Using Data on Enacted Curriculum in Mathematics & Science

Sample Results from a Study of Classroom Practices and Subject Content

Summary Report
from
Survey of Enacted Curriculum Project

Completed by:

Council of Chief State School Officers
Wisconsin Center for Education Research
Eleven State Collaborative

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Summary Report
May 2000

Project Team

- Council of Chief State School Officers, State Education Assessment Center
- Wisconsin Center for Education Research at the University of Wisconsin, Madison
- State Collaborative: Iowa, Kentucky, Louisiana, Massachusetts, Minnesota, Missouri, North Carolina, Ohio, Pennsylvania, South Carolina, West Virginia

Project funding provided by a grant from the National Science Foundation (REC98-03080), and support from the collaborative states.

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About the Project Team

This report, *Using Data on Enacted Curriculum in Mathematics and Science*, summarizes some of the results from a two-year collaborative project to develop and test the use of Surveys of Enacted Curriculum for analyzing mathematics and science education taught in classrooms. The project was carried out by the work of many people and several organizations:

- **CCSSO:** As the lead organization, the Council of Chief State School Officers formed the study team, gained cooperation of states and support of the National Science Foundation, and managed the components of the study. CCSSO is responsible for the study products and future use and application of the materials developed in the project.
  Staff: Rolf K. Blank, project director; Linda Dager Wilson, mathematics consultant; Jennifer Manise, senior project associate; Barbara Brathwaite, Doreen Langesen, project assistants, and Cynthia Dardine, report layout.

- **WCER:** Wisconsin Center for Education Research led the design and development of the survey instruments and the alignment study. The Wisconsin Center also managed data input, editing, and analysis, and designed the reporting formats and use of software.
  Staff: Andrew Porter, WCER director and senior researcher; John Smithson, project manager; Molly Gordon, Eleanor Cameron, project assistants.

- **State Collaborative**: State education representatives from the 11 state partners worked on selecting schools and districts for study participation, provided followup for data collection, assisted in survey design and analysis, and recommended approaches to reporting study results.
  State Staff: *Iowa*: Tony Heiting, Matthew Ludwig; *Kentucky*: Ann Bartosh, Carol Hanley; *Louisiana*: Jennifer Falls, Gary Kratzer; *Massachusetts*: Anne Collins, Joyce Croce, David Perda; *Minnesota:* Ed Hessler, Sharon Stenglein; *Missouri*, Greg Steuwe-Portnoff, Walt Brown; *North Carolina*: Mike Kestner, Linda Patch; *Ohio:* Anne Mikesell, Stan Santilli; *Pennsylvania*: Robert Livingston; *South Carolina*: Lane Peeler, Linda Sincalir; *West Virginia*: Phyllis Barnhart, Larry Lamb.

- **National Science Foundation** (NSF): The survey instrument development, study design, and collection and analysis were supported by a grant from the NSF, Education and Human Resources Directorate, Division of Research, Evaluation and Communication (REC 98-03080). We appreciate the advice and encouragement of NSF/REC program officers, Bernice Anderson and Larry Suter.

Table of Contents

[Separate volume available from CCSSO]
Cross-State Analysis of Enacted Curriculum Data from 1999 Study (Fall, 2000)

List of Charts

Executive Summary

Last year, schools and teachers in 11 states participated in a study of the "enacted curriculum" in mathematics and science classrooms. Over 600 teachers across the states completed self-report surveys that covered the subject content they taught and the instructional practices they used in their classes. The goals of the study were to:

- Measure differences in instructional practices and curriculum content among teachers and schools,
- Determine if there are differences in math and science teaching that are related to state policy initiatives and state standards, and
- Demonstrate the use of "surveys of enacted curriculum" to analyze classroom practices and to produce useful analyses and reports for educators.

The study of enacted curriculum was a collaborative effort involving state education leaders in science and mathematics education, researchers from the Wisconsin Center for Education Research (WCER), and project managers from the Council of Chief State School Officers (CCSSO). Educators and researchers worked together to develop survey instruments that would gather reliable data from teachers and students, as well as formats for reporting survey results that would communicate key findings to educators. The project received core support from the National Science Foundation (NSF).

This summary report provides an overview of some of the findings from the study and examples of how the data on enacted curriculum can be reported and used. It is intended to help educators and decision-makers identify the kinds of information that would be available from the "surveys of enacted curriculum" and to suggest ideas and strategies for more expanded use of these kinds of surveys and data by educators at the school, district, and state levels.

Purposes for a Survey of Enacted Curriculum

The survey approach used in this study offers a practical research tool for collecting consistent data on mathematics and science teaching practices and curriculum based on teacher reports on what is taught in classrooms. The enacted curriculum data give states, districts, or schools an objective method of analyzing current classroom practices in relation to content standards and the goals of systemic initiatives. The methods of aggregating and reporting survey data allow educators to analyze differences in classroom practices and curriculum among teachers and schools with varying characteristics, and districts and states can analyze differences in classroom curriculum related to state initiatives or to the state or district standards in math and science.

The data are collected by teacher self-report with surveys designed for elementary, middle, or high school teachers. Teachers are asked to report on the range of practices and subject areas covered during the course of the school year and to provide information on the school, class, and their preparation and professional development for teaching.

Main Topics and Issues Reported

The major concepts underlying the Survey design are from state content standards, state initiatives in science and mathematics education, and prior research studies on classroom instructional practices and curriculum content. The Survey is intended to answer many of the key questions educators and policy-makers have about patterns of classroom curriculum and practice across classrooms, schools, districts, and states. The following outline of major concepts in our framework and sample summary findings from our 1999 study typify the kinds of issues and questions that can be explored with the Survey data.

1. **Active Learning in Science**

   Question: To what extent are students involved in active, hands-on learning approaches in science class?

   - Sample survey data suggest one-fourth of science class time is spent on hands-on science or laboratory activities, but there is wide variation among schools.
   - Survey data allow comparison of active science methods in schools that are involved in state *initiatives* and science teaching in typical schools.

2. **Problem Solving in Mathematics**

   Question: To what extent are students in math class learning problem-solving and reasoning skills, and learning how to apply knowledge to novel problems?

   - A majority of teachers report teaching problem solving in math, but teachers use a wide variety of instructional practices, such as small groups, writing, data analysis, and applying concepts to real world problems.
   - Differences are found in the types and depth of instruction of problem-solving activities between *initiative* and comparison schools.

3. **Mathematics and Science Content in Classrooms**

   Question: How does math and science content taught in classes compare to the goals outlined in state and national standards?

   - In middle grades math and science, most recommended standards are covered, but the level of expectation and depth of coverage vary widely among schools and classes.
   - Data reveal differences in extent of teaching science content across the standards and the extent of articulation between grades.
   - Schools differ in extent of emphasis on algebra, geometry, and data/statistics at elementary and middle grades.

4. **Multiple Assessment Strategies in Math and Science**

   Question: What methods of student assessment are used in class, and are the strategies consistent with goals of learning in content standards?

   - A majority of teachers use multiple assessment methods in math and science classes, but infrequently use extended student responses that require student explanation and justification of answers.
   - In science, the survey data allow analysis of differences in the use of performance tasks, or hands-on activities, for assessment in class.

5. **Use of Education Technology and Equipment**

   Question: How is education technology, e.g., calculators and computers, used in math and science instruction? Do teachers have science equipment available in their classes, and how often is it used?

   - A majority of elementary and middle grades teachers use calculators in teaching math; graphing calculators are available in the typical grade 8 classroom but are rarely used.
   - The average elementary classroom has basic science equipment, but rate of use varies widely among teachers.

6. **Influences on Curriculum and Practices**

   Question: What effect do state and national standards for science and math learning have on the curriculum taught in classrooms?

   - State frameworks/standards and national standards are reported by most teachers as strong positive influences on their curriculum.
   - Survey data allow comparisons of degree of influence on curriculum of state and national standards, textbooks, state and district tests, and teacher preparation and knowledge.

7. **Alignment of Content Taught with State Assessments**

   Question: Do state assessments reflect what is being taught in classes?

   - Analysis of teacher reports and state assessment items show that tests cover a narrower range of expectations for students than reported instruction, with tests focusing more on memorization, facts, and performing procedures and less on solving novel problems and applying skills and concepts.
   - The data on alignment between teacher reports on instruction/content and state assessments allow teachers and assessment staff to examine the areas of weakness and strength of tests and classroom practices.

8. **Teacher Preparation**

   Question: How well prepared are our teachers to teach science and mathematics?

   - The survey data show how well prepared teachers are for using innovative teaching strategies and handling students with varied needs and capacities.
   - Middle grades teachers in math and in science receive more professional development than elementary teachers both in methods of teaching and subject content. Teachers report very positive reactions to professional development related to standards, curriculum, and assessment in their recent activities.

Study Objectives and Design

The design for the Survey of Enacted Curriculum in mathematics and science conducted in 1999 came from earlier research and development projects of the Council of Chief State School Officers (CCSSO) and the Wisconsin Center for Education Research (WCER). CCSSO had worked with state education leaders in developing content standards and assessments in science and mathematics. WCER researchers had tested the validity and usefulness of a survey approach to collecting reliable, comparable data on classroom curriculum and practices.

The movement of states toward standards-based reform in mathematics and science produced strong interest in reliable data for evaluating the effects of reforms. CCSSO and WCER recognized the possibility of applying research-based models and instruments for studying curriculum to broader purposes of reporting indicators of curriculum and instruction that could be used by policymakers and educators. CCSSO submitted a proposal to the National Science Foundation (NSF) to lead a study of change in curriculum and instruction related to state standards and state initiatives for improvement of mathematics and science.

State Participation. States were asked to voluntarily participate in the study if they were interested in gaining information on effects of their reform efforts and gaining knowledge about the development and use of a survey approach to analyzing curriculum. In 1998, 11 states chose to participate, and state specialists in mathematics, science, assessment or evaluation were invited to join the study management team. The states chose a sample of 20 schools at each of two grade levels (e.g., elementary, middle) for the study. Half the schools selected had high involvement in their state's initiative for improving math or science education ("Initiative" schools), and the other half were schools with less involvement but were similar to the first group based on student demographics ("Comparison" schools).

Data Collection. The Survey of Enacted Curriculum is primarily conducted through teacher self-reports of classroom instruction over the course of a school year. Two teachers per grade level and subject were selected by the principal of each school. Basic information was collected about the schools, and a student survey was conducted in one-fourth of the classes for data validation. Ten of the 11 states chose to focus their school selection at the elementary and middle school level, and one at the middle and high school level.

The Survey for a specific grade level and subject includes more than 150 questions covering:

- Instructional Practices, including classroom activities, assessment, influences on curriculum, and use of technology and equipment;
- Subject Content, including curriculum topics taught by expectations for learning; and
- Teacher Characteristics, including teacher education, professional development, and teacher reports on school conditions.

Teachers completed the survey individually, and many used their own time outside of school. Teachers were guaranteed confidentiality, and the main incentive was to contribute to their state's study of reform initiatives in math and science education. At the same time, they were assured data would not be used for school accountability or teacher evaluation purposes. In Spring 1999, CCSSO obtained completed Surveys from a total of 604 teachers across the 11 states.

Examples of Data Reporting

Selection of schools and teachers for the study in each of the 11 participating states was based on the degree of school involvement in the state math or science reform initiative. The collected data from the sample schools present sufficient numbers of responses to provide meaningful statistics, such as mean and standard deviation, and the numbers allow analysis of the significance of reported differences related to curriculum and instructional practices in "Initiative" vs. "Comparison" schools. The results from the 1999 Survey reported in the following charts are not nationally representative, nor are they representative of all mathematics and science teaching in schools in the 11 states.

The data presented in this report are primarily intended to demonstrate to educators and policymakers the kinds of analyses and reporting that are possible with the Survey of Enacted Curriculum. That is, the kinds of summary data and charts displayed in this report can be produced for an educational system should a state, district, or school conduct the Survey with all their teachers or with a randomly selected, representative sample of teachers. The kinds of results reported for the 1999 sample of teachers and schools in this summary report effectively illustrate the potential of the how the Survey of Enacted Curriculum could be used for future applications.

Selected Data Charts. Keeping in mind the uses of our study and the limitations of the data, we present sample data charts from the 1999 Survey focusing on eight concepts that are central for analyzing differences in classroom curriculum and for studying effects of state initiatives and standards:

- **Active Learning in Science**
- **Problem Solving and Reasoning in Mathematics**
- **Mathematics and Science Content Being Taught**
- **Multiple Assessment Strategies**
- **Uses of Educational Technology and Lab Equipment**
- **Influences on Curriculum and Practices**
- **Alignment of Content Taught with State Assessments**
- **Teacher Preparation**

These sample charts include only a portion of the data from the Survey of Enacted Curriculum and represent only a sample of what can be done with the results. We hope these sample results stimulate the interest and curiosity of educators to either look further at the 1999 Survey results or to conduct their own Survey using this model. Data from the 1999 study are available by state and aggregation across the 11 states. Educators who want to try their own application and use of the Survey tools in their state, district, or school can obtain them by contacting CCSSO.

Reporting Format. The Survey results are reported and analyzed using several formats: Item Profiles, Summary Scales, and Content Maps and Graphs.

Item Profiles present data from individual survey questions, grouped by topic and item format (see middle of Chart 1). The data are shown in horizontal bar graphs. The mean is indicated by a solid vertical line, and the shaded bar represents responses that are one standard deviation above the mean and one standard deviation below the mean. Generally the responses at the mean and within the bar represent about two-thirds of all responses to a question. The number of teacher responses per group (e.g., middle, elementary) is reported in parentheses. (e.g., 104).

Summary Scale is an average score for a group of 5 to 8 questions in the survey centered on a specific concept underlying curriculum or instruction, e.g., active learning in science (see top of Chart 1). Scales are formed by purposeful selection of items, and statistical analysis of responses to determine scale reliability (e.g., .78 for scale in Chart 1). The selected scale items typically cut across different sections of the survey, and items may have different kinds of responses. The scale measures are "standardized scores," meaning the average score for the scale for the whole group of teachers is set equal to 0, and the standard deviation (a measure of variation in responses) for the whole group is 1. Scale score differences would mean that sub-groups of teachers, e.g., elementary vs. middle school teachers, differ on the concept being measured.

Content Maps and Graphs. Teachers report time spent on subject content during the year using a content matrix covering topics and expectations for learning. Responses of teachers are aggregated by grade level and reported with two statistical software programs: a mapping program which gives a three-dimensional picture of variation in time across the whole curriculum (see Chart 3), and histograms, which show average percent time by topic and expectation (see Chart 4).

The Analysis Guide (following Examples) provides Survey sample items and a section of the content matrix as well as further explanation of how statistics are generated from survey data and reported in these formats.

