DOCUMENT RESUME

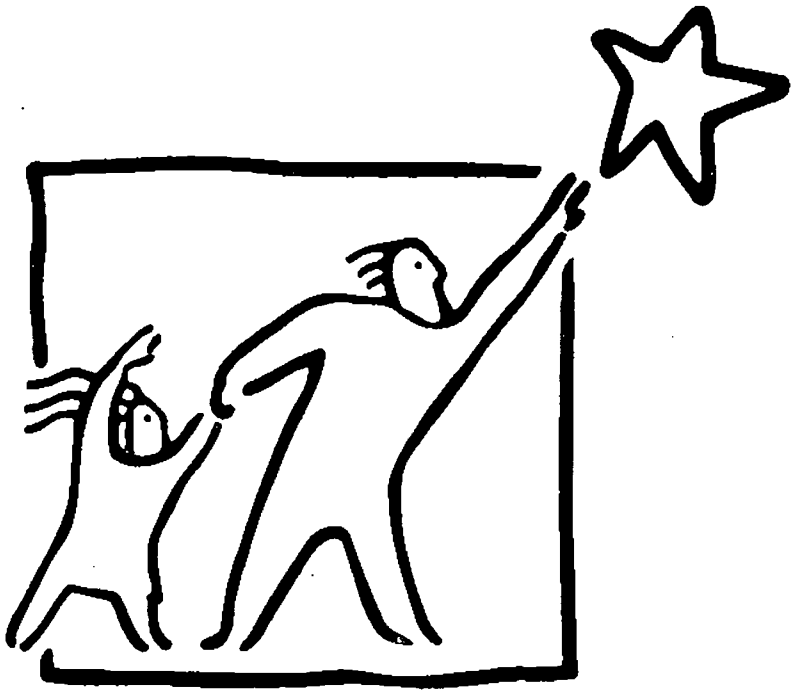
ED 455 579 EA 031 115

TITLE	Implementing Academic Standards: Papers Commissioned by the National Education Goals Panel.
INSTITUTION	National Education Goals Panel, Washington, DC.
REPORT NO	NEGP-97-04
PUB DATE	1997-07-00
NOTE	260p.; For full text: http://www.negp.gov/standards.html.
AVAILABLE FROM	National Education Goals Panel, 1255 22nd Street, N.W., Suite 502, Washington, DC 20037. Tel: 202-724-0015.
PUB TYPE	Collected Works - General (020)
EDRS PRICE	MF01/PC11 Plus Postage.
DESCRIPTORS	Academic Achievement; *Academic Standards; Accountability; *Educational Administration; Educational Change; Elementary Secondary Education; *Program Implementation; Science Education; Standardized Tests
IDENTIFIERS	*National Education Goals Panel

ABSTRACT

The papers in this volume describe how states have incorporated academic standards into their education goals. As part of the National Education Goals Panel, this collection of essays describes how nine states have recently implemented these standards, discusses how textbooks and teaching could help students reach the standards, and provides information on the resources and advice available from the professional organizations that developed national standards in mathematics and science. The text is divided into four parts. The first section, "Current State Policy and Standards," focuses on efforts to improve mathematics and science education in light of the Third International Mathematics and Science Study. It looks at standards-based reform in nine states and asks how these standards have persisted or changed. The second session addresses special issues relating to teachers and textbooks, with topics on teaching for high standards and overcoming structural barriers to good textbooks. The third section details special issues relating to math and science and describes the role of national policy standards in state policy, as well as benchmark and standards as tools for science education reform. The last section presents the National Education Goals Panel Statement on voluntary national education content standards. (Contains 12 references.) (RJM)

IMPLEMENTING ACADEMIC STANDARDS



Papers Commissioned by the

NATIONAL EDUCATION GOALS PANEL

JULY 1997

97-04

NATIONAL EDUCATION GOALS PANEL

GOVERNORS

James B. Hunt, North Carolina, Chairman, 1997
John Engler, Michigan
William Graves, Kansas
Roy Romer, Colorado,
Paul E. Patton, Kentucky
Tommy G. Thompson, Wisconsin
Cecil Underwood, West Virginia
Christine Todd Whitman, New Jersey

MEMBERS OF THE ADMINISTRATION

Carol H. Rasco, Senior Advisor to the Secretary, US Department of Education
Richard W. Riley, Secretary of Education

MEMBERS OF CONGRESS

U.S. Senator Jeff Bingaman, New Mexico
U.S. Senator James Jeffords, Vermont
U.S. Representative William F. Goodling, Pennsylvania
U.S. Representative Dale E. Kildee, Michigan

