) made a fundamental shift in its policy on the role of states in educational assessment and evaluation, and the organization adopted a far-reaching position on the responsibility of states to ensure that the data on education collection by states were of high technical quality and useful comparability from state to state. CCSSO established the State Education Assessment Center to coordinate the development, analysis, and use of state-level data and charged the Center with implementing an education indicators model to report state-by-state data.

This paper reports on the process of developing a state indicators system using the CCSSO model. There are three sections. First, the model for state education indicators is outlined. Then, the design and implementation of two projects within the State Education Assessment Center are examined to show how comparative state indicators can be developed, the kinds of data that will be reported, and how the indicators can be used. The two projects are: a) the State Science/Math Indicators Project, an effort to develop a set of indicators for monitoring and reporting on states' progress in improving science and mathematics education; and b) the National Assessment Planning Project, an effort by a consortium of 18 national organizations to prepare for expanding the National Assessment of Educational Progress (NAEP) to produce state-by-state comparisons of student achievement.

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. The goal of the model is to relate educational outcomes to state program policies and practices, accounting for factors outside the education system that determine, to some extent, what schools 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 relationship between them.

Figure 1 illustrates the CCSSO model and the types of indicators and data to be included in the model. The model and a core set of indicators were recommended by a committee of state superintendents and their staff (CCSSO, 1985). The committee also established three criteria for selecting indicators: a) importance/utility for states, b) technical quality, and c) feasibility.

Since 1985 the State Education Assessment Center has been developing a system for collecting data and reporting on the indicators. As shown in Figure 1, some of the indicators are now in place and being reported on an annual basis (CCSSO, 1988), while others, such as student achievement and dropout rates, are being prepared. The Assessment Center has three principal roles in implementing the indicators model:

1. Developing a consensus among states on the specific measures that will be used for each indicator;
2. Providing technical assistance to states to improve their systems of assessment, accountability, and data collection; and
3. Working with federal agencies and others responsible for collecting educational data to obtain state comparative data and ensure that valid state comparisons can be made.

The Assessment Center works closely with planning groups and task forces of state education specialists. A planning group or task force could be comprised of state specialists responsible for state information systems, assessment programs, finance data, or curriculum depending on the specific indicator area. For each category of indicators, state representatives provide recommendations on indicator development and report on what can be done by each state department of education. The states then collaborate with Assessment Center staff in a series of steps to collect and report comparative state data, including:

- Establishing common definitions and standards for data collection;
- Surveying states to identify current state indicators and data;
- Analyzing differences between states in definitions and procedures;
- Recommending adjustments to standardize data across states; and
- Providing technical assistance to states for improving data systems and reporting data.

SCIENCE/MATHEMATICS INDICATORS: Process of Developing and Reporting State Comparative Indicators

To develop the indicators in the CCSSO model, one approach was to gain support from federal agencies that have a similar interest in educational indicators. Financial support was particularly important for developing the indicators that would be based on data collected by states and to be reported with a standard definition and format. CCSSO found that the National Science Foundation's interest in improving the nation's capacity for monitoring science and math education coincided with the states' interest in comparative indicators at the subject level in areas such as student achievement, student participation, teachers, and resources.

With support of the National Science Foundation, the Assessment Center began a project in 1986 to develop indicators of the condition of science and mathematics education at elementary and secondary levels. The goals of the project, now in its third year, are to: a) 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 b) to develop a system of indicators that provides the capability for state-to-state comparisons of science and mathematics education as well as national indicators to assess the condition of education in these subjects. The project has been conducted through a planned set of steps. The steps are displayed in Figure 2, and summarized as follows.

1. <u>Conceptual Framework for State Science/Math Indicators</u>.

A conceptual framework for science and math indicators was based on the CCSSO model as well as recent studies of indicators of science and mathematics education, such as studies by the National Academy of Sciences and the Rand Corporation (studies supported by the National Science Foundation) (Murnane & Raizen, 1988; Shavelson, et al., 1987). The conceptual framework, outlined in a paper circulated to all the states (Blank, 1986), included six areas of desired, or "ideal," indicators for science and math: student outcomes, instructional time/enrollment, curriculum content, teacher quality, school conditions, and resources. The framework also gave a rationale for improving our indicators of science and mathematics based on needs for state-by-state indicators and potential uses of education indicators by states. The elements of this rationale are outlined in Figure 3.

2. Survey with States to Identify Commonalities and Differences in Indicators

Based on the conceptual framework, the project surveyed the state departments of education to determine which indicators and data are available through state assessment programs, information systems, or other sources, such as curriculum studies. A network of three state education specialists in each state were selected by the state superintendents to complete the survey and to work on the project. The network includes specialists in science and mathematics curriculum, assessment, and information systems. One reason for such a network is to have staff from different divisions of state agencies share their ideas about the needs for and uses of indicators of science and mathematics education as well as to understand the difficulties of collecting and reporting valid data

The survey results led to several steps in analysis. First, the results were arrayed for the 50 states to determine the extent to which state data are available on the desired science/math indicators (Blank & Espenshade, 1988). Second, for states that have data, the specific collection forms and data systems were analyzed to determine whether data could be reported in a common way with only small changes, adaptations, or additions. Third, the states' operational definitions and procedures for collecting and aggregating data were pinpointed.

3. Recommendations from Task Forces.

The project convened a task force comprised of state participants in the project network and experts on science/math indicators to analyze the survey results and recommend a set of priority state-by-state indicators for science/math education. The three CCSSO criteria for selecting indicators were applied, i.e., importance/utility, quality, and feasibility.

The priority indicators, the expected sources of data , and the year data will be available are displayed in Figure 4. Data on several of the indicators will be obtained through the National Assessment of Educational Progress (NAEP) which is being planned to begin on a state-by-state basis in 1990. A second source of state-by-state data is the Schools and Staffing Survey conducted by the National Center for Education Statistics in 1988. The third source is the state education departments.