Active Learning in Science

Chart 1 displays data from the science teacher survey results across the 11 participating states in the 1999 Survey of Enacted Curriculum. Data related to Active Learning in Science are reported in two ways: a Summary Scale that combines the data from eight survey items, and individual Item Profile graphs for seven items. The Scale provides a reliable summary measure of differences across the teacher sample in Active Learning and the degree of variation among teachers. We display individual item results to allow readers to see the relative amounts of class time spent on classroom practices related to active science learning.

Active Learning is one of the central concepts in state and national standards for student learning in science that underlies the Survey and the study of state initiatives. The data in Chart 1 are intended to illustrate how the Survey of Enacted Curriculum can be used to analyze the extent of active science learning, and the kinds of classroom practices being used. We can also analyze differences in active learning strategies across the whole sample and differences between Initiative and Comparison schools. Several examples of Survey results are demonstrated:

- *Percent of Time*. The first set of item profiles, in the middle of the chart, show the percent of science class time that are reported spent on three kinds of active learning: a) collecting information, b) doing lab activities or investigations, and c) students working in groups. Teachers reported in our 1999 Survey that from 10% to 15 % of time in science class was spent on each of these activities. In the left column we see there is wide variation among classes in use of active learning practices at both elementary and middle grades--varying from 5% of time to over 18%. This amount of variation is equivalent to each type of activity varying from once per month to once per week.
- *Summary Scale*. Both the summary scale on active learning, at the top, and the item profiles indicate that elementary classes spend more time on active learning in science than middle grades classes. The second and third columns on the scale results indicate that science classes in Initiative schools spent significantly more time on lab activities and investigations than classes in Comparison schools.
- *Experiments/Investigations*. In the bottom part of Chart 1, more detailed information is presented on what students do during experiments or investigations. The Survey included eight items--with four results highlighted in the chart. In a typical classroom experiment or investigation, students would be expected to be engaged in a number of these activities in combination or sequence. Thus, it is useful to examine groups of activities with similar time. One can note that three activities are conducted more often: "use science equipment," "follow step-by-step directions," and "make tables, graphs or charts." Students spend less time "changing something in an experiment to see what happens." One can also note in column two and three that the elementary and middle grades classes in Initiative schools had significantly greater use of science equipment/tools in experiments or investigations.
- *Further Survey Data*. In the Appendix, we report results on "Use of class time during the most recent science instructional unit," where teachers allocated time by major activities. For example, the average teacher reported one-quarter of science class time was used for hands-on activities, investigations or experiments. Teachers in Initiative schools reported significantly more time on active learning in science than those in Comparison schools.

Chart 1
Active Learning in Science

* Item included in Summary Scale

Source: CCSSO/WCER, Survey of Enacted Curriculum, 1999

Reasoning and Problem Solving in Mathematics

Both reasoning and problem solving were curriculum standards for K-12 math education set out in the NCTM *Mathematics Standards* (1989), and this learning goal is found in the state standards for the states involved with the study (Blank, et al., 1997). Key questions related to this standard are: "How much instructional time do teachers spend on this goal?" "What do teachers mean when they use the term 'problem solving'?" The results in Chart 2 illustrate how Survey data can be used to answer such questions.

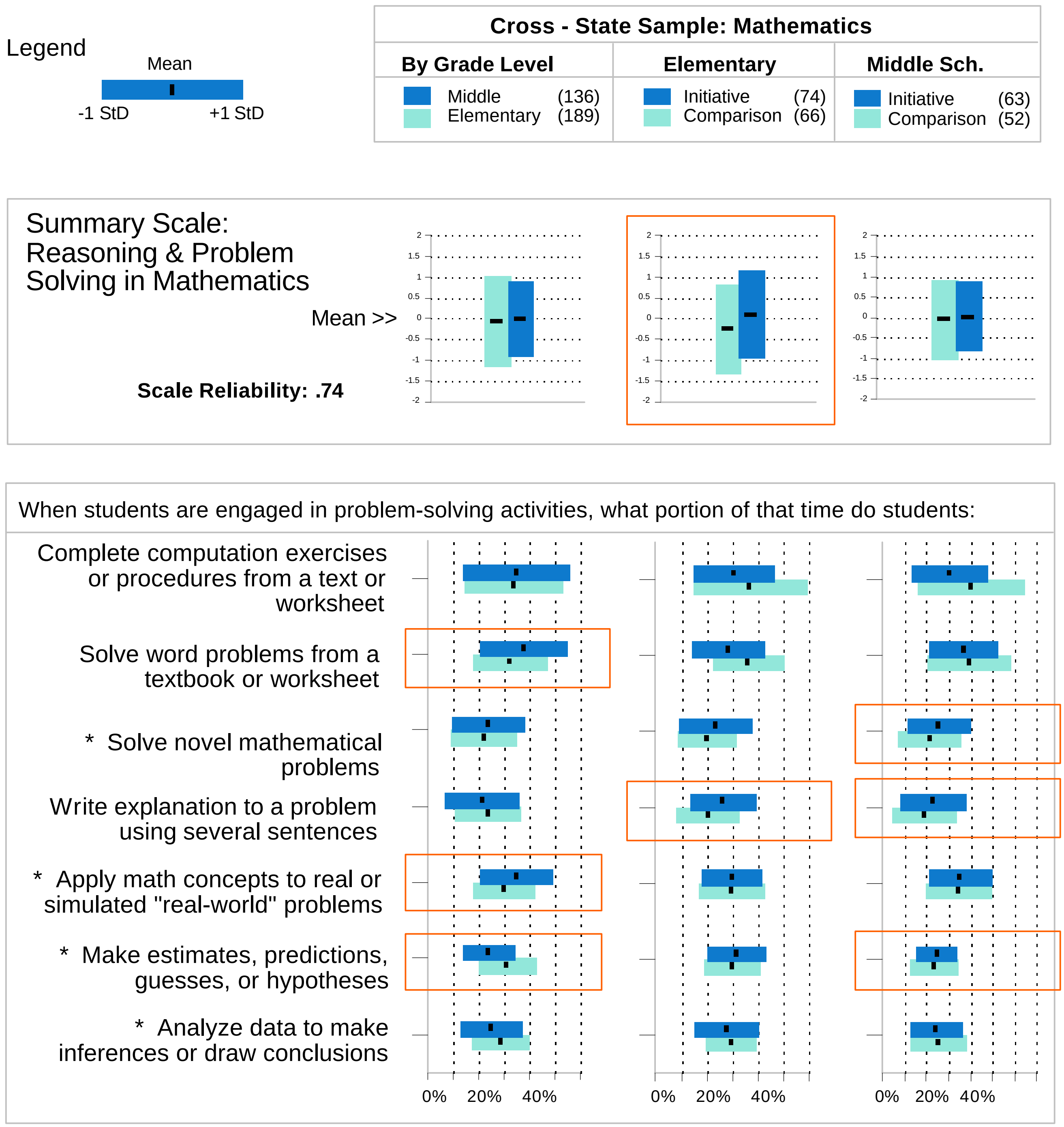
Summary Scale. The scale on reasoning and problem solving, displayed at the top of the Chart, is comprised of seven Survey items that, taken together, provide a reliable index of the degree to which teachers are focusing math instruction on improving students' reasoning and problem solving skills and knowledge. (The average teacher scale score is set at 0 using a statistical procedure.)

- The scale results show there is wide variation in time focused on mathematical reasoning and problem-solving activities.
- There is little difference in overall results for middle and elementary math classes, but there are significantly higher scores for Initiative elementary math classes than for Comparison classes. This finding indicates that elementary mathematics teachers in schools participating in one of the state reform initiatives spent significantly more time on reasoning and problem solving activities.

Item Profiles. When interpreting the results from questions on mathematical reasoning and problem solving, it is important to know how teachers interpret the term "problem solving." For example, do they mean completing exercises in a text or solving novel problems (those for which students have no ready procedure)? The second section of the chart identifies these distinctions. For example:

- An average of 30% of time in elementary and middle grades math in "problem solving activities" is spent on computational exercises from texts or worksheets. Over one-fourth of time in middle school math is spent on word problems from texts or worksheets. There is wide variation in time on these activities--from under 20% to over 50%.
- Middle grades classes spend significantly more time on applying math concepts to real-world problems, while elementary classes spend significantly more time on making estimates or predictions.
- The math classes in Initiative schools spend less time on computation exercises or word problems from texts than classes in Comparison schools (about 10% less time for each). In Initiative schools, there is significantly more time spent on writing explanations at elementary and middle grades. Significantly more time is spent in Initiative schools on solving novel problems in middle grades math.

Chart 2
Reasoning and Problem Solving in Mathematics



* Item included in Summary Scale

Source: CCSSO/WCER, Survey of Enacted Curriculum, 1999

Indicates statistically significant mean differences.

Mathematics and Science Content Being Taught

The Survey of Enacted Curriculum incorporates an innovative approach to data collection on subject content taught in class. Teachers are asked to report the amount of time spent on content in mathematics or science using a "subject content matrix." The two dimensions of the matrix are *content topics* and *expectations for students*. Teachers first identify the major math or science standards covered in class, then amount of time spent teaching specific topics, and then report the expectations they had for student learning (e.g., memorize, use procedures, analyze information). Teachers report subject content taught over one school year. (See the Reference Guide section for explanation of content matrix.)

The main advantages of content matrix design for data collection on content taught is its consistency with standards-based learning, as described in national professional standards (NCTM, 1989; AAAS, 1993; NRC, 1995) and most state standards. In our approach, curriculum is viewed as a combination of the math or science disciplinary knowledge to be learned (e.g., geometry) and the skills and capacities that students are expected to gain through instruction (e.g., solve real-world problems). Content responses from teachers were aggregated across the 11 states by teacher grade level (elementary, middle) and by Initiative vs. Comparison schools.

Science Content

Chart 3 presents a Cross-State Sample "content map"--a three-dimensional map of topics by expectations by time--that reflects the 1999 Survey results from elementary science teachers. Chart 4 presents a Cross-State Sample "content graph" that reflects the same data. Most of the reporting elementary teachers were at grade 4 with some at grade 3 and grade 5.

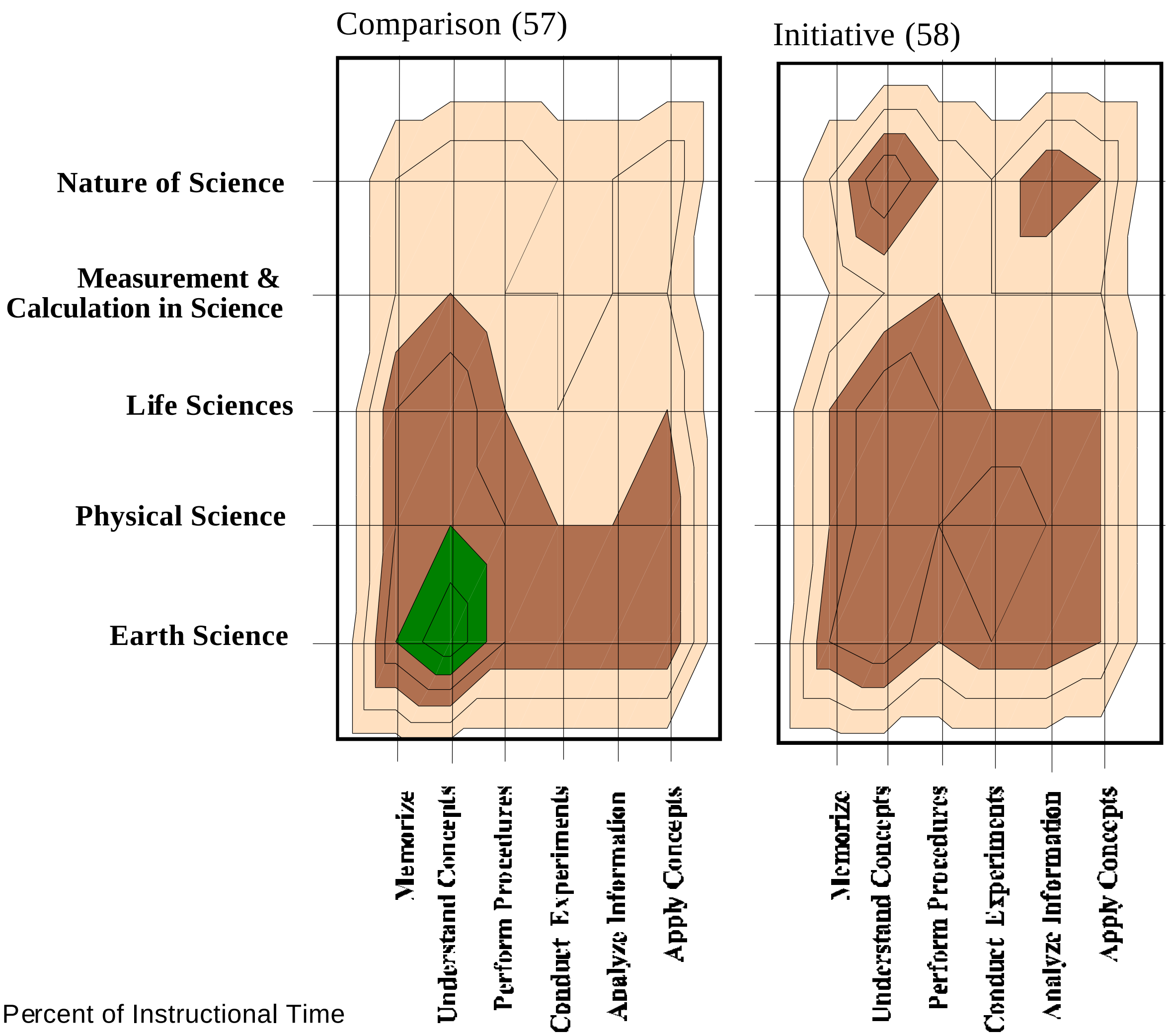
- Life Science, Physical Science, and Earth Science were reported by teachers as taught from 20 to 30% of time on average. Measurement and Calculation in science averaged 12% of time. The aggregate category "Nature of Science" averaged nearly 20% of time--this category includes teaching scientific method, history of science, science and technology, and science-health-environment. The most striking aspect of data on science topics is the wide variation in time spent in each category, especially among Initiative schools.
- All six expectations for science learning were reported an average of 15% of time, except Understand Concepts which averaged over 20%. In science, Memorize means learning facts, definitions, terms, and formulas. Understand Concepts means student explanations, observe and explain teacher demonstrations, explain methods of science, and display data--with time varying from 10% to 35% of time among Comparison schools.
- Teachers in Initiative schools reported slightly more time spent on Nature of Science than teachers in Comparison schools. Initiative classes had higher expectations for Analyzing Information about Nature of Science and Understanding Concepts, and slightly higher expectations for Conducting Experiments than did Comparison classes.