STATE LEGISLATORS

Representative G. Spencer Coggs, Wisconsin
Representative Ronald Cowell, Pennsylvania
Representative Mary Lou Cowlishaw, Illinois
Representative Douglas R. Jones, Idaho

NATIONAL EDUCATION GOALS PANEL STAFF

Ken Nelson, Executive Director
Leslie A. Lawrence, Senior Education Associate
Cynthia D. Prince, Associate Director for Analysis and Reporting
Emily O. Wurtz, Senior Education Associate
Cynthia M. Dixon, Program Assistant
John J. Masaitis, Executive Officer

Preface

July 1997

America can take pride in the tremendous strides most states have taken in recent years to develop academic standards. For the first time, we can specify and publicly debate what students should be expected to know and be able to do. Most states developed standards through a broad consensus-building process, open at every stage to public scrutiny. The process was demanding but vital to secure public input. Our common goal has been to focus instruction on the knowledge and skills that will be required of students in their future jobs and adult lives.

As chairman of the National Education Goals Panel, I applaud the states that have undertaken this effort. The Goals Panel has long advocated that clear and challenging academic standards can help states and districts both measure and improve students' academic achievement.

But articulating what students *should* know and be able to do is not enough. Stating academic standards is an empty exercise unless accompanied by sustained efforts to support schools and teachers in their use. Student achievement does not and will not match the high standards we have set until we implement those standards by supporting schools in their use.

The National Education Goals Panel has assembled information regarding standards implementation, especially in the areas of mathematics and science. The papers in this volume describe how states have recently implemented their standards, how textbooks and teaching could help students reach standards, and the resources and advice available from the professional organizations that developed national standards in mathematics and science.

The Goals Panel takes pride in presenting *Implementing Academic Standards*. We thank the authors, and we thank the dedicated educators working to implement standards directly with students.

James B. Hunt Jr.
Governor, North Carolina
1997 Chairman, National Education Goals Panel

All of the Papers in this volume are available on-line at http://www.negp.gov/standards.html

TABLE OF CONTENTS

CURRENT STATE POLICY ON STANDARDS ..... **SECTIONS A — C**

Reflections on State Efforts to Improve Mathematics and Science Education in Light of Findings from TIMSS
Andrew Zucker, with assistance from Patrick Shields, Nancy Aldeman, and Daniel Humphrey. ..... A-1 to A-20

Clarifying Questions About Persistence and Change: Standards-Based Reform in Nine States
Diane Massell ..... B-1 to B-8

Persistence and Change: Standards-Based Reform in Nine States
Diane Massell, Michael Kirst, Margaret Hoppe ..... C-1 to C-61

SPECIAL ISSUES RELATING TO TEACHERS AND TEXTBOOKS ..... **SECTION D — E**

Teaching for High Standards: What Policy Makers Need to Know and Be Able To Do
Linda Darling Hammond and Deborah Loewenberg Ball ..... D-1 to D-39

Overcoming Structural Barriers to Good Textbooks
Harriett Tyson Bernstein. ..... E-1 to E-18

SPECIAL ISSUES RELATING TO MATH & SCIENCE ..... **SECTIONS F — G**

Improving Student Learning in Mathematics and Science: The Role of National Policy Standards in State Policy
National Council of Teachers of Mathematics and Center for Science, Mathematics and Engineering Education, National Research Council. ..... F-1 to F-65

Benchmarks and Standards As Tools for Science Education Reform:
George D. Nelson ..... G-1 to G-20

NATIONAL EDUCATION GOALS PANEL POLICY RELATED TO STANDARDS .. **SECTION H**

National Education Goals Panel Statement on Voluntary National Education Content Standards, adopted November 15, 1993. ..... H-1 to H-2

CURRENT STATE POLICY ON STANDARDS

REFLECTIONS ON STATE EFFORTS TO IMPROVE MATHEMATICS AND SCIENCE EDUCATION IN LIGHT OF FINDINGS FROM TIMSS

BY:

Andrew A. Zucker
Program Manager, Mathematics and Science Education

With assistance from:

Patrick Shields
Nancy Adelman
Daniel Humphrey

April 1997

SRI Project 1817

This paper and related work of SRI International are available on-line at http://www.sri.com/policy

This paper was commissioned by the National Education Goals Panel (Purchase Order #4331FJ700008) for release at its meeting on July 30, 1997. The opinions and recommendations expressed in this paper are those of the author and do not necessarily reflect those of the Goals Panel or its members.