The first two data sources are based on national surveys with representative samples of respondents in each state, and thus comparability between states is not an issue. To use state-collected data, the CCSSO project worked with a second task force of state specialists in science, mathematics, and data systems to develop a reporting system and common reporting formats for the selected indicators. Included in the reporting system is a taxonomy of course titles and teacher assignments and a "cross-walk" that would relate each state's data to the common reporting format.

4. Regional Workshops for State Staff on Science/Math Indicators.

To assist states in implementing the science/math indicators, a series of regional workshops were conducted across the country with the state participants in the project network. About 110 state education staff participated in one of the five regional meetings. The workshops allowed states individually and collectively to respond to the reporting plan and specifications for each state. Second, state participants discussed the uses of science/math indicators for policy and program decisions in states and how state data systems can be improved. Third, recommendations were made on additional indicators in science and mathematics that states would like to see developed.

The discussion of uses of science/math indicators focused on three indicators that will be obtained through state-collected data: secondary course enrollment, teachers assignments, and assignments by certification status. Some of the questions that could be answered with these science/math indicators are:

Indicator: Enrollment in Science/Math Courses in Grades 7-12

- What types of courses are students taking to meet state science and math graduation requirements?
- How does course-taking in science/math differ in LEAs and schools with different characteristics?
- What is the trend in student enrollments in science and math courses from one year to the next? What is the rate of attrition from science and math (by examining enrollments over time)?

Indicator: Teacher Assignments in Science/Math

- What is the age of teachers in science/math, particularly the numbers of new and older teachers? What is the race/ethnicity and sex distribution of science/math teachers?
- How many different course preparations do most science/math teachers have?

Indicator: Assignments by Certification

- What are the state-by-state differences in shortages of science and math teachers, as indicated by out-of-field teaching?
- How do the data on current teachers show need for funding support for incentive programs for science/math teachers, such as scholarships or retraining?

At the regional workshops, states also discussed how science/math indicators can be used within states to examine educational progress according to characteristics of districts and schools, such as size, student composition, and local policies.

5. **Pilot Study with 10 States.**

In the spring of 1988, ten states participated in a pilot study to test the common reporting format for the three indicators to be based on state-collected data. These data provided an initial analysis of the applicability of the reporting formats and identified any problems states had in using the formats. The results were used to prepare for the phase-in of state-by-state reporting during the 1988-89 school year (SEAC, 1988).

Some of the data from the pilot study are reported in Tables 1-4. Tables 1 and 2 show individual state data according to the secondary course enrollment taxonomies for science (Table 1) and mathematics (Table 2). The data from these two states also provide breakdowns of course enrollments by gender.

Several basic principles were used in developing the taxonomy for reporting course enrollments. First, the course categories are intended as measures of the relative level of student progress in science and mathematics, for example, the percent of students taking first-year general biology vs. the percent taking first-year applied biology. They are not intended to provide comparisons across states in actual course content. However, the taxonomy does include category definitions that states can use in checking their data categories against the common reporting format. Second, the taxonomies for both science and math are designed to be forward-looking in anticipating the direction of curriculum development, such as integrated math for different high school grade levels, and the increase in science and math courses, e.g., "applied" courses, with the increase in graduation requirements.

Tables 3 and 4 show some of the pilot study data on teacher characteristics. The teacher data were broken down by teaching subject (math, biology, chemistry, physics, earth science, physical science) according to teachers with primary assignment (50% or more of their time) in a specific subject versus those with secondary assignment (less than 50% of their time) in the subject. In Table 3, the teacher assignments for those 50% or more (primary assignment) in biology are cross-tabulated with teacher age, sex, and race/ethnicity. The two age categories indicate the numbers of new teachers and older teachers for each state. The age proportions probably follow the age profile of all teachers in a state, but they also point out potential teacher shortages by subject. For example, Wisconsin has a quarter to a third of teachers with primary assignments in science/math who are over age 50. The data on gender indicate that southern states, such as Alabama, South Carolina, and Arkansas, have more female than male science and math teachers, while for northern states there are more male teachers. All of the states appear to have underrepresentation of minority teachers given their student populations. It is likely that periodic collection of these data would produce very useful trend analyses of science/math teacher characteristics by state.

Table 4 illustrates state data on the indicator of teacher assignments by certification status, in this case for mathematics. The indicator is based on a cross-tabulation of teachers assignments (above or below 50% time) in mathematics, biology, chemistry, physics, earth science, and physical science by their certification status in the specific subject. These data provide a method of identifying the number of teachers in each field that are teaching "out of field" (which includes certified teachers who are assigned to a field in which they are not certified, and emergency, temporary, or provisionally certified teachers). For example, 4% of Kentucky's teachers assigned 50% or more in math are not certified in math, while 58% of their teachers assigned less than 50% in math are not certified in math.

6. <u>Implementation of Indicators System</u>.

In the third year of the project (beginning October 1988), reporting on three secondary-level indicators is being phased-in with those states that have the data available through state information systems (32 states have data on all three priority indicators). The project is assisting other states in developing their state data capacity. The project is also obtaining state representative data on science/math indicators from national surveys, such as the NCES Schools and Staffing Survey.

In the 1989-90 school year, the project will coordinate the full implementation of data reporting on the priority science/math indicators and will work with all the states in collecting, editing, tabulating, and analyzing state data on science and mathematics. CCSSO will be working with the National Science Foundation to develop and implement an ongoing system for state-by-state reporting of the science/math indicators. The data collection programs of the National Center for Education Statistics are currently being considered as a way of collecting and reporting the data from states, possibly on a biannual basis.