Mathematics Content

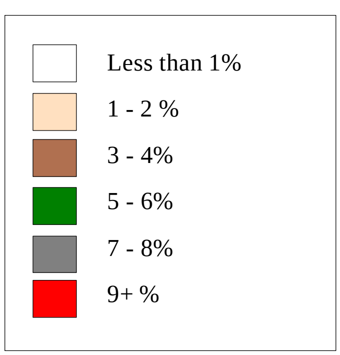
Chart 5 presents a Cross-State Sample "content map" for middle grades mathematics; Chart 6 presents a Cross-State Sample "content graph" for the same data. Across the states, all the middle level math teachers were teaching grade 8 and reported on grade 8 math teaching. The content maps reflect patterns of responses from teachers in Initiative and Comparison schools and identify the intersection of content topic by expectation for student learning. In the content graphs, each cell has bars representing average percent time for Comparison vs. Initiative teachers, and the row and column marginals indicate the mean and range of responses for each topic area (e.g., number sense) and type of expectation (e.g., memorize).

- Middle level (grade 8) math teachers reported that the most time was spent on Number Sense (average 25% time) and Algebraic Concepts (average 30% time). Geometric Concepts was reported taught less (average 15%), Measurement and Data Analysis/Statistics were taught an average of 12 percent of time. Our further analyses of the content matrix data (not shown) indicate that the specific topics reported most often under Number Sense were fractions, decimals, percent, and ratio and proportions, and the highest topics in Algebra were use of variables and multi-step equations.
- Teaching of Algebra and Geometry is highly varied among teachers/classes. Time reported on teaching Algebraic Concepts varied from 18 to 40 percent of time across classes in both Initiative and Comparison schools. Time on Geometry varied from 6 to 22 percent across classes in both groups of schools.
- Expectations for learning as reported by teachers focused heavily on Understand Concepts and Perform Procedures (over 20% each). Expectations by teachers that students Analyze/ Reason and Memorize were slightly less (15% each), and Integrate Concepts and Solve Novel Problems were expected the least time. Understand Concepts refers to students' ability to represent a concept, apply it to a problem, or explain its use. Perform Procedures means using numbers for counting or ordering, doing computation, or solving equations. Solve Novel Problems means doing non-routine problems or those for which the student has no routine strategy or algorithm.
- Middle level teachers in Initiative schools did not report significantly different distributions of time than did Comparison school teachers on any of the five broad subject areas. One can observe small differences in the topic/expectations intersections. Teachers in Initiative focused slightly more on Solve Novel problems and Integrate when teaching Number sense than did Comparison teachers. Teachers in Comparison schools focused slightly more time on Analyze/Reason when teaching Algebraic concepts, but also had wider variation in expectation for Analyze/Reason. Initiative teachers placed slightly more time on the expectation of Integrating concepts.

Chart 3
Elementary School Science Content Map
Cross-State Sample



Percent of Instructional Time



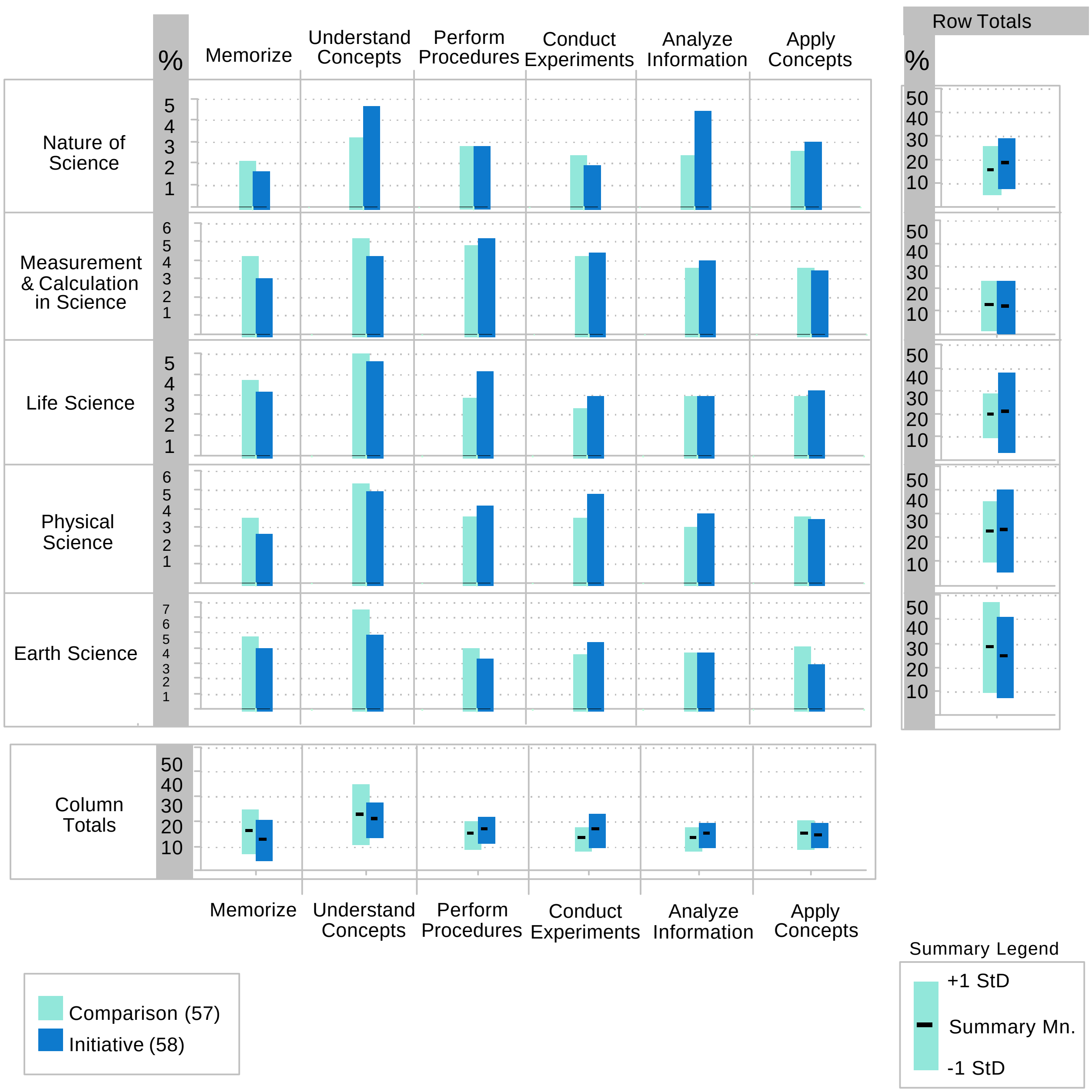
Measurement Interval = 1%

Alignment between Initiative and Comparative Teacher Reports of Practice:

By Topic Coverage	.85
By Expectations	.94
Topic by Expectations	.81

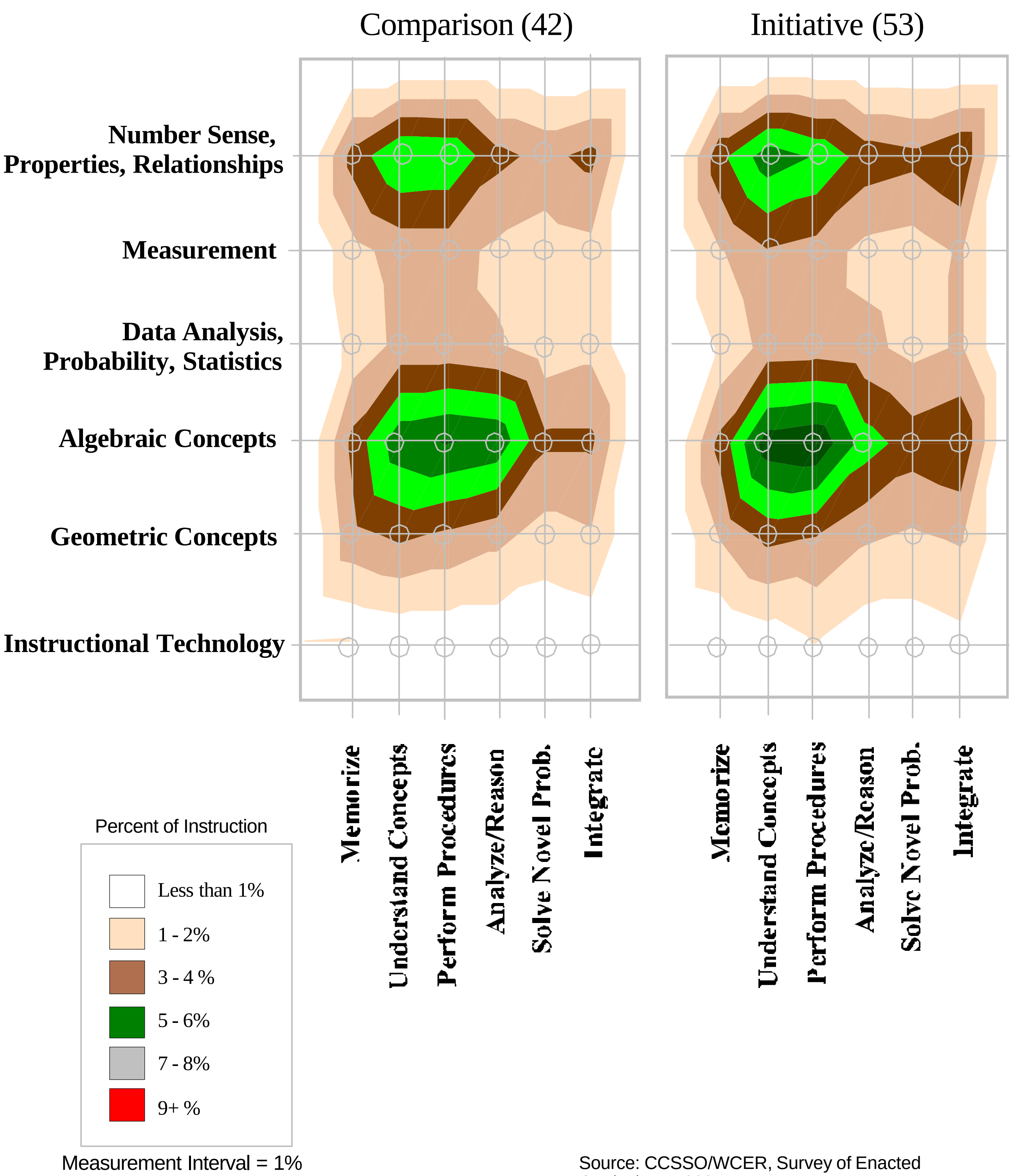
Source: CCSSO/WCER, Survey of Enacted Curriculum, 1999

Chart 4
Elementary School Science Content Graphs
Cross-State Sample



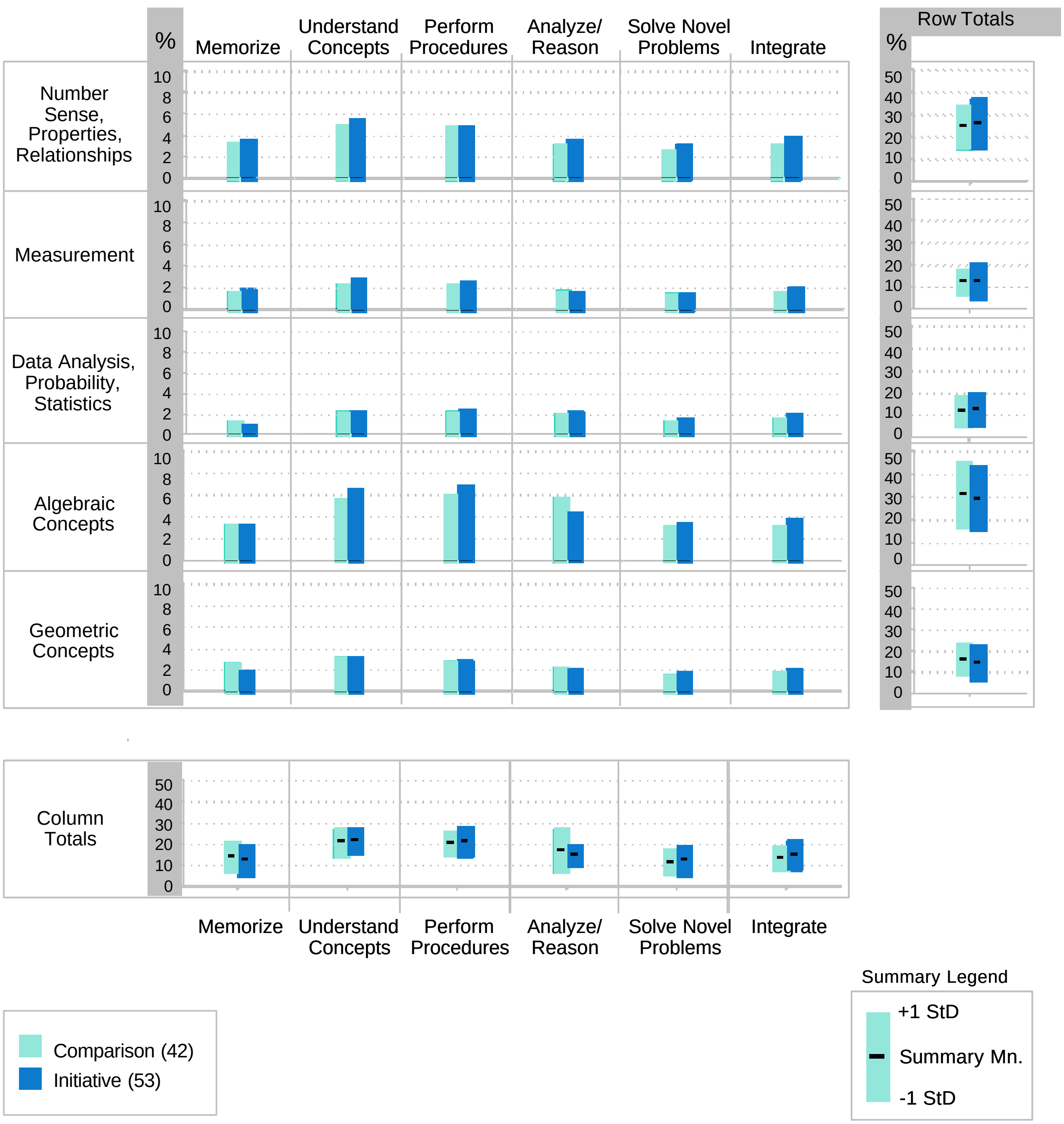
Source: CCSSO/WCER, Survey of Enacted Curriculum, 1999

Chart 5
Middle School Mathematics Content Map
Cross-State Sample



Source: CCSSO/WCER, Survey of Enacted Curriculum, 1999

Chart 6
Middle School Mathematics Content Graphs
Cross-State Sample



Source: CCSSO/WCER, Survey of Enacted Curriculum, 1999

Multiple Assessment Strategies in Math and Science

Mathematics and science teachers are being encouraged to make use of a variety of assessment strategies, rather than relying on a single type of assessment, such as paper-and-pencil tests comprised of objective items or routine procedural problems. The purpose of varied assessment strategies is, in part, to increase the validity of the inferences that teachers can make about student learning. Using multiple sources of evidence allows the strengths in one type of assessment to compensate for weaknesses in another. But to what extent are mathematics and science teachers moving beyond a reliance on a single type of assessment, and what other strategies are they using? The results in Chart 7 illustrate how Survey data can be used to find out.