REFLECTIONS ON STATE EFFORTS TO IMPROVE MATHEMATICS AND SCIENCE EDUCATION IN LIGHT OF FINDINGS FROM TIMSS

Introduction

In recent years, many states have articulated clearer, more ambitious standards for what students should know and be able to do as they progress through school. However, results of the Third International Mathematics and Science Study (TIMSS), as well as results from periodic administrations of the National Assessment of Educational Progress (NAEP), demonstrate the gap between current student achievement in the United States and the higher academic standards that states are aiming for. The National Education Goals Panel (NEGP) would like to suggest methods for implementing rigorous state standards effectively so that, over time, they will help raise student achievement. The Goals Panel has therefore asked SRI International[1] to describe how states have been implementing their standards. How are states using standards as they select and fund textbooks or curricula, provide support for teachers and instruction (including states' policies relating to pre- and in-service teacher professional development), and conduct assessments of students' learning? The purpose of the paper is to illustrate selected state efforts in these areas, discuss what we know about how states currently support or implement their state standards, and recommend ways to make those processes more effective.

In preparing this paper, SRI International used an extensive data set collected for prior and ongoing work. SRI is currently completing the last of 5 years evaluating the National Science Foundation's (NSF's) Statewide Systemic Initiatives (SSI) Program.[2] That program has supported 25 states and Puerto Rico in ambitious efforts to improve mathematics and science education in elementary and secondary schools. Research conducted for the evaluation has focused on efforts in all the Statewide Systemic Initiatives (SSIs). However, a particularly intensive data-gathering effort has taken place in a dozen case study states. SRI has published case studies describing mathematics and science education improvement efforts in three of those states (Connecticut, Delaware, and Montana—see Zucker and Shields, 1995), and plans to publish case studies about the other nine (Arkansas, California, Kentucky, Louisiana, Maine, Michigan, New York, Vermont, and Virginia) later this year. Much of the data used to prepare this paper comes from the SSI evaluation.

Other sources of information include SRI's current evaluation of the Dwight D. Eisenhower Mathematics and Science Education State Curriculum Frameworks Projects (a program that has supported 16 states to develop and implement curriculum frameworks in mathematics, science, or both) and the evaluation conducted last year by SRI of the American Association for the Advancement of Science's Project 2061 (the first U.S. effort

[1] SRI International, the former Stanford Research Institute, is one of the world's largest not-for-profit research and consulting companies. It is headquartered in Menlo Park, California.

[2] SRI's partners in this effort include the Consortium for Policy Research in Education (CPRE), Policy Studies Associates, Woodside Research Consortium, and the Council of Chief State School Officers.

to develop national science education standards). A variety of secondary data sources are also referenced.

TIMSS Findings: Some Key Claims

TIMSS shows (as NAEP does) that American students are performing at levels below those that most people believe are appropriate or those that correspond to the higher academic standards established in recent years by many states. TIMSS not only compared student achievement in mathematics and science at three grade levels in 50 educational systems around the world; the study also examined the goals and many characteristics of classroom practices in those education systems. The TIMSS findings are provocative and have stimulated a good deal of discussion about efforts to raise student achievement.

Some key TIMSS claims about American education can be found in publications called *A Splintered Vision* (Schmidt et al., 1997), *Pursuing Excellence* (Peak, 1996), and *Characterizing Pedagogical Flow* (Schmidt, 1996). Several findings that are especially pertinent to this paper are identified below.

Curriculum

- **Science and math curricula (and our textbooks) include too many topics.** That is, the U.S. has a curriculum that is "a mile wide and an inch deep."

- **Findings for *some* U.S. subjects/courses differ from the general findings.** In particular, U.S. Algebra I classes are far more focused than other 7th- and 8th-grade classes.

- **There are also some important differences between mathematics and science.** As an example, although the core of mathematics topics is broad, it varies little among states. On the other hand, the number of core science topics is much smaller, and the overlap among state curricula is also small. (Also, although 8th-grade American students achieve scores slightly above the international average in science, they are below average in mathematics.)

- **The U.S. science and mathematics curricula (including textbooks) are less challenging than in some other nations.** For example, curricula in France, Spain and, to some extent, Japan reportedly pose more varied demands on students than do the U.S. curricula.

Instruction

- **The way that American teachers organize lessons may be flawed.** American teachers act primarily as "information transmitters." Moreover, typical teachers in the U.S. use far more activities in a single lesson than seems appropriate.