During the current year, the project is working with small groups of states on developing additional indicators. The project organized a meeting of 10 state science supervisors to identify and plan indicators of elementary science in November 1988. During the next year the project will be working with states to determine how data could be collected and reported to provide valid, state-by-state comparisons on elementary science. From the recommendation of the science supervisors, the project planned and organized a conference on "Alternative Methods of Science Assessment" in January 1989 which was attended by 60 state assessment directors and state science supervisors from 39 states (Blank & Selden, 1989). Presentations on recent developments in science assessment provided the basis for states to consider ways of improving state assessment programs.

NATIONAL ASSESSMENT PLANNING PROJECT

In 1987-88, the CCSSO State Education Assessment Center led a consortium of 18 national education organizations in developing a plan for expanding the National Assessment of Educational Progress (NAEP) to include state-by-state comparisons. For twenty years NAEP served as "The Nation's Report Card" in providing the only comprehensive, longitudinal data on what students in the U.S. know and can do in various subject areas. NAEP was based on a national representative sample of 25,000 students at each of three grade levels. For the 1990 assessment, states will be able to participate in a state-by-state assessment in mathematics, and in 1992 in reading.

The National Assessment Planning Project led by CCSSO filled a specific need of the states and the U.S. Department of Education, which was to obtain a consensus among the states on how to proceed with designing a national assessment in mathematics that would provide valid, useful state-to-state comparisons. There were two major questions of concern to state and local educators and policy-makers First, there was a question about whether the educational objectives (intended knowledge skills) upon which the assessment would be based reflects what states have set as their educational goals and objectives. Second, there was concern about how the comparative data would be analyzed and reported so that states would be compared in a fair and meaningful manner.

Organization of the Planning Project

The Assessment Planning Project aimed for broad input from groups with an interest in a state-by-state assessment and to build a consensus of support among states, educators, and policy-makers There were four important levels of the Project organization:

- **Steering Committee** -- representatives of 18 education organizations, including teacher unions, administrators, state organizations, mathematics educators, and education researchers -- made policy recommendations and established the agenda and structure for the Project;

- **Mathematics Objectives Committee** -- technical working committee comprised of mathematicians, state math supervisors, teachers, math assessment specialists, and a school principal -- wrote the report on mathematics objectives and a framework for assessment design;

- **Analysis and Reporting Committee** -- technical working committee comprised of state assessment directors, education researchers, statisticians, and a local district test director -- wrote the report on how to categorize and compare states' assessment results and needs for demographic, policy, and program data to analyze the results.

- **State committees of math teachers and curriculum specialists** -- in each state, the draft reports were reviewed and commented on for use in revisions by the technical committees.

Purposes of State Comparisons

The Steering Committee established recommendations on the purpose of state comparisons and the conditions that should be met for making such comparisons:

> The purpose of State Level Student Achievement Comparison is to provide data on student performance to assist policy-makers and educators to work toward the improvement of education. Such data can be useful by encouraging and contributing to a discussion of the quality of education and the conditions that determine it (CCSSO, 1988).

In a paper summarizing the work of the Planning Project, Cody (1987) outlined specific contributions that state comparative assessments which are appropriately designed can make to education:

1. **Identify and select problems**, such as needed improvement efforts with:
   - o Subjects or topics in the curriculum,
   - o Racial or ethnic groups in the student population,
   - o Different levels of performance, e.g., basic vs. advanced,
   - o Students in a region or by urban, suburban, rural.
2. **Determine programs and practices that make a difference**, such as:
   - o Resource investments, e.g., per pupil expenditures, calculators, computers, textbooks
   - o Teacher training, inservice, and support programs
   - o Policies on instructional time and course requirements, as reflected in data on students opportunity to learn the topics assessed
   - o School effectiveness programs
3. **Measure progress**
   - o Consistent, reliable trend data from a representative sample of students in the state
   - o Presence or absence and degree of improvement in student learning
   - o Feedback related to state reform efforts.

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Assessment in Mathematics

The Mathematics Objectives Committee carried out three essential tasks in their report (CCSSO, 1988). First, the Committee established a set of principles upon which a mathematics assessment should be based. Second, the Committee designed a framework for the assessment which specifies mathematics abilities and content areas. Third, the Committee wrote sample items which illustrated how each type of objective should be assessed.

The principles for the state-by-state mathematics assessment are:

- **Be inclusive of state curricula and mathematics knowledge, but not "lowest common denominator," and be dynamic and forward-looking**

The committee decided the assessment needed to incorporate the states curriculum objectives, but that it could not be simply a consensus of what is common across all the states current objectives. The assessment should look forward as to where curriculum development, instruction, and student learning should be going and it should be inclusive of different levels of mathematics knowledge (basic and advanced) as well as different approaches to teaching. The three key sources for writing objectives reflect this principle:

1) Curriculum and Evaluation Standards for School Mathematics, final draft report of the National Council of Teachers of Mathematics;

2) States curriculum frameworks, standards, and objectives, and review by the states of the Committee's work;

3) Objectives for the 1986 NAEP Mathematics Assessment, to link the 1990 assessment to previous assessments.

- **Develop a relatively simple framework for assessment objectives to facilitate interpretation and understanding of test results.**

The 1986 NAEP math objectives were organized in seven content and five process categories producing a matrix of 35 cells. The Committee favored fewer categories, recommending that desired complexity in areas of process and content be attained through specific topics in content areas. The recommended framework, or matrix, is displayed in Figure 5. The matrix arrays three areas of mathematical abilities -- conceptual understanding, procedural knowledge, problem solving -- by five content areas -- numbers and operations, measurement,. geometry, data analysis, statistics and probability, and algebra and functions.