The *Summary Scale* on Multiple Assessment Strategies in science is based on several Survey items. Together these items provide a reliable index of the degree to which science teachers are using multiple assessment strategies in the classroom. (The average teacher scale score is set at 0 using a statistical procedure.)

- The results show wide variation, with the greatest variation amongst middle school teachers from Initiative schools. That is, some of the middle school science teachers in Initiative schools appear to use greater variety in their assessment strategies than their counterparts in the Comparison schools.

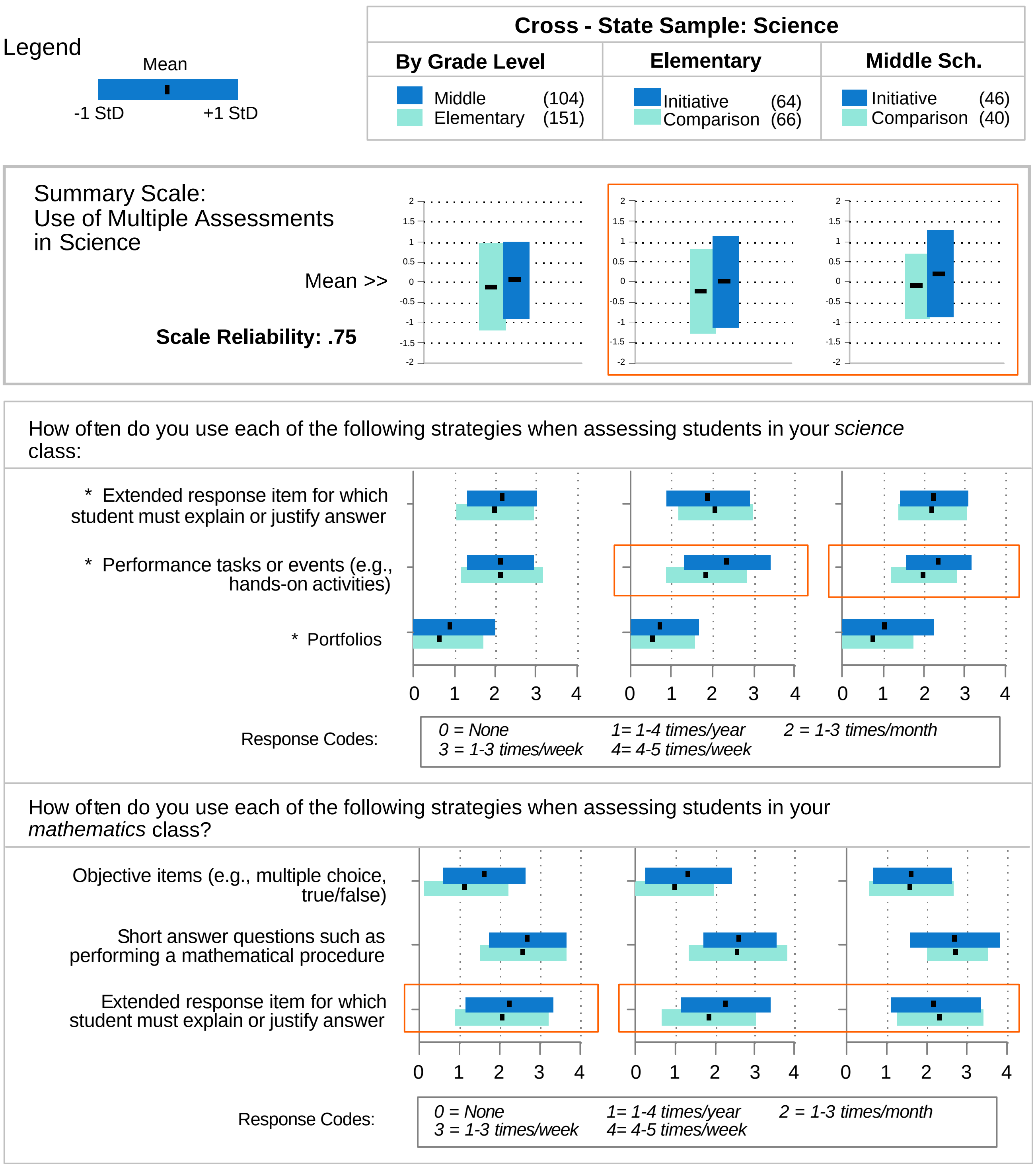
Science Item Profiles. The responses from science teachers on use of a variety of assessment strategies are displayed in the middle section of the chart and reveal useful results:

- *Portfolios*. First, we note significant differences in the use of the reported strategies in science and wide variation in the use of *portfolios*. Some teachers are not using portfolios at all, while some middle school science teachers are using portfolios in assessment 1 to 3 times per month.
- *Performance tasks* are used to a significantly greater degree by Initiative teachers than Comparison teachers at the elementary and the middle grade levels.
- *Extended response*. Teachers report that students are asked to write explanations for answers, on average, about 1 to 3 times per month.

Mathematics Item Profiles. The responses from math teachers on several of the assessment questions are displayed in the third section of the chart:

- *Short answer.* The most common assessment of student knowledge in class is short answer questions, such as asking students to perform a mathematical procedure. Students are given this type of assessment, on average, once a week. This is evident across grade levels and with both Initiative and Comparison schools.
- *Extended response*. Middle grades teachers are significantly more likely than elementary teachers to ask students to explain or justify their answers (1-3 times/month). There is relatively little use of objective items for mathematics assessment, especially in elementary classrooms where the average is a few times per year.

Chart 7
Multiple Assessment Strategies in Math and Science



* Item included in Summary Scale

Source: CCSSO/WCER, Survey of Enacted Curriculum, 1999

Indicates statistically significant mean differences.

Use of Educational Technology and Equipment

An important indicator of active, inquiry-based methods of teaching science and math, as well as school system capacity for supporting this approach, is the availability and use of educational technology and laboratory equipment. Science and mathematics standards advocate learning to apply knowledge to real problems and to gain skills that will be used outside of school. Science and mathematics applications in careers now involve computers, calculators, and a variety of simple and complex lab equipment. Thus, a key component of the Survey of Enacted Curriculum concerns the use of equipment and technology in teaching science and math. Chart 8 illustrates how the data can be reported to examine several kinds of questions concerning availability and instructional uses.

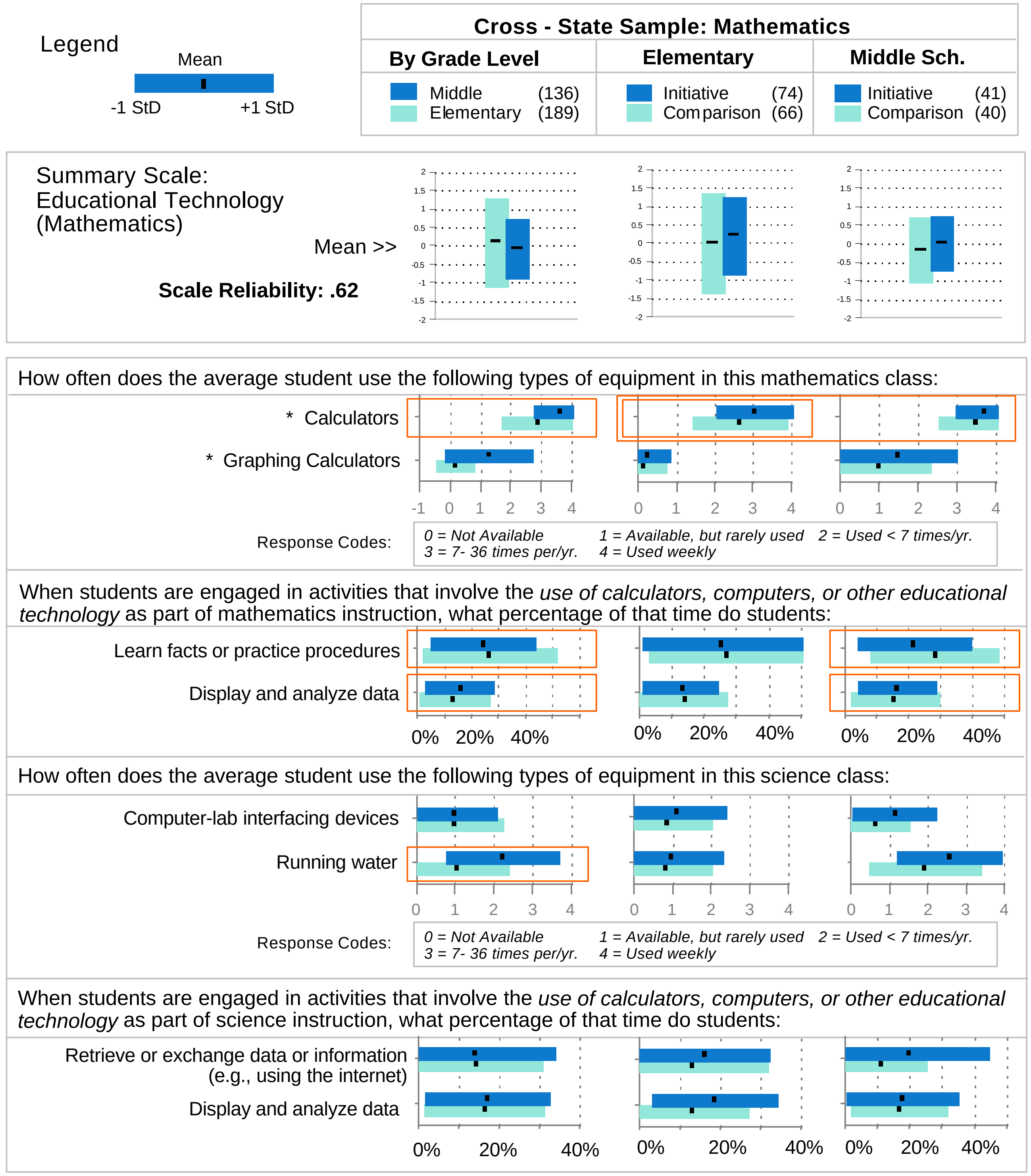
Use of Technology. The *Summary Scale* at the top of Chart 8 includes six items that ask teachers to report the extent of calculator and computer use in class and how they are applied in instruction. The scale shows wide variation among math classrooms. Elementary grades use of technology is much more varied than middle grades. At both grade levels, Comparison schools have slightly lower scores on the summary scale and more variation among classrooms.

- *Calculator use*. Teacher reports on student use of calculators indicate that middle grades consistently use them at least weekly, while elementary classes vary from less than monthly to weekly. Graphing calculator use varies widely: about one-third of middle grades classes do not have them, and the average class rarely uses them. Initiative school classes use graphing calculators more often than Comparison classes.
- *Instructional applications*. The Survey data show that educational technology's most frequent uses in math instruction are Learning Facts or Practicing Procedures (average 25%) and Displaying/Analyzing Data (18%). In science classes, calculators and computers are often used for Retrieving Information or Displaying/Analyzing Data (both 18% avg.). However, these uses vary widely, from 0% o 40% of time, showing that teachers make very different or no use of educational technology.

Equipment in Science. We highlight two uses of science equipment in classrooms:

- Running water (a traditional indicator of lab capacity) is not available in about one-third of elementary classes and rarely used in the average elementary class. The average middle grade science class uses running water less than monthly, although classes in Initiative schools average monthly to weekly use.
- Recently, "high-tech" approaches to experimentation in classrooms involve computer-lab interfacing devices, often called computer-based labs (CBLs). The sample data in the study indicate that one-third of classes did not have CBLs available, while the average class had access but rarely used them. About one-third of middle grades classes used them several times per year.

Chart 8
Use of Educational Technology and Equipment



* Item included in Summary Scale

Indicates statistically significant mean differences.

Source: CCSSO/WCER, Survey of Enacted Curriculum, 1999

Influences on Curriculum and Practices

The Survey includes questions for teachers aimed at the main influences on their classroom curriculum. In some schools, textbooks and materials that are selected by districts, states, or schools may be a major influence on what is taught. Many states and districts have established standards for student learning in mathematics and science, and these standards have been guided or influenced by national standards developed and published by professional organizations (NCTM, AAAS, NRC). Even where widely disseminated and used by teachers, standards do not provide curricula for teaching in classrooms. Teachers may rely on their own knowledge and experience, their colleagues, or mandated assessment programs to determine what is taught. The question of influences on curriculum is important for analyzing commonalities in curriculum and for determining how change and improvements can be made in science and math education.

Chart 9 provides Cross-State Sample results for mathematics and science as reported by teachers in the 1999 Survey concerning major influences on their curriculum and teaching practices.

- *Influences on Mathematics.* The item profiles (in the middle section) indicate that the most consistent positive influences reported by teachers were state frameworks/standards and textbooks/materials. State tests and national standards had slightly less influence on average, and there was greater response variation concerning state tests, with a significant portion reporting a negative influence. Teachers in Initiative schools had a more positive response regarding influence of state tests, and Initiative teachers had a significantly more positive response to national mathematics standards.
- *Influences on Science.* The item profiles indicate that state frameworks/standards and textbooks/materials were reported by teachers as consistently positive influences, with state tests and national standards slightly less important. At the middle grades level, state science frameworks and state tests were a greater influence on teacher curriculum in Comparison schools than in Initiative schools.
- *Summary Scale results for influences on mathematics* indicate wide variation in the influence of state and national math education standards on classroom curriculum. Middle school mathematics is influenced slightly less than elementary curriculum by standards, and elementary curriculum in Initiative schools receives a slightly stronger positive influence from standards than curriculum in Comparison schools.

Chart 9
Influences on Curriculum and Practices

* Item included in Summary Scale

Indicates statistically significant mean differences.

Source: CCSSO/WCER, Survey of Enacted Curriculum, 1999

Alignment of Content Taught with State Assessments

The content matrix portion of the Survey of Enacted Curriculum provides a useful analysis function beyond simply reporting curriculum content taught. Eight states participating in the Study of State Initiatives volunteered to conduct an analysis of their state assessments in mathematics and science in relation to the content matrix. The results of the assessment analysis provide data for conducting correlational analyses of the teacher-reported class content and the content covered by the state assessment for the same grade and subject. (See the Reference Guide for a sample page from the content matrix section of the Survey.)

The assessment analysis was conducted by teams of experts, generally 4 to 5 people per assessment subject/grade. The experts included state math and science specialists and university-based mathematicians, scientists and educators of these subjects. The teams to conduct the analyses were chosen by CCSSO and WCER. The analysis teams were trained in coding procedures and developed a common set of rules and criteria for judging items for placement in the content matrix by topic and expectation. The same criteria and procedures were used in an analysis and coding of items from the 1996 National Assessment of Educational Progress (NAEP) in Mathematics and Science.

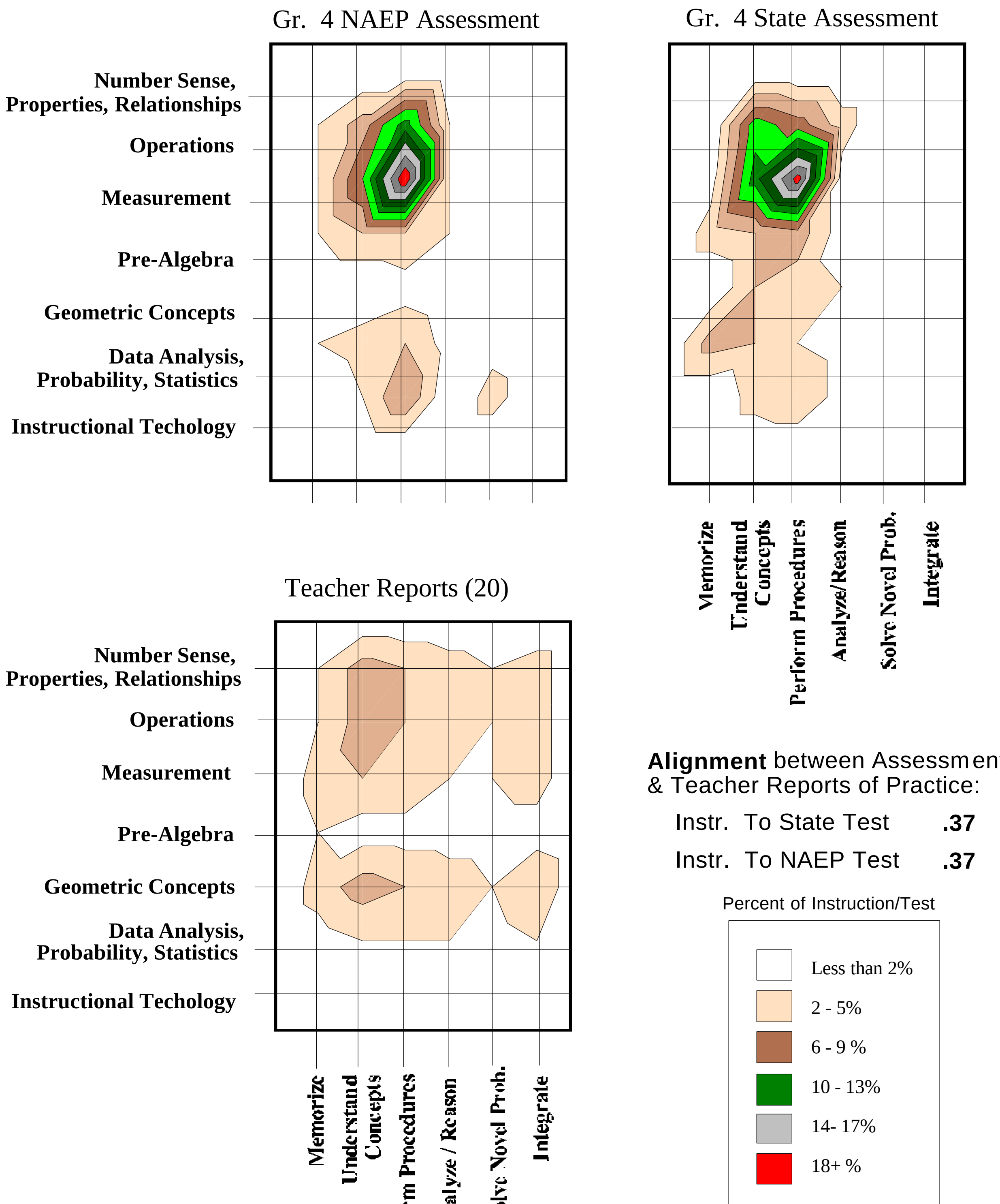
Mathematics Alignment. Chart 10 shows the alignment analysis for one state (not identified) in grade 4 mathematics, including the teacher-reported data on content taught, the analysis of state assessment items, and the same analysis of NAEP assessment items for grade 4.

- The state assessment and NAEP assessment focused strongly on Operations, Number Sense, and Performing Procedures. Teacher reports of content taught show greater distribution to content topics and expectations than the coding of the test items. Teachers indicated that some time was spent on all six expectations across Number Sense, Operations, Measurement and Geometric Concepts. The alignment statistic of .37 means that less than half the intersections of content topics by expectations reported by teachers were in common with the assessment items found on the state mathematics test and on the NAEP test.

Science Alignment. Chart 11 shows the alignment analysis for one state (not identified) in grade 8 science, including the teacher-reported data on content taught, the analysis of state assessment items, and the same analysis of NAEP assessment items for grade 8.

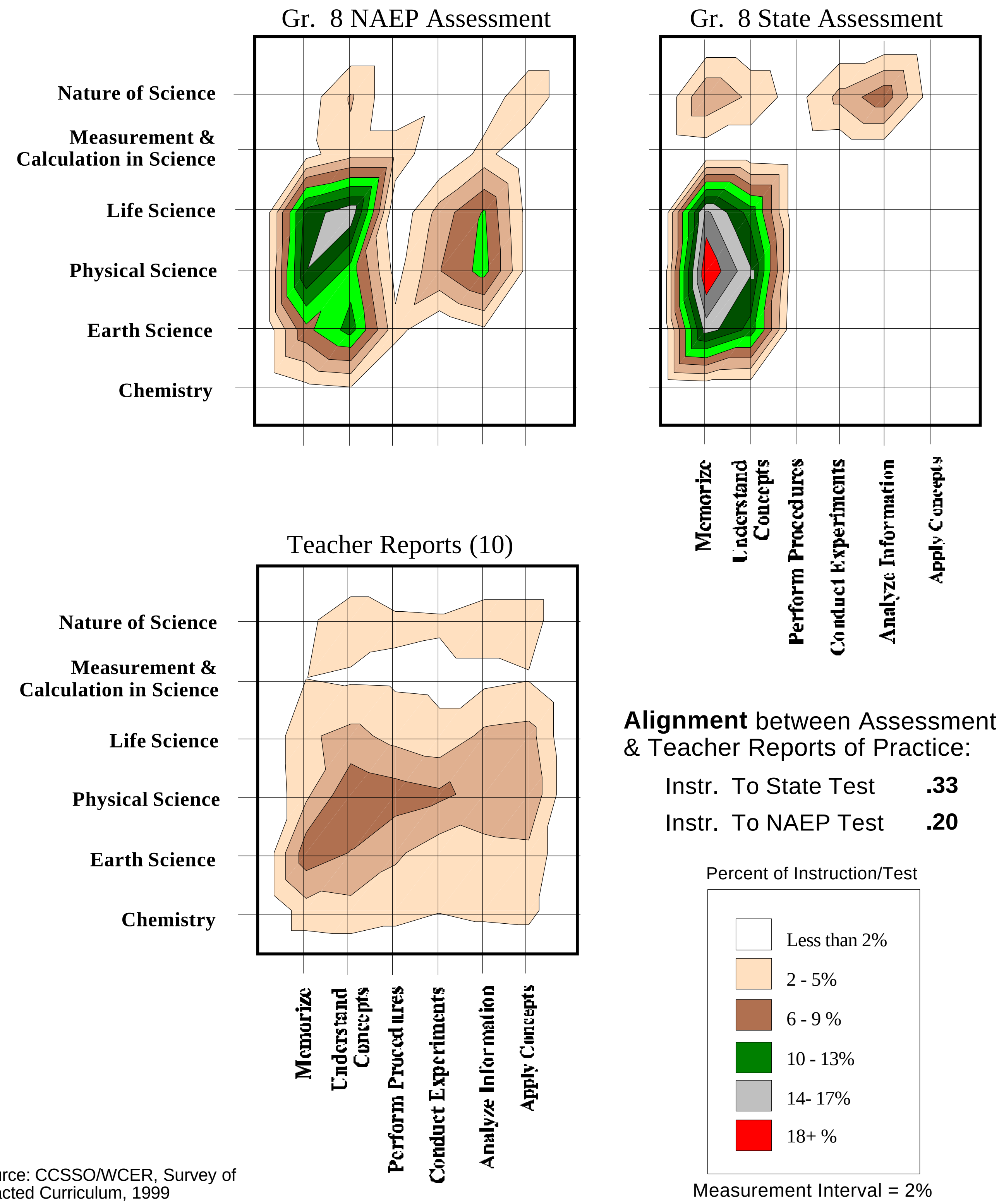
- The NAEP assessment focused strongly on Life Science, Physical Science, Understand Concepts and Perform Procedures, and some emphasis on Analyze Information. The state assessment focused on Physical, Earth, and Life Sciences, and on Memorize and Understand Concepts. Teacher reports of content taught indicate greater distribution to the six expectations in the content areas of Physical, Life, and Earth Sciences than the coding of the test items. The alignment statistic of .33 means that less than half the intersections of content topics by expectations reported by teachers were in common with the assessment items found on the state science test.

Chart 10
Grade 4 Mathematics
Alignment Analysis



Source: CCSSO/WCER, Survey of Enacted Curriculum, 1999

Chart 11
Grade 8 Science
Alignment Analysis



Source: CCSSO/WCER, Survey of Enacted Curriculum, 1999

Teacher Preparation

A key feature of the Survey of Enacted Curriculum is the section requesting information on formal preparation, including college major and number of college courses related to teaching mathematics or science. Questions also ask about the amount of professional development and training activities received by teachers in the past year, teacher reactions, and use of their development. Finally, the Survey asks for teacher views on how well prepared they consider themselves for using a variety of teaching strategies and for teaching with various groups of students. The Survey results for the Cross-State Sample are shown in Charts 12 and 13.

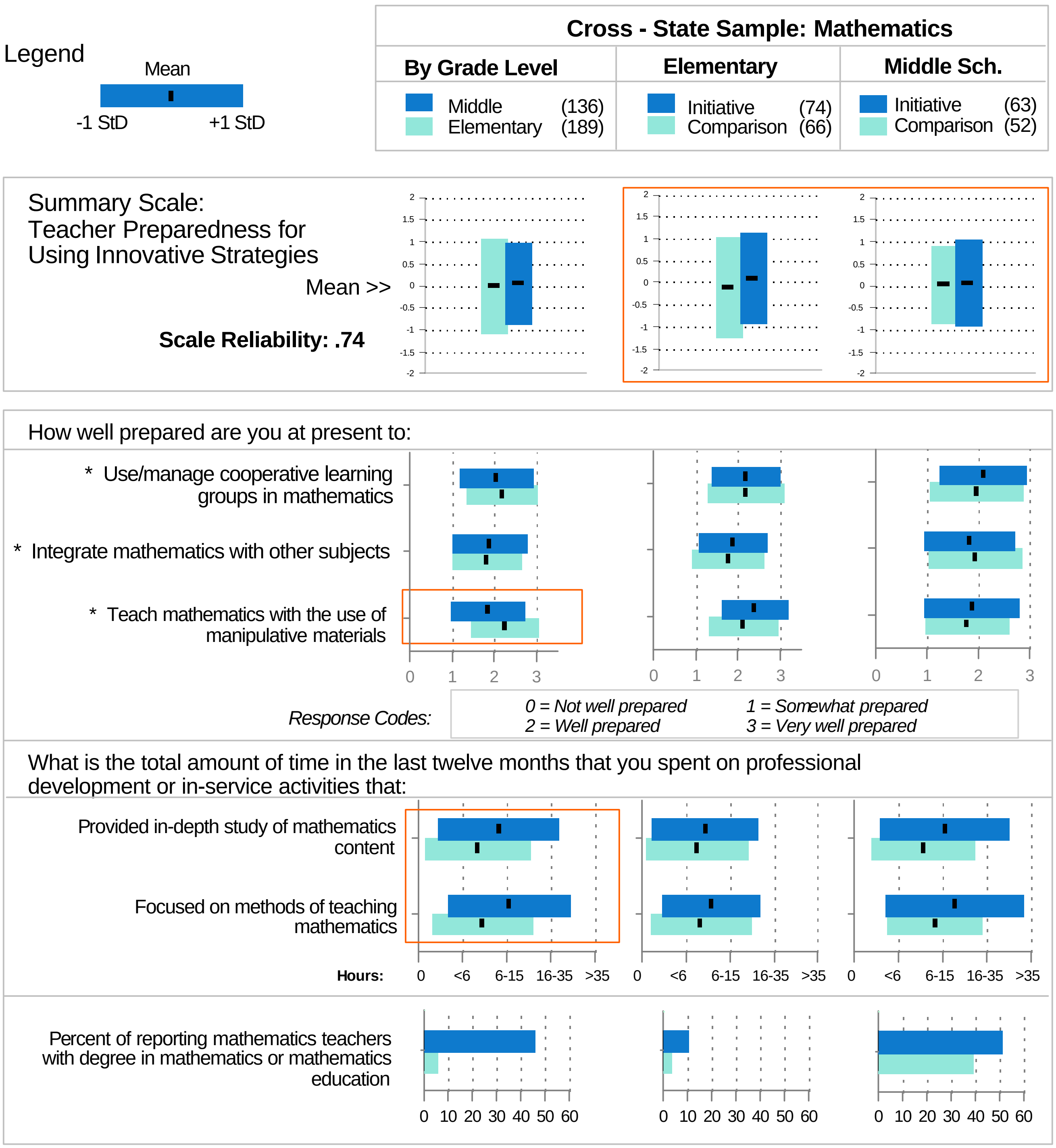
Mathematics

- *Professional Development*. Middle grade teachers received an average of 6 to 15 hours of professional development in 12 months on in-depth study of math content and the same amount of time on methods of teaching math. Elementary teachers averaged less than 6 hours in each area. At both levels, there are significant differences in professional development time at both levels, varying from a total of less than 6 hours to a total of almost 40 hours. Teachers in Initiative schools received more professional development in math than teachers in Comparison schools. (The Survey includes questions on teachers' reactions to professional development, and the data indicate areas most used by teachers are: new curriculum, standards, teaching methods, multiple assessment strategies, and needs of all students).
- *Teacher Major*. Almost half of the middle grades math teachers reported having a major in math or math education compared with 5% of elementary teachers. Initiative schools reported about 10% more teachers with math majors.
- *Innovative Strategies*. Teachers reported they are well prepared, on average, to use cooperative learning groups, to integrate math with other subjects, and to teach with manipulatives. With each of these innovative strategies, teacher responses were varied--a significant portion of teachers were only somewhat prepared, while many were very well prepared.