- **In designing and testing items based on the mathematics objectives, do not treat content and mathematical ability categories as discrete or mutually exclusive categories.**

Abilities and content areas are typically integrated and overlapping. Thus, some assessment exercises need to be multi-dimensional and designed to cut across content categories. The Committee recommended the degree weight that should be given to each category in the distribution of exercises by grade level of the assessment. Figure 6 shows the weight that should be given to the abilities and content areas. The distribution is not specified according to a matrix in order to emphasize the need for integrating abilities and content Conceptual understanding exercises, for example, are to be distributed across content areas.

Analysis and Reporting

The recommendations of the Analysis and Reporting Committee (CCSSO, 1988) focused on two important principles for attaining fair and valid state comparisons with assessment data.

- **Test scores should not be reported by simply an average score of students assessed in each state; far more information is needed.**
- **State comparative assessments need to include demographic data on each state and its students, as well as measures of state education policies, programs, and practices that may be related to student assessment scores.**

The recommended format and methods for reporting state scores are illustrated in sample reporting formats in Figures 7 and 8. First, mathematics results should be reported according to a scale, similar to NAEP's proficiency scales, to show the percent of students in each each grade who score in or above each of the defined proficiency levels (e.g., in 1986, a level of 150 means accomplishment of "simple arithmetic facts," while 350 means accomplishment of "multi-step problem-solving and algebra."). Results should be reported according to the sub-scale scores for content and ability areas. Second, the state scores should be broken out by gender, race/ethnicity, and type of community, as well as showing trends over time (e.g., '90 to '92 assessments).

The recommendations on state-by-state comparisons included reporting demographic variables, such as per capita income, percent of adults with 4 years high school, and percent of school age population in poverty, and rank-ordering states by a composite index of these variables. Figure 9 shows how assessment scale scores could be reported using such an index for state rankings. The Committee did not support the idea of using either expected scores (vs. actual scores) or "adjusted scores" through regression statistical analysis with demographic variables; instead recommending that state scores be reported next to the state rankings on demographic characteristics. A second recommendation was to compare state achievement scores by disaggregating scores according to student socio-economic background. For example, even though the number of economically disadvantaged students to be tested in each state would vary, scale scores could be reported for the group of disadvantaged students in the state sample to determine differences in achievement for this sub-population.

Data should be collected on measures of school processes, teacher characteristics, and instructional practices that have been shown to be related to student achievement. It was recommended that these variables be limited to those that can be affected by state policies, programs, and practices, and by what is reasonable to ask of students, principals, and teachers and by the quality of data that can be obtained. Other surveys and research studies may be more appropriate for answering broader research questions about educational organization and processes. The specific types of education variables recommended for the state-by-state national assessment are listed in Figure 10.

SUMMARY

This paper has outlined the approach of the Council of Chief State School Officers to developing and implementing a model for comparative state education indicators. The process for putting these indicators in place has emphasized a high degree of involvement by state education specialists and by experts in education research, measurement, and statistics. A set of standards for selecting education indicators have been consistently applied to ensure that state comparisons are valid and meaningful Finally, the description of two projects on state-by-state indicators demonstrates that the indicators are based on analyses of what information is important to collect about education progress in specific subject areas, such as mathematics and science, and how the information should be reported.

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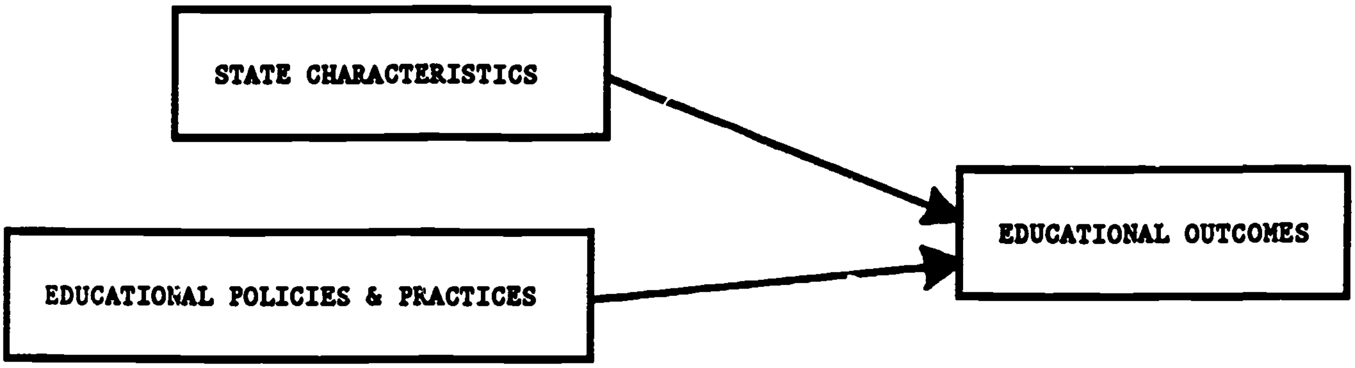
Figure 1

CCSSO EDUCATION INDICATORS MODEL & SCIENCE/MATH INDICATORS



EDUCATIONAL POLICIES & PRACTICES

Current Report: State Policies

- Graduation requirements
- Teacher preparation/certification
- School participation

Developing: State-by-State Data

- Allocated time in elementary subjects
- Science & Math Indicators:
  - Secondary course enrollments
  - Teacher assignments
  - Assignments by certification
- Teacher work force
- Expenditures