Science

- *Professional Development*. Middle grades science teachers received an average of nearly 20 hours of professional development both in methods of teaching science and study of science content. Elementary teachers received about 10 hours less development in each area. Teachers in Initiative schools received significantly more science education development at both elementary and middle grades levels. (Data are available to analyze professional development activities by the reactions and use by teachers, and in science, the highest use is with activities in student assessment, in-depth content study, new teaching methods, and implementing state or national standards.)
- *Teacher Major*. Almost 60% of middle grades science teachers have a major in science or science education compared with 10% of elementary teachers. In Initiative schools, 70% of middle grades teachers had a science major.
- *Innovative Strategies*. Teachers reported they are well prepared, on average to integrate science with other subjects, to manage hands-on or lab activities, and to use a variety of assessment strategies. With each of these innovative strategies, teacher responses varied, particularly with elementary teachers. About one-third of elementary teachers reported that they are not well prepared to teach with any of these three strategies.

Chart 12
Teacher Preparation - Mathematics

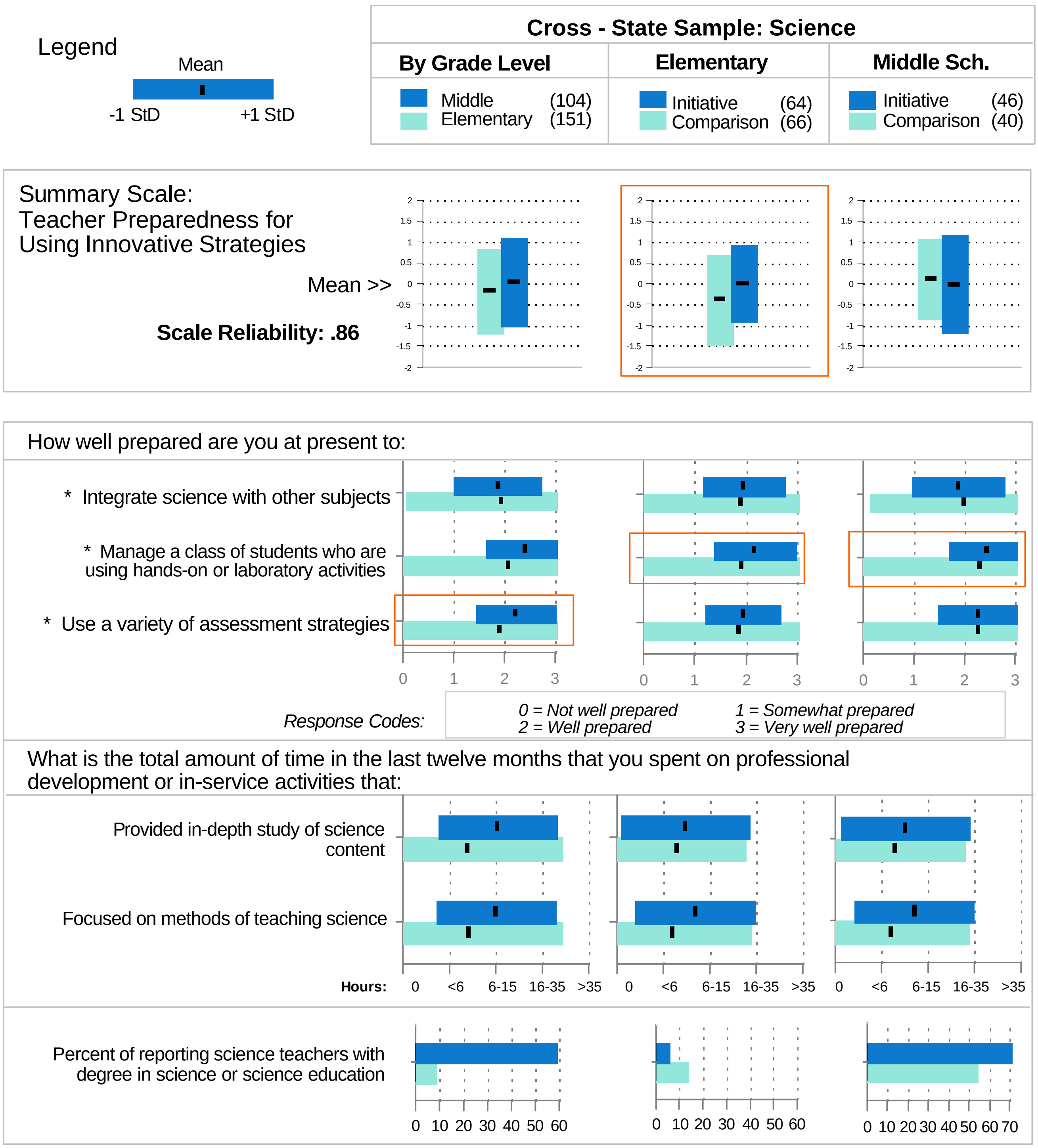


* Item included in Summary Scale

Source: CCSSO/WCER, Survey of Enacted Curriculum, 1999

[orange box] Indicates statistically significant mean differences.

Chart 13
Teacher Preparation - Science



* Item included in Summary Scale

Source: CCSSO/WCER, Survey of Enacted Curriculum, 1999

Indicates statistically significant mean differences.

Uses of Enacted Curriculum Data

In the 1990s, states and school districts have worked to improve the quality of mathematics and science teaching through a variety of policy and program initiatives, including more challenging content standards, professional development on teaching methods and subject knowledge, new curriculum materials, and system wide student assessments. As initiatives have been developed and implemented, and goals for student achievement have been raised, educators and decision makers have sought information to evaluate progress of change in instruction and to assess the needs of teachers, particularly in instructional practices and delivery of curriculum that will meet challenging standards in mathematics and science. Reliable, comparable state-level indicators have been developed and reported (Blank, et al., 1999; Reese, et al., 1997); however, broad state-level indicators have typically not provided sufficient detail about the breadth and depth of curriculum content and practices actually taught in classrooms.

The charts and description of sample results from the multi-state study, outlined above, highlight the kinds of findings and data possible with the Survey of Enacted Curriculum, and these examples illustrate how the data can be reported and analyzed. Curriculum data can serve a variety of audiences--teachers, curriculum specialists, administrators, parents, and policymakers. Used properly, the survey data can be extremely helpful to school systems.

Survey Topics. The survey is designed to be completed through self-report by teachers. In the 1999 study, a sample of teachers in a school were selected, but the data are likely to be even more useful when all teachers in a school or several grade levels across schools are surveyed. The total survey includes 155 questions plus a subject content matrix. The topics can be summarized by the following outline:

- ➜ Subject Content
  - Curriculum topics taught during school year
  - Teacher expectations for student learning by topic
- ➜ Classroom Instructional Practices
  - Instructional activities in a subject--main types and specifics
  - Use of calculators, computers, lab equipment
  - Assessment strategies
  - Time allocation in recent unit
  - Homework
  - Class and student characteristics
- ➜ Teacher Preparation
  - Professional development, time and topics
  - Course preparation of teachers in math/science
  - Influences on teacher decisions about curriculum and instruction
  - Teacher perceptions of areas of preparation
  - Teacher views of school conditions for teaching

Applications of the Data. Reliable, comparable data on curriculum and teaching as they are actually delivered in classrooms are generally not available to teachers, specialists, or administrators. In the past, the methods of collecting such data were either too costly or difficult to analyze and compare across classes, schools, and districts. Now, data from Surveys of Enacted Curriculum can be useful to several audiences.

State and local decision-makers can use data on instructional practices and content to inform policy decisions, plan professional development, and evaluate the effectiveness of reform initiatives in changing practice. Principals and other administrators can use instructional activity measures to inform parents and others of practices within a school, district, or state, and data can be analyzed by teacher background and level of preparation. Teachers will find the data useful for curriculum planning, for reflection on their own practice, and as a basis for pursuing collaborative discussions with colleagues about teaching strategies specific to content.

We can summarize four primary categories of applications for the Survey data as identified by state education leaders participating in the project:

✓ ***Interpreting Student Assessment Results —*** The Enacted Curriculum Surveys can be given in their entirety, including moderately detailed questions on instructional practices and content (totaling up to 1.5 hours response time), or selected components of the Survey can be used. The Survey can be given simultaneously with student assessments to help analyze results and develop strategies for instructional improvement. The subject content matrix data reported by teachers can be analyzed with the student assessment results to determine strengths and weaknesses in curriculum and teaching strategies.

✓***Aligning Curriculum with Standards*** — Almost every state and many districts have developed content standards for student learning. The Enacted Curriculum Surveys can provide a database for monitoring the degree to which classroom curriculum is moving toward the standards. Standards are written with specific benchmarks or indicators of student performance, and the Survey data are reported both by broad categories matched to standards and by specific item profiles and teacher expectations that match to the benchmarks.

✓ ***Needs Assessment, Program Evaluation, Planning —*** State departments of education and local districts are responsible for evaluating programs for improving instruction or professional development. The Enacted Curriculum Surveys can provide a tool for identifying needs, determining effects on curriculum, or planning programs.

✓ ***School Curriculum Improvement —*** Teachers, schools and districts often seek ways to improve dialogue among teachers regarding their own practice and curriculum content. Working with Enacted Curriculum data can provide important incentives, as well as comparable measures for starting more in-depth discussion about how teachers can improve their own practice, advance articulation of curriculum between grades/courses, and share strategies for improvement.

Department heads, curriculum specialists, professional development leaders, and administrators and teachers may want to use the enacted curriculum data as a basis for working together in analyzing differences and similarities in curriculum and teaching practices. They also may want to use these basic indicators to begin more detailed discussion of the range of teaching strategies used in classes, and to plan how improvement might be made in math and science teaching.

Survey Development and Procedures

The Survey of Enacted Curriculum was originated by CCSSO as a component of the Science Education Project of the State Collaboratives on Assessment and Student Standards (SCASS)(CCSSO, 1998; Martin, Blank & Smithson, 1996). A grant from the National Science Foundation provided support for CCSSO and states to develop, demonstrate, and test survey instruments for classroom curriculum in science and mathematics and methods of analyzing and reporting data. A multi-state team of educators, assessment specialists, and researchers worked together to design and edit the surveys. Major concepts for development of surveys came from state and national standards for student learning and teaching. Example items and response formats were adapted from national surveys (NCES/NAEP, 1997; Weiss, 1994) and the TIMSS international survey (NCES, 1996).

Survey Design. Prior work by Andrew Porter and colleagues at the Wisconsin Center for Education Research in the "Reform Up Close" study (1993) and other research on curriculum change (1998) had demonstrated the validity of teacher self-report surveys as compared to results obtained through daily logs of content and instruction, interviews, and observation. Porter and John Smithson from the Wisconsin Center provided research expertise and data collection and analysis leadership for the 1999 State Initiatives study.

The Survey instruments in science and mathematics were complected prior to the 1998-99 school year. The surveys for this study were designed for elementary teachers, middle level teachers and high school teachers. One main goal of the Survey is to analyze classroom practices across grade levels, and many of the Survey sections and items are identical between grade levels. The major section that differs is the content matrix in math and science, which has more content topics in the higher grade levels.

The designed instruments were pilot-tested in summer 1998, and the teachers participated in a focus group discussion aimed toward survey improvements. In the Spring 1999 data collection, one-fourth of teachers participating in the Survey were asked to conduct brief surveys with one class of their students. These items focused on classroom practices and activities for which students would be most able to report. The data were intended for validation analyses of the teacher responses.

Sampling and Data Collection. State superintendents of education were contacted in Fall 1998 to determine interests in states participating in a Study of State Initiatives in Mathematics and Science Education. Superintendents and their staff were provided information on the study objectives and the intended survey approach to data collection and analysis. The study was designed to use a common data collection approach, but the state initiatives used as the basis for sample selection could vary.

Each state was asked to provide funding for travel expenses for two staff to participate in collaborative team meetings.

Eleven states agreed to participate: Iowa, Kentucky, Louisiana, Massachusetts, Minnesota, Missouri, North Carolina, Ohio, Pennsylvania, South Carolina, West Virginia. Six of the 11 states had been a part of the State Systemic Initiatives (SSI) program supported by the National Science Foundation. These states typically had multiple program and policy initiatives including standards, curriculum materials, professional development, and assessment. In several states the initiatives focused on assessment development and training for teachers. Several states also focused on implementing new content standards for science and math.

State leaders were asked to select schools and teachers to participate in the study based on their state initiative. The initiatives varied by state but methods of sampling were consistent. Each state was asked to include schools from urban, suburban, and rural districts, and schools were to vary in size and student composition. Each state was given the following sampling plan:

Goal: Total of 160 teachers and up to 80 schools per state

- 20 schools at each of two grade levels (e.g., elementary, middle)
  10 "Initiative" schools and 10 "Comparison" schools (matched on enrollment, poverty level, community)
- Per school: 2 teachers of science, 2 teachers of math
  Schools added if 4 teachers were not present per school.

Analysis Guide

The following pages of this report provide explanatory materials, including:

- Sample sections of the Survey of Enacted Curriculum;
- A guide for Interpreting Content Maps shown in the report;
- Charts on Use of Class Time;
- Descriptive Data about the surveyed schools, teachers, and classes;
- Information on State Initiatives, Standards and Assessments.

Teacher Reporting on Subject Content. The Subject Content section of the Survey requests information regarding topic coverage and teacher's expectations for students in the target mathematics class for the current year. It is not intended to reflect any recommended or prescribed content for the grade level. For Middle School Mathematics, six content areas are surveyed: Number Sense/Properties/Relationships, Measurement, Data Analysis/Probability/Statistics, Geometric Concepts, Algebraic Concepts, and Instructional Technology. (The figure on the following page shows one area, Number Sense.)