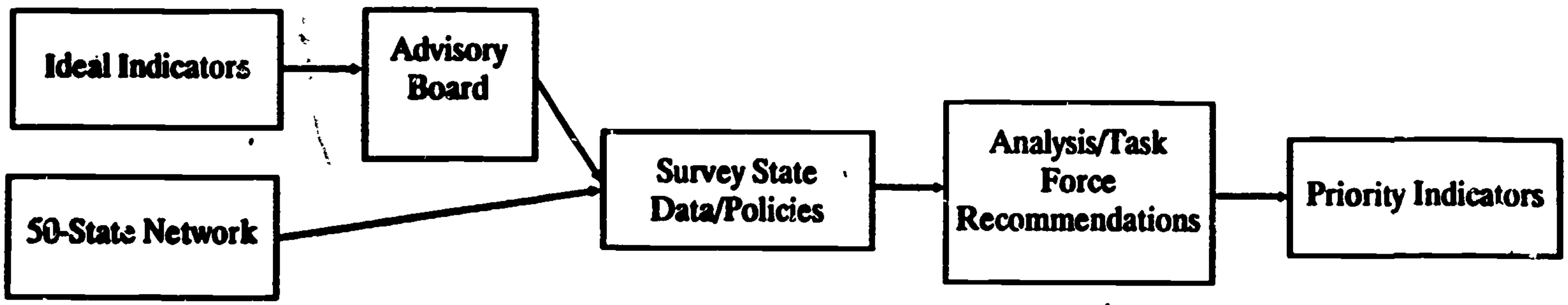
STATE CHARACTERISTICS (Current)

- School System Demographics
- Population Characteristics
- Resources
- Student needs

EDUCATIONAL OUTCOMES (Developing)

- Graduation rate & dropout rate
- Student achievement
- Post high school status

Year 1 - Identify & Select Science/Math Indicators



Year 2 - Plan Indicators with States

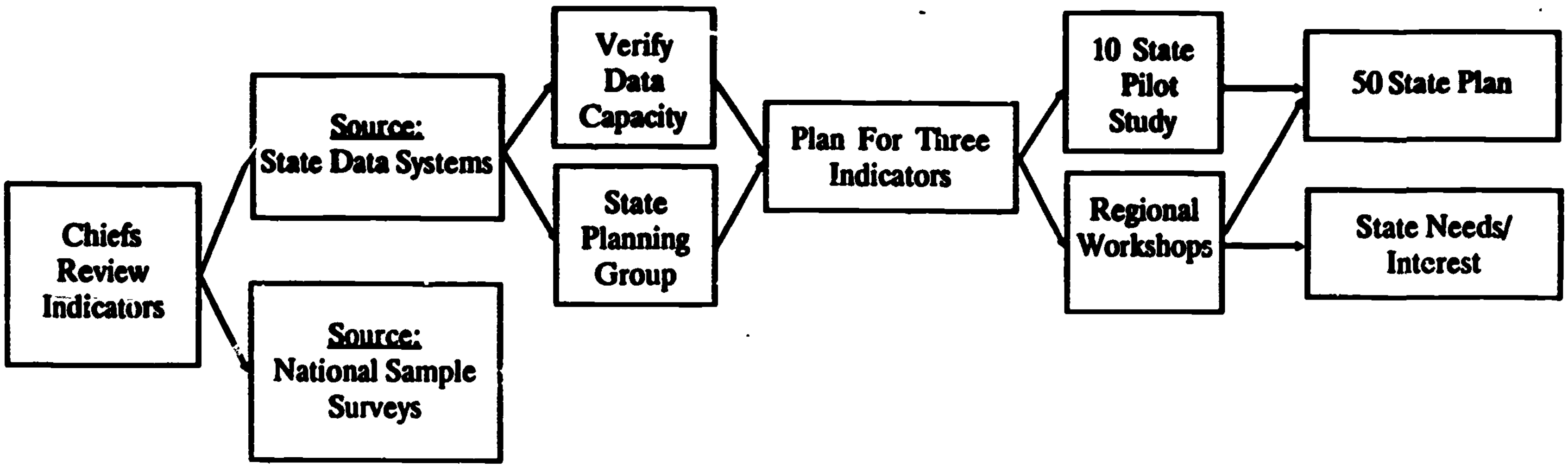


Figure 2

Year 3 + 4 Implement Priority Indicators; Work with Groups of States

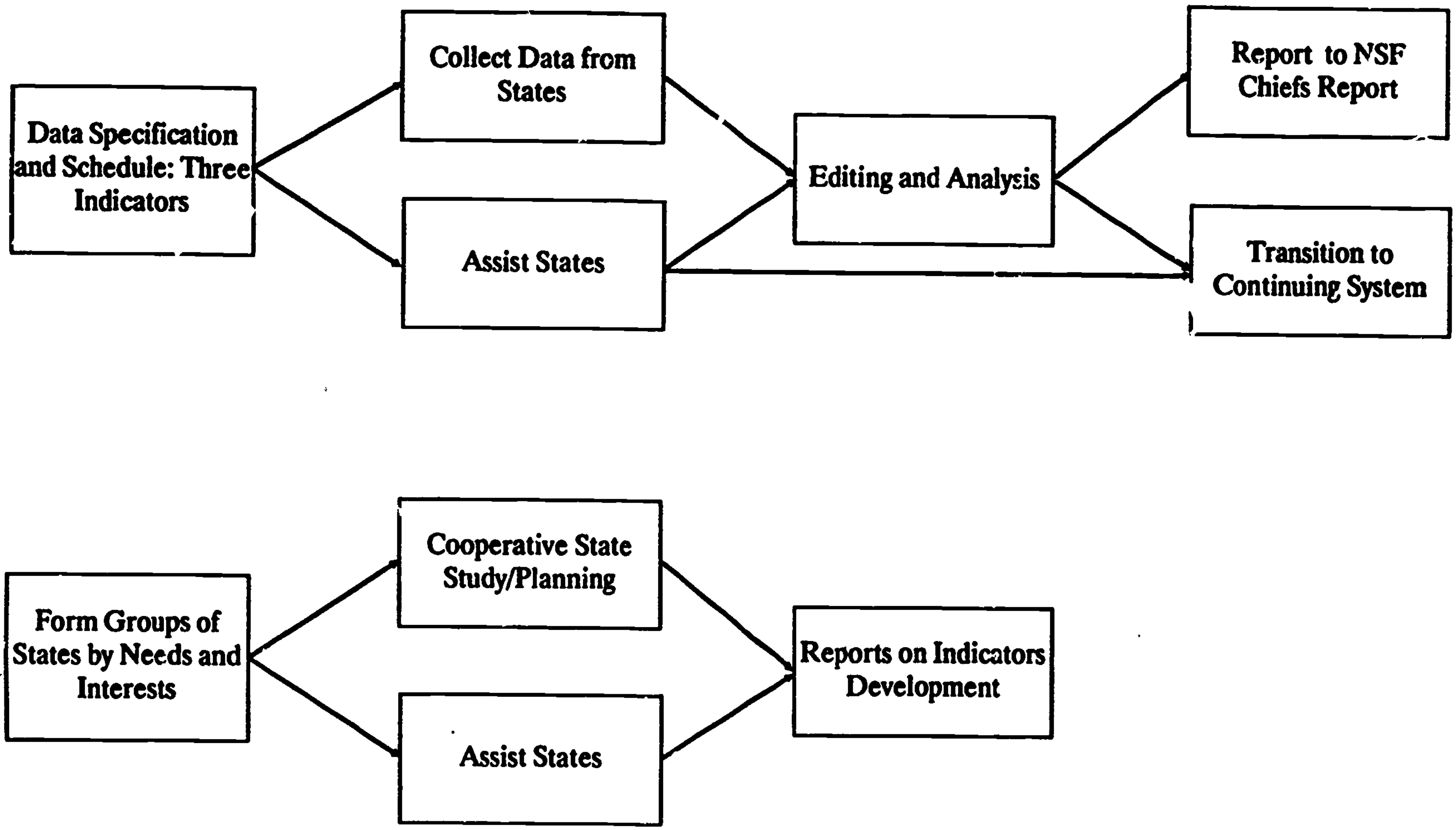


Figure 3

WHAT IS THE PROBLEM?

WHY EDUCATIONAL INDICATORS?

I. NATIONAL

- **ECONOMIC COMPETITION (INTERNATIONAL)**
- **SCIENCE/MATH LITERACY**
- **CAPACITY FOR MEASURING PROGRESS**
  - **OUTCOMES**
  - **PARTICIPATION**
- **RELATE TO POLICIES**

II. STATES

- **STATE POLICIES/REFORMS**
- **USEFUL STATE-TO-STATE COMPARISONS**
- **IDENTIFY/ANALYZE PROBLEMS**
- **PLANNING & ASSISTANCE**

Figure 4

Council of Chief State School Officers

PRIORITY STATE-BY-STATE INDICATORS OF SCIENCE & MATH*

INDICATOR	DATA SOURCE
Student Outcomes	
STUDENT ACHIEVEMENT	NAEP (1990)
STUDENT ATTITUDES/INTENTIONS	NAEP (1990)
Instructional Time/Enrollment	
GRADES 7-12 COURSE ENROLLMENT	State Data (CCSSO**)
ELEMENTARY MINUTES PER WEEK	Schools/Staffing Survey (CES, Spring 1988)
Curriculum Content	
STUDENTS' "OPPORTUNITY-TO-LEARN"	NAEP (1990)
School Conditions	
CLASS SIZE by Subject/Course	Schools/Staffing Survey and State Data (Available in some states, not currently requested by CCSSO)
NO. of COURSE PREPARATIONS PER TEACHER	
COURSE OFFERINGS PER SCHOOL	

* Science/Math Indicators Project, CCSSO State Education Assessment Center, February, 1988. Priority indicators were recommended by Project Task Force (September, 1987) and reviewed by CEIS (September, 1987) and CCSSO (November, 1987).

** To be reported to CCSSO on a state-by-state basis through the Science/Math Indicators Project.

INDICATOR	DATA SOURCE
Teachers	
COURSES/CREDITS IN SCIENCE/MATH	Schools/Staffing Survey (CES, Spring 1988)
TEACHING ASSIGNMENTS By Subject/Field By Age, Gender, Race/Ethnicity	State Data (CCSSO**)
TEACHING ASSIGNMENTS BY CERTIFICATION FIELD/SUBJECT (Number of Uncertified Teachers)	State Data (CCSSO**)
Equity	
GENDER AND RACE/ETHNICITY by Indicator	State Data (CCSSO**) (where available)

Figure 5

MATHEMATICS ASSESSMENT

THE FRAMEWORK

The mathematics assessment framework is organized by mathematical abilities and content areas. The mathematical abilities assessed are:

Conceptual Understanding
Procedural Knowledge
Problem Solving

Content is primarily from elementary and secondary school mathematics up to but not including calculus. The mathematics content areas assessed are:

Numbers and Operations
Measurement
Geometry
Data Analysis, Statistics, and Probability
Algebra and Functions

Framework for the Fifth Assessment

CONTENT AREAS

MATHEMATICAL ABILITIES	Numbers & Operations	Measurement	Geometry	Data Analysis Statistics & Probability	Algebra & Functions
Conceptual Understanding					
Procedural Knowledge					
Problem Solving					

Figure 6

TABLE 1: PERCENTAGE DISTRIBUTION OF EXERCISES BY GRADE AND MATHEMATICAL ABILITIES

Mathematical Abilities	Grade 4	Grade 8	Grade 12
Conceptual Understanding	40	40	40
Procedural Knowledge	30	30	30
Problem Solving	30	30	30

TABLE 2: PERCENTAGE DISTRIBUTION OF EXERCISES BY GRADE AND CONTENT AREA

Content	Grade 4	Grade 8	Grade 12
A. Numbers and Operations	45	30	10
B. Measurement	20	15	10
C. Geometry	15	20	25
D. Data Analysis, Statistics & Probability	10	15	20
E. Algebra & Functions	10	20	35