To complete this section, the teacher identifies topic/sub-topic areas covered in his/her mathematics class, using "time on topic" column (0=none - not covered, 1=slight coverage - less than one class/lesson, 2=moderate coverage - one to five classes/lessons, 3=sustained coverage - more than five classes/lessons).

Then the teacher indicates the relative emphases of each Expectation for Students for every sub-topic taught using scale bubbles for six categories: Memorize, Understand concepts, Perform procedures, Analyze/reason, Solve novel problem, and Integrate. Four scale bubbles indicate: 0=no emphasis, 1=slight emphasis - accounts for less than 25% of the time, 2=moderate emphasis - accounts for 25% - 33% of the time, 3=sustained emphasis - accounts for more than 33% of the time.

Teacher reporting on Instructional Activities. See example section from Mathematics survey on following page.

Sample Sections from Survey

Subject Content: Mathematics

Time on Topic		***Middle School Mathematics Topics***	***Expectations for Students in Mathematics***					
<none>	1	**Number sense / Properties /**	**Memorize**	**Understand Concepts**	**Perform Procedures**	**Analyze / Reason**	**Solve Novel Problems**	**Integrate**
⓪ ① ② ③	1 0	Place value	⓪ ① ② ③	⓪ ① ② ③	⓪ ① ② ③	⓪ ① ② ③	⓪ ① ② ③	⓪ ① ② ③
⓪ ① ② ③	1 0	Whole numbers	⓪ ① ② ③	⓪ ① ② ③	⓪ ① ② ③	⓪ ① ② ③	⓪ ① ② ③	⓪ ① ② ③
⓪ ① ② ③	1 0	Operations	⓪ ① ② ③	⓪ ① ② ③	⓪ ① ② ③	⓪ ① ② ③	⓪ ① ② ③	⓪ ① ② ③
⓪ ① ② ③	1 0	Fractions	⓪ ① ② ③	⓪ ① ② ③	⓪ ① ② ③	⓪ ① ② ③	⓪ ① ② ③	⓪ ① ② ③
⓪ ① ② ③	1 0	Decimals	⓪ ① ② ③	⓪ ① ② ③	⓪ ① ② ③	⓪ ① ② ③	⓪ ① ② ③	⓪ ① ② ③
⓪ ① ② ③	1 0	Percents	⓪ ① ② ③	⓪ ① ② ③	⓪ ① ② ③	⓪ ① ② ③	⓪ ① ② ③	⓪ ① ② ③
⓪ ① ② ③	1 0	Ratio, proportion	⓪ ① ② ③	⓪ ① ② ③	⓪ ① ② ③	⓪ ① ② ③	⓪ ① ② ③	⓪ ① ② ③
⓪ ① ② ③	1 0	Patterns	⓪ ① ② ③	⓪ ① ② ③	⓪ ① ② ③	⓪ ① ② ③	⓪ ① ② ③	⓪ ① ② ③
⓪ ① ② ③	1 0	Real numbers	⓪ ① ② ③	⓪ ① ② ③	⓪ ① ② ③	⓪ ① ② ③	⓪ ① ② ③	⓪ ① ② ③
⓪ ① ② ③	1 1	Exponents, scientific notation	⓪ ① ② ③	⓪ ① ② ③	⓪ ① ② ③	⓪ ① ② ③	⓪ ① ② ③	⓪ ① ② ③
⓪ ① ② ③	1 1 1	Factors, multiples, divisibility	⓪ ① ② ③	⓪ ① ② ③	⓪ ① ② ③	⓪ ① ② ③	⓪ ① ② ③	⓪ ① ② ③

INSTRUCTIONAL ACTIVITIES IN MATHEMATICS

Listed below are some questions about what students in the target class do in mathematics. For each activity, pick one of the choices (0, 1, 2, 3) to indicate the percentage of instructional time that students are doing each activity. Please think of

What percentage of mathematics instructional time in the target class do students:

NOTE: No more than two '3's , or four '2's should be reported for this set of items.

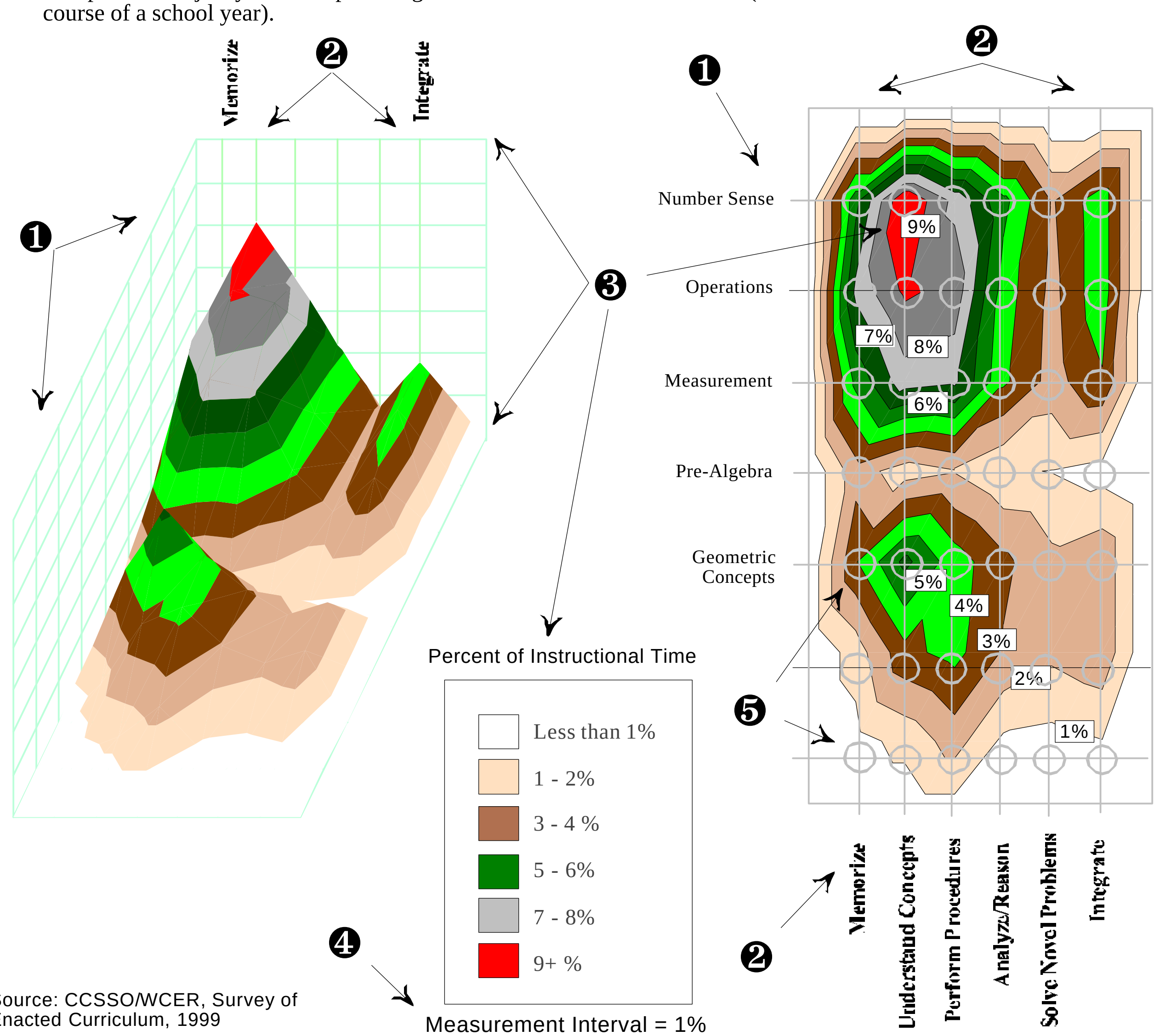
		None	Less than	25% to 33%	More than 33%
34	Watch the teacher demonstrate how to do a procedure or solve a problem.	⓪	①	②	③
35	Read about mathematics in books, magazines, or	⓪	①	②	③
36	Collect or analyze data.	⓪	①	②	③
37	Maintain and reflect on a mathematics portfolio of their own work.	⓪	①	②	③
38	Use hands-on materials or manipulatives (e.g., counting blocks, geometric shapes, algebraic tiles).	⓪	①	②	③
39	Engage in mathematical problem solving (e.g., computation, story-problems, mathematical investigations).	⓪	①	②	③
40	Take notes.	⓪	①	②	③
41	Work in pairs or small groups (non-laboratory).	⓪	①	②	③
42	Do a mathematics activity with the class **outside** the	⓪	①	②	③
43	Use computers, calculators, or other technology to learn mathematics.	⓪	①	②	③
44	Work individually on assignments.	⓪	①	②	③
45	Take a quiz or test.	⓪	①	②	③

Interpreting Content Maps

Content maps provide a three-dimensional representation of instructional content using a surface area chart which results in a graphic very similar to topographical maps. The grid overlaying each map identifies a list of topic areas (indicated by horizontal grid lines; see ❶ below) and six categories of cognitive expectations for students (indicated by vertical lines; see ❷ below). The intersection of each topic area and category of cognitive expectation represents a measurement node (see ❺ below). Each measurement node indicates a measure of instructional time for a given topic area and category of cognitive expectation based upon teacher reports. The resulting map is based upon the values at each of these measurement nodes. It should be noted that the spaces between each measurement node, that is the surface of the map, are abstractions and are not based upon real data—the image of the map is simply a computer generated graphic based upon the values for each intersecting measurement node. The map display is utilized to portray the third dimension (percent of instructional time; see ❸ below) onto this grid utilizing shading and contour lines to indicate the percent of instructional time spent (on average across teachers) for each topic by cognitive expectation intersection.

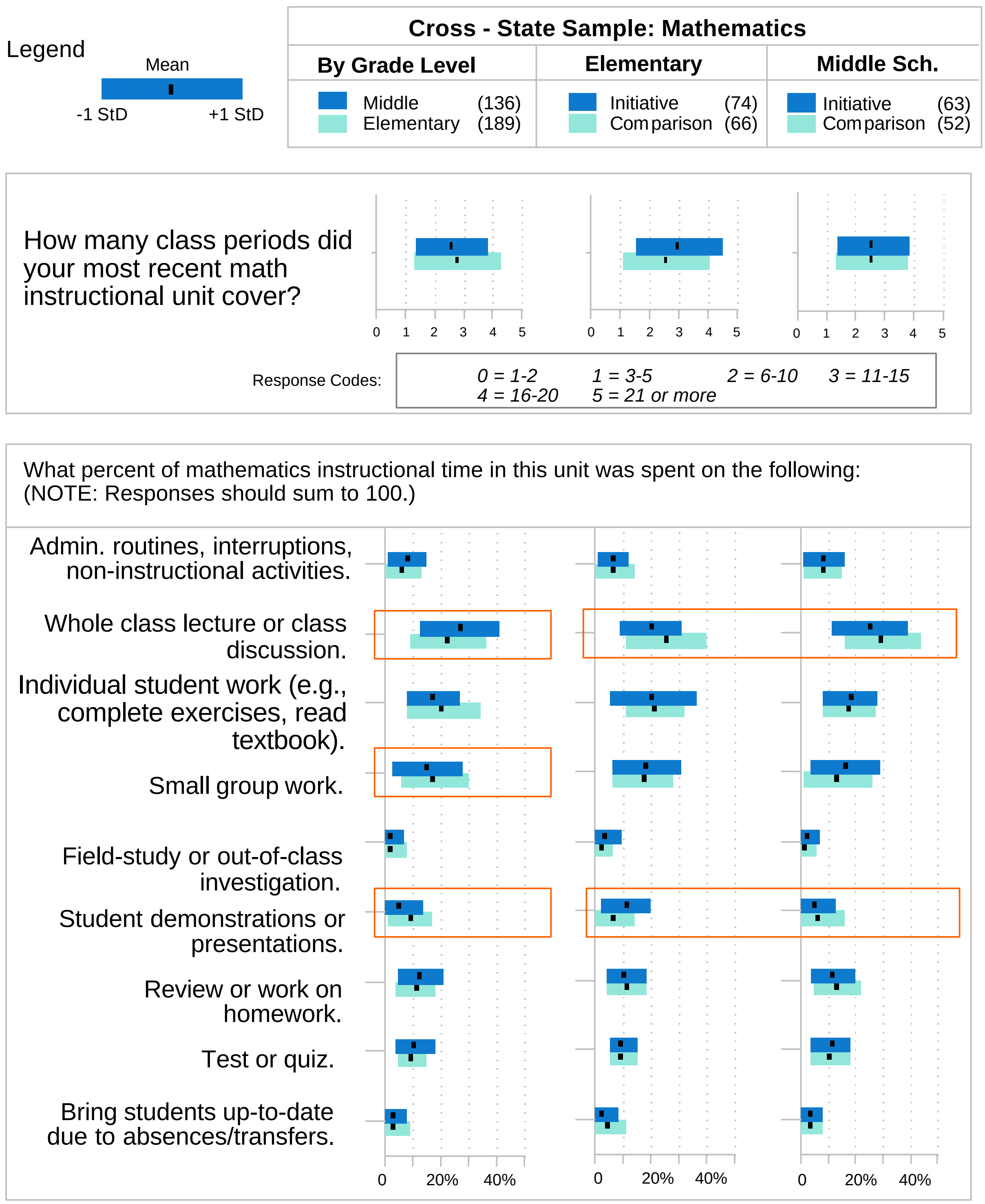
The increase (or decrease) in instructional time represented by each shaded band is referred to as the measurement interval (see ❹ below). To determine the amount of instructional time for a given measurement node, count the number of contour lines between the nearest border and the node and multiply by the measurement interval.

The graphic at left below displays the three dimensional counterpart of the image represented by the content map displayed on the right. Both graphs indicate that Understanding Concepts related to Number Sense and Operations occupies the majority of time spent on grade four mathematics instruction (9% or more of instructional time over the course of a school year).