Figure 7

State Mathematics Proficiency For All Students And By Gender

(State) Grade 4

Scale	All Students '90	'92	Chg.	Female '90	'92	Chg.	Male '90	'92	Chg.
150	___	___	___	___	___	___	___	___	___
200	___	___	___	___	___	___	___	___	___
250	___	___	___	___	___	___	___	___	___
300	___	___	___	___	___	___	___	___	___
350	___	___	___	___	___	___	___	___	___
Average	___	___	___	___	___	___	___	___	___

GRADE 8
(The Same)

GRADE 12
(The Same)

Figure 8

State Mean Sub-Scale Score By Type Of Mathematics Question By Race/Ethnicity

(State) Grade 4

Ability	Black Students			Hispanic Students			White Students		
	'90	'92	Chg.	'90	'92	Chg.	'90	'92	Chg.
Conceptual Understanding	___	___	___	___	___	___	___	___	___
Procedural Knowledge	___	___	___	___	___	___	___	___	___
Problem Solving	___	___	___	___	___	___	___	___	___
Combined (# Items)	___	___	___	___	___	___	___	___	___

Topic	Black Students			Hispanic Students			White Students		
	'90	'92	Chg.	'90	'92	Chg.	'90	'92	Chg.
Numbers and Operations	___	___	___	___	___	___	___	___	___
Measurement	___	___	___	___	___	___	___	___	___
Geometry	___	___	___	___	___	___	___	___	___
Data Analysis Statistics & Probability	___	___	___	___	___	___	___	___	___
Algebra & Functions	___	___	___	___	___	___	___	___	___
Combined (# Items)	___	___	___	___	___	___	___	___	___

GRADE 8
(The Same)

GRADE 12
(The Same)

Figure 9

STATES RANKED ON COMPOSITE INDEX OF DEMOGRAPHIC VARIABLES

STATES	1986 Per Capita Income	1980 % Adults 4 yrs H.S.	1980 % School Age Pop. in Poverty	Achievement Grade 4 Proficiency Scales 150	200	250	300	350	Aver.
Alaska	17,796	82.5	11.0	—	—	—	—	—	—
Nevada	15,437	75.5	9.0	—	—	—	—	—	—
Connecticut	19,600	70.3	10.2	—	—	—	—	—	—
New Hampshire	15,911	72.3	8.7	—	—	—	—	—	—
Wyoming	12,781	77.9	7.4	—	—	—	—	—	—
Colorado	15,234	78.6	10.5	—	—	—	—	—	—
Washington	15,009	77.6	10.0	—	—	—	—	—	—
Minnesota	14,994	73.1	9.3	—	—	—	—	—	—
Massachusetts	17,772	72.2	12.1	—	—	—	—	—	—
Hawaii	14,886	73.8	11.4	—	—	—	—	—	—
Kansas	14,650	73.3	10.5	—	—	—	—	—	—
Oregon	13,328	75.6	10.4	—	—	—	—	—	—
California	16,904	73.5	13.8	—	—	—	—	—	—
New Jersey	18,626	67.4	13.2	—	—	—	—	—	—
Wisconsin	13,909	69.6	9.5	—	—	—	—	—	—
Maryland	16,864	67.4	11.6	—	—	—	—	—	—
Utah	10,981	80.0	9.6	—	—	—	—	—	—
Nebraska	13,742	73.4	11.4	—	—	—	—	—	—
Iowa	13,348	71.5	10.6	—	—	—	—	—	—
Michigan	14,775	68.0	12.2	—	—	—	—	—	—
Illinois	15,586	66.5	13.9	—	—	—	—	—	—
Delaware	15,010	68.6	14.4	—	—	—	—	—	—
Montana	11,803	74.4	12.5	—	—	—	—	—	—
Ohio	13,933	67.0	12.0	—	—	—	—	—	—
Vermont	13,348	71.0	12.7	—	—	—	—	—	—
New York	17,111	66.3	17.5	—	—	—	—	—	—
Indiana	13,136	66.4	10.8	—	—	—	—	—	—
Arizona	13,474	72.4	15.4	—	—	—	—	—	—
Virginia	15,408	62.4	14.1	—	—	—	—	—	—
Pennsylvania	14,249	64.7	13.0	—	—	—	—	—	—
Rhode Island	14,579	61.1	12.4	—	—	—	—	—	—
Idaho	11,223	73.7	13.1	—	—	—	—	—	—
Florida	14,646	66.7	17.2	—	—	—	—	—	—
Missouri	13,789	63.5	13.7	—	—	—	—	—	—
Maine	12,790	68.7	14.8	—	—	—	—	—	—
North Dakota	12,472	66.4	13.7	—	—	—	—	—	—
Oklahoma	12,283	66.0	14.7	—	—	—	—	—	—
Texas	13,478	62.6	18.1	—	—	—	—	—	—
South Dakota	11,814	67.9	19.0	—	—	—	—	—	—
New Mexico	11,422	68.9	21.2	—	—	—	—	—	—
Georgia	13,446	56.4	20.1	—	—	—	—	—	—
North Carolina	12,438	54.8	17.5	—	—	—	—	—	—

Figure 10

EDUCATION VARIABLES

- The number of mathematics courses the student has completed in high school. (Grade 12)
- The types of mathematics courses the student has completed or the advanced level courses the student has completed such as Algebra 2, Geometry, Statistics. (Grade 12)
- The amount of time the student spends on mathematics homework. (Grades 4, 8 & 12)
- The actual time (minutes per week) that students receive mathematics instruction. (Grades 4, 8 & 12)
- Whether students have had the opportunity to learn through class instruction specific topics within a process or content area of mathematics. Have certain topics been part of the scheduled and presented instructional program? (Grades 4, 8 & 12)
- Whether teachers of mathematics have a state certificate to teach mathematics. (Grades 4, 8 & 12)
- Years of experience teaching mathematics. (Grades 4, 8 & 12)
- Number of courses or credits teachers of mathematics classes received in college and graduate school in mathematics and in mathematics pedagogy. (Grades 4 & 8)
- Whether teachers of mathematics have college majors or minors in mathematics. (Grades 4, 8 & 12)
- The extent of the mathematics teachers' recent professional development in mathematics or mathematics education (graduate courses, inservice workshops, conferences, meetings, etc.). (Grades 4, 8 & 12)
- Per pupil expenditures.

The specific method of collecting data on the above variables is beyond the purview of this particular report. NAEP has access to technical experts on its staff and elsewhere to design the appropriate questions or methods to secure useful data.

Table 1

SECONDARY COURSE ENROLLMENT - SCIENCE

SOUTH CAROLINA
(1987-88)

Science Courses	Total Enrollment	Boys	Girls
Grades 7-8			
General Science	4,973	N/A	N/A
Life Science	44,848	N/A	N/A
Earth Science	44,851	N/A	N/A
Physical Science	579	N/A	N/A
Other Science, 7-8	541	N/A	N/A
Grades 9-12			
Biology, 1st Year			
Biology, 1st Year, General	47,282	23,736	23,546
Biology, 1st Year, Applied	—	—	—
Biology, 2nd Year, Advanced Placement	1,145	609	536
Biology, 2nd Year, Other Advanced	3,263	1,351	1,912
Chemistry, 1st Year			
Chemistry, 1st Year, General	18,774	8,805	9,969
Chemistry, 1st Year, Applied	—	—	—
Chemistry, 2nd Year, Advanced Placement	Not Offered *		
Chemistry, 2nd Year, Other Advanced	1,009	564	4[illegible]5
Physics, 1st Year	4,800	2,861	1,939
Physics, 1st Year, General	4,508	2,642	1,866
Physics, 1st Year, Applied	292	219	73
Physics, 2nd Year, Advanced Placement	Not Offered *		
Physics, 2nd Year, Other Advanced	—	—	—
Earth Science, 1st Year			
Earth Science, 1st Year, General	—	—	—
Earth Science, 1st Year, Applied			
General Science	15,878	8,939	6,939
Physical Science	33,250	16,791	16,459
Other Science, 9-12	2,526	1,465	1,061

* These courses were not offered during the 1987-88 school year.

Table 2

SECONDARY COURSE ENROLLMENT - MATHEMATICS

WISCONSIN (1987-88)

Mathematics Courses	Total Enrollment	Boys	Girls
Grades 7-8			
Math, Grade 7	50,608	25,778	24,830
Math, Grade 7, Accelerated (Pre-Algebra)	—	—	—
Math, Grade 8	50,577	25,906	24,671
Math Grade 8, Accelerated (Algebra 1)	5,035	2,420	2,615
Grades 9-12			
Review Math			
Level 1 (General, Remedial)	24,212	13,339	10,873
Level 2 (Consumer, Vocational, Applied)	18,735	10,011	8,724
Level 3 (General Math 3)	—	—	—
Level 4 (General Math 4)	—	—	—
Informal Math			
Level 1 (Pre-Algebra, Basic, Algebra 1(A)*)	18,530	9,473	9,057
Level 2 (Basic Geometry, Practical)	—	—	—
Level 3 (Basic Algebra 2)	—	—	—
Formal Math			
Level 1 (Algebra 1, Algebra 1(B)**)	59,164	29,741	29,423
Level 2 (Geometry, Plane, Solid)	45,092	22,000	23,092
Level 3 (Algebra 2, Intermediate)	28,541	14,073	14,468
Level 4 (Trigonometry, Advanced Math)	28.744	15,322	13,422
Level 5 (Calculus)	2,550	1,478	1,072
Level 5, Advanced Placement (Calculus)	—	—	—
Other Mathematics, 9-12	—	—	—
Computer Science Courses			
Grades 7-8			
Computer Science/Programming	11,725	6,079	5,646
Grades 9-12			
Computer Science/Programming I	31,906	18,135	13,771
Advanced Computer Science/Programming II	12,135	6,530	5,605

* First year of a two-year course sequence
** Second year of a two-year course sequence

Table 3

TEACHERS ASSIGNED 50% OR MORE BIOLOGY (GRADES 9-12) BY AGE, SEX, RACE/ETHNICITY

STATE	No. Teachers 50% or More Biology	Age		Sex		Race/Ethnicity				
		Under Age 30	Over Age 50	M	F	H	W	B	A	I
Alabama	589	43 (7%)	72 (12%)	226	363		468	117	2	2
South Carolina	431	76 (18%)	44 (10%)	168	263		332	99		
Pennsylvania (1986-87)	1,485	82 (6%)	6 (0.4%)	1,074	411	3	1,440	38	2	2
Kentucky	282	27 (10%)	47 (17%)	156	126	1	270	9	1	1
Wisconsin	829	43 (5%)	228 (28%)	698	131	3	816	8	1	1
North Dakota	68	5 (7%)	11 (16%)	58	10		68			
Arkansas	283	33 (12%)	35 (12%)	128	155		249	33		

Table 4

TEACHERS IN MATHEMATICS (GRADES 9-12) BY CERTIFICATION STATUS *

STATE	Total	Assigned 50% or More			Assigned Less than 50%		
		Total	Math Certified	Out of Field	Total	Math Certified	Out of Field
Alabama	1,580	1,216	1,190	26 (2%)	364	327	37 (10%)
South Carolina	1,933	1,625	1,500	125 (1%)	308	101	207 (67%)
Pennsylvania	5,522	5,353	5,281	72 (1%)	169	135	34 (20%)
Kentucky	1,719	1,404	1,353	51 (4%)	315	132	183 (58%)
North Dakota	472	292	292	0	180	180	0

* For 1988-89, data will be displayed with each state's certification requirements.