Source: CCSSO/WCER, Survey of Enacted Curriculum, 1999

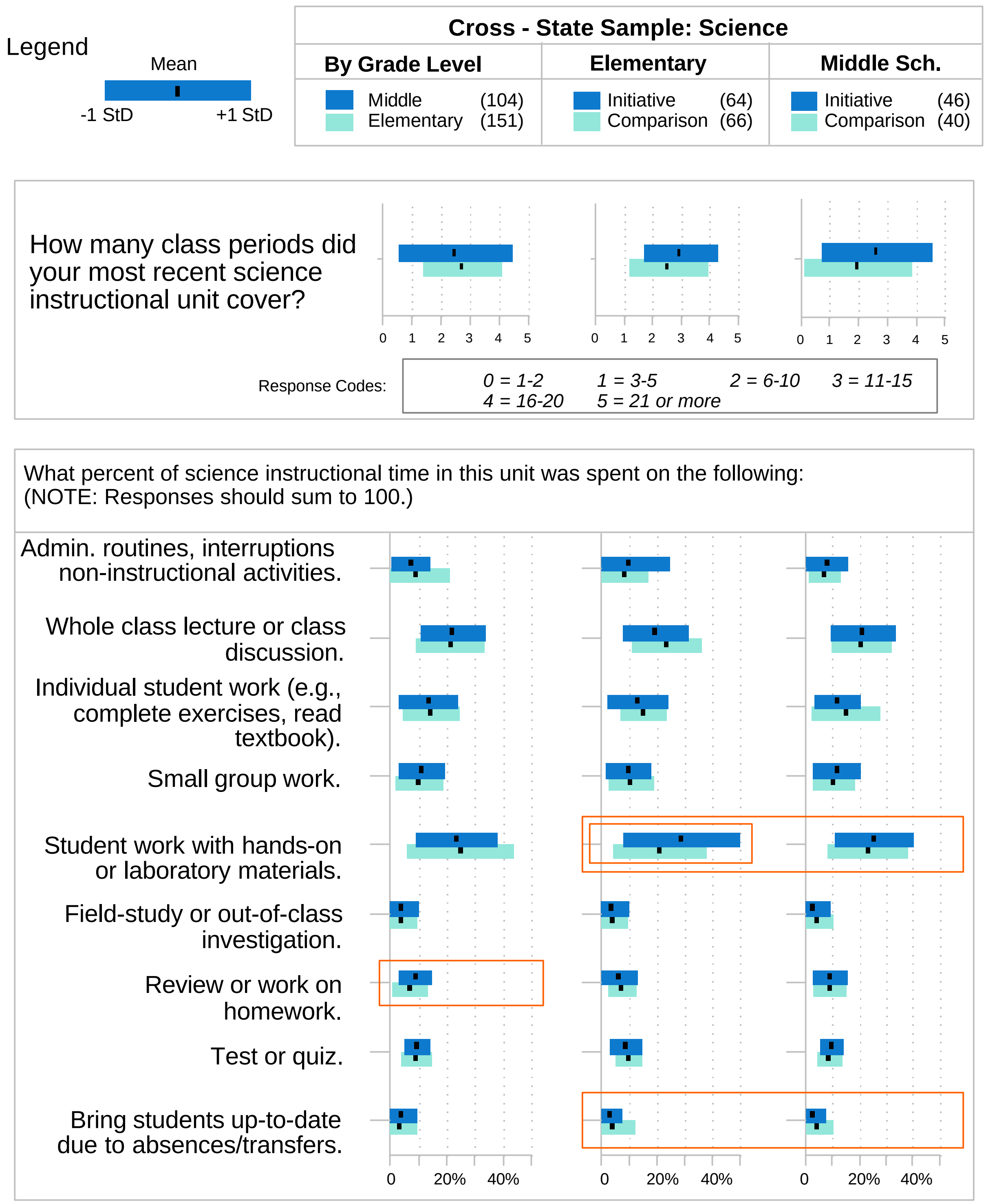
Use of Class Time
During Most Recent Unit of Instruction in Mathematics



Source: CCSSO/WCER, Survey of Enacted Curriculum, 1999

Indicates statistically significant mean differences.

Use of Class Time
During Most Recent Unit of Instruction in Science



Source: CCSSO/WCER, Survey of Enacted Curriculum, 1999

Indicates statistically significant mean differences.

Descriptive Data on Schools, Teachers, and Classes Participating in the 1999 Survey of Enacted Curriculum

Number of States	**11**

Teachers Responding to Survey
(whole or in part)

Teachers	Mathematics	Science
Elementary	189	151
Middle	136	104
High	32	17

Schools by Enrollment
(selected as Initiative vs. Comparison)

	Schools with Math or Science Surveys		
	Initiative	**Comparison**	**Not reported**
Under 300	11	10	3
301 - 600	49	38	20
601 - 1000	42	38	7
1001 or more	19	8	2
Not reported	28	22	30
Total	149	116	62

School % Poverty

	Schools with Math or Science Surveys		
	Initiative	**Comparison**	**Not reported**
0 - 34%	77	46	13
35 - 74%	62	64	12
75 - 100%	8	1	7
Not reported	2	5	30
Total	149	116	62

Class Reported by Teacher
(1 class per teacher)

	Math	Science
Grade 3	16	14
4	155	126
5 or 6	4	10
7	19	20
8	111	75
9 or higher	30	10

Teaching Time
Elementary (hours/week)

	Math %	Science %
Less than 4	4.8	44.9
4 - 4.9	16.2	31.5
5 or more	79.1	23.5

Teaching Time (continued)

Middle Grades (hours/week)		Math %	Science %
	Less than 4	20.2	13.4
	4 - 4.9	31	34
	5 or more	49	52.6

Achievement Level of Students

		Math %	Science %
	High	16	9.7
	Average	50.2	47.2
	Low	13	14.1
	Mixed	19.6	29

Teacher Characteristics

Experience: Yrs. in Subject		Math %	Science %
	0-2	12.8	11.8
	3-5	18.6	13.7
	6-11	21	22.6
	12 or more	47.6	51.9

Major: Bachelors or Highest		Math %	Science %
	Elementary Ed.	40.6	43.5
	Middle Ed.	6.7	4.2
	Math Ed.	13.3	
	Science Ed.		12.6
	Mathematics	10.5	
	Science field		11
	Other	28.9	26.7

		Math %	Science %
	BA/BS	51.4	42.4
	MA/MS or higher	48.7	57.6

Teacher Professional Development

Content study in field (hrs. in last year)		Math %	Science %
	< 6	32.6	52.8
	6 - 15	25.2	21.6
	16 or more	22.2	25.7

Methods of teaching in field		Math %	Science %
(hrs. in last year)	< 6	47	34.9
	6 - 15	29.4	46.7
	16 or more	23.7	18.4

Teacher Demographics

		Math %	Science %
	Female	82.1	76.8
	Male	17.9	23.2
	White	93.9	90.7
	Minority	6.1	9.4

Information on State Initiatives, Standards and Assessments

The study of state reform is based on a design for surveying a selected sample of teachers and analyzing the data to determine effects of a state initiative in mathematics or science education on teaching practices and curriculum. In some states the initiative is directly linked to state content standards. In others, the initiative relates to a broader set of state education policies to improve education. Six of the 11 states were in the state systemic initiative (SSI) program supported by the National Science Foundation. Following is a summary outline of key state information upon which the study is based.

Iowa

Surveys, Spring 1999	*Grades*
Mathematics	4, 8
Science	4, 8

State Initiative	*Year Implemented*
Mathematics:	
First Governor's Conference on Reform in Math Ed. (K-12)	1992
Science:	
New Standards project	1992
Science SCASS Assessment project	1993
Nat. Science Ed./NCTM Standards Awareness / Implementation	1996

State Content Standards

(Standards and Frameworks developed at the District level)

State Assessments

(No statewide assessment)

Kentucky

Surveys, Spring 1999	*Grades*
Mathematics	4, 8
Science	4, 8

State Initiative	*Year Implemented*
Appalachian Rural Systemic Initiative (ARSI)	
KERA -- State Reform	1990
Partnerships for Reform Initiatives in Science and Mathematics (PRISM)–NSF/SSI	1991
Kentucky Middle Grades Mathematics Teacher Network	4 years
Eisenhower Regional consortium for Mathematics and Science Education at AEL	1993
Informal Science Organization/School Partnerships	
K - 4 Mathematics Specialist Program	3 years

State Content Standards

Transformations: KY Curriculum Framework	1995
KY Core Content for Math and Science Assessment	1996
Program of Studies for KY Schools, PK-12	1997

State Assessments

KIRIS	Math/Science	Gr. 4, 8	1991
Commonwealth Accountability Testing System (CATS)			
	Math Gr. 5, 8; Science Gr. 4, 7		1998

Louisiana

Surveys, Spring 1999	*Grades*
Mathematics	4, 8
Science	4, 8

State Initiative

Math & Science: LA Systemic Initiatives Program
K-3 Reading and Mathematics Initiative
Developing Education Excellence and Proficiency
Math:Gr. 3-8, Science: Gr. K-12

State Content Standards

LA Mathematics and Science Content Standards (1997)
LA Mathematics and Science Curriculum Frameworks (1995)

State Assessments

Math: CRT Gr. 4,8	NRT Gr. 3,5,6,7,9
Science: CRT Gr. 4,8	NRT Gr. 3,5,6,7,9

Massachusetts

Surveys, Spring 1999	*Grades*
Mathematics	4, 8
Science	4, 8

State Initiative	*Year Implemented*
Partnerships Advancing the Learning of Math and Science (PALMS):	1992

PK-12/ Higher Education Goals: -- Increase student achievement in math, science and technology. Reduce achievement gaps for ethnic, bilingual, and gender groups

Focal Areas:

1) Data-driven systems
2) Standards-based curriculum, instruction, assessment
3) Qualified/quality teachers
4) Middle school/high school and transitions
5) Parent/community involvement

State Content Standards

Mathematics Curriculum Framework: Achieving Mathematical Power (1995)

Science and Technology Curriculum Framework: Owning the Questions through Science and Technology Education (1995)

State Assessments

MCAS (began '97-98): Math, Science: Grades 4, 8, 10

Minnesota

Surveys, Spring 1999	*Grades*
Mathematics	4, 8
Science	4, 8

State Initiative	*Year Implemented*
Minnesota Graduation Standards	Fall 1998

Basic standards (R, W, Math) and High Standards in 10 areas including Math and Science.

Math reform schools: Have implemented NSF math curricula. Non-reform: traditional, textbook programs.

Science reform schools: Some, not all using kit-based programs--FOSS or STC; Others, with teachers in the "best practice network in science"

State Content Standards

Mathematics K-12 Curriculum Framework (1997)

Science K-12 Curriculum Framework (1997)

State Assessments

Basic Stands. Test	Math, Gr. 8 (3 yrs.)
Comp. Assess.	Gr. 3,5 (began 97-98)

Missouri

Surveys, Spring 1999	*Grades*
Mathematics	4, 8
Science	3, 7

State Initiative

"Initiative" schools were selected from two programs:

(1) Schools that participated voluntarily in the first year that state-level performance-based math and science assessments became available. Mathematics assessment began Spring 1997, and implemented statewide 1998. Science assessment began Spring 1998.

(2) Schools in districts that participated in the voluntary inservice training program on performance-based assessment, which began being offered by the state in 1993.

State Content Standards

Math Curriculum Frameworks (1996)

Science Curriculum Frameworks (1996)

Show Me Standards (1996)

State Assessments

Missouri Assessment Program

Math: Grades 4, 8, 10 (began 1996-97)

Science: Gr. 3, 7 (began 1997-98)

North Carolina

Surveys, Spring 1999	*Grades*
Mathematics	4, 8

State Initiative

"The ABC's of Public Education" is an initiative that began in 1992. There are three parts: A: Accountability; B: Basics and High Education Standards; and, C: Maximum local control. Key aspects of each part:

A -- Individual schools held accountable, staff responsible, students tested in grades 3-8, high school end of course tests, and schools judged on raising achievement.

B -- State standards in Reading, Writing, and Mathematics; and grade specific objectives per content area and tests based on objectives.

C -- Principals and teachers make decisions on materials and instruction; state provides information on "best practices," curriculum standards, and technology.

State Content Standards

NC Standard Course of Study, Mathematics Competency-based Curriculum Teacher Handbook K-12 (1994)

Strategies for Instruction in Mathematics (state-provided for each grade)

State Assessments

North Carolina Testing Program: Math: Gr. 3-8 (began 1992), Algebra 1 (began 1989)

Ohio

Surveys, Spring 1999	*Grades*
Mathematics	4, 8
Science	4, 8

State Initiative	*Year Implemented*
Urban Schools Initiative	1996

The Urban Schools Initiative was launched by the Ohio Department of Education to comprehensively address the challenges facing urban school communities. The initiative represents all twenty-one of Ohio's urban school districts, 24% of the states total student population, and 72% of its minority students. The Urban Schools Initiative (USI) has been a leader in developing and implementing new programs, attracting grants and making a positive impact on students. With its District Team, School Readiness Resource Centers, Professional Development and Disciplinary Intervention Grants and its widely circulated report, Through the Eyes of Children, Ohio's USI has had a substantial impact on the state's urban school communities.

State Content Standards

Model Competency-Based Mathematics Program (1990)
Model Competency-Based Science Program (1994)

State Assessments

Ohio Proficiency Test Program
Mathematics: 4, 6, 9, 12
Science: 4, 6, 9, 12

Pennsylvania

Surveys, Spring 1999	*Grades*
Mathematics	4, 8
Science	4, 8

State Initiative

State Content Standards

Mathematics Curriculum Framework (1996)
Science and Technology Framework (1995)
Mathematics Standards (1999)

State Assessments

Math: NRT Gr. 5, 8, 11
Science: Developing

South Carolina

Survey	*Grades*	
Science, Spring 1999	4, 8	
Mathematics, Fall 1999	4, 8	

State Initiative	*Year Implemented*
SC State Systemic Initiative (K-12) -- reform, standards implementation	1992
Teachers Leading Teachers (Gr. 4-8) -- reform, physical science content	
Science SCASS Assessment project (K-12)	1995
Nat. Sci. Standards-- Building a Resource (K-12)	
Instructional Improvement Initiative (K-12) -- Low performing schools, to increase student achievement	

State Content Standards	*State Assessments*
SC Science Framework (1996)	Basic Skills Assess.
SC Acad. Achievement. Standards for Science (1996)	Science: Gr. 3, 6, 8
SC Science Curricul. Standards (1998)	Math: Gr. 3, 8,10
Expert review and Revisions to Sci. Standards (1999)	
Mathematics Standards (1998)	
Mathematics Framework (1993)	

West Virginia

Surveys, Spring 1999	*Grades*
Mathematics	8, 10
Science	8, 10

State Initiative	*Year Implemented*
Mathematics Reform: Project MERIT	1998
(Mathematics Education Reform Initiative for Teachers)	
Focus on the way mathematics is taught particularly in grades 6-10.	
Schools were selected for SEC based on their participation in the project.	
Science Reform: Project CATS	1995
(Coordinated and Thematic Science)	
Focus on integration of science curriculum particularly grades 6-10.	
Initiative schools were selected for SEC based on the schools with teachers trained in CATS.	

State Content Standards	*State Assessments*	
Instructional Goals and Objectives for Mathematics (1996)	NRT:	Math, Gr. K-11;
Instructional Goals and Objectives for Science (1996)		Science: Gr. 3-11

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