Standards-based reform

- Fundamental changes in various components of the U.S. education system may be needed to improve student achievement. **The TIMSS reports suggest that changes are needed in teacher preparation, working conditions in schools, the quality of curricula and textbooks, and other aspects of American education.**

Some Comments on These Claims

Virtually all the major findings are consistent with or expand on findings from other research, and this consistency adds to the credibility of TIMSS. For example, SRI convened a panel of experts to review selected science texts as part of an evaluation of the American Association for the Advancement of Science's Project 2061. Findings from that review are consistent with the TIMSS findings. In particular, the SRI review of two popular high school biology textbooks published in 1995 and 1996 found that the glossaries in each contain about 1,000 technical terms (which are also used in the body of the books) and that the authors "have not eliminated material extraneous to what is required to meaningfully convey key concepts" (Zucker, Young, and Luczak, 1996).

Thus, the TIMSS data, like the SRI research just reported, support some key principles advocated in American national mathematics and science education standards documents. For example, one important tenet of *Benchmarks for Science Literacy* (written by Project 2061 staff) is that it would be good practice in teaching science to spend more time on fewer important topics. This approach is sometimes referred to as the principle that "less is more" (although a better summary might be "do more of less"). That position is supported by TIMSS data showing that U.S. science and mathematics curricula try to cover a great many topics but (when compared with curricula in many other nations) sacrifice intensity of coverage, and deeper understanding, to do so.

Similarly, the National Council of Teachers of Mathematics (NCTM) standards focus attention on the importance of teaching mathematics for understanding, not just so that students commit key facts and procedures to memory. The science education standards also focus on the importance of conceptual understanding. This principle is supported by TIMSS data showing that typical U.S. lessons are not as focused as lessons in many other countries, concentrate on less challenging material, and utilize the teacher primarily as a transmitter of information.

Currently, however, TIMSS data do have some significant limitations. For example, TIMSS has not yet released information about high school students. The absence of current information from TIMSS about high schools should not lead us to ignore some of the unique problems at that level. (For example, one of these problems is that the majority of high school science teachers are specialists who seem quite satisfied with their current textbooks, despite the fact that many of the books are laden with an excess of specialized terms [for supporting data, see Weiss, 1994].) This is a topic to which we will return.

The TIMSS reports published to date typically focus on the U.S. as a whole, not individual states. This national portrait obscures variations across the states, both in current practices and in efforts under way to effect change. We know that some of the differences between state education systems are large.[3] It is useful to consider which states have adopted distinctly different approaches to curriculum, instructional materials, support for teachers, or other components of their education system.

Lessons from State Education Improvement Efforts

In this section, examples of distinctive and promising approaches to mathematics and science education among the states are identified. In addition, there is a discussion of the broader lessons learned from SRI's evaluation of NSF's SSI program concerning different strategies that states use to support (or "implement") standards-based education reform.

Curricula and textbooks

Instructional materials are basic to what happens in schools. The TIMSS data challenge us to consider whether typical American textbooks are likely to be effective in the hands of typical teachers. In fact, SRI found that in many of the SSI states instructional materials are still a "weak link," especially in certain domains (e.g., high school science). Only six of the SSIs focus on the instructional materials used in mathematics and science classrooms as a major part of their change strategy.

To improve student achievement, high-quality textbooks (or other instructional materials, such as kit-based elementary science programs) need to be identified (or developed, if necessary), and decision-makers need to be well informed about them. Whether decisions are made at the state or the local level, we believe it would make sense for more states to adopt and/or disseminate information about *existing* high-quality curriculum materials.

In a few cases, the SSIs have engaged in ambitious efforts to create new instructional materials. One successful example can be found in Montana.

- **Montana's SIMMS Project: High-quality materials development.** Montana's Systemic Initiative for Montana Mathematics and Science (SIMMS) is producing six 1-year-long, integrated mathematics courses for grades 9-12. The materials are innovative (e.g., they assume that students have access to powerful computers and graphing calculators throughout, and they focus extensively on applications of mathematics in real-world settings), they have been highly rated by at least two sets of external reviewers, and both the utility and sustainability of the effort are reflected in the fact that the materials are being distributed nationwide by a

[3] For example, in the early 1990s, California's high school science classes (average size 27) were 60 percent larger than Wyoming's (average size 17). States also vary widely in the percentage of teachers certified in the subjects they teach, as well as in many other areas of education (Blank and Gruebel, 1995).

commercial publisher. Note that schools in Montana, a local-control state, are not required to use the new SIMMS curriculum, but many do. The legislature has provided millions of dollars to fund technology for SIMMS students and teachers throughout the state.

Montana is not the only state to focus on using the curriculum to implement a new "vision" for mathematics and science education. For example, many years ago New York developed an integrated high school mathematics curriculum for college-bound students, eliminating separate courses for algebra, geometry, and other strands of mathematics, and it is still used. New York is also one of the few states to focus on technology (in the sense of engineering) as a topic that all students must study in middle schools. More recently, California developed a course called Math A as a richer option for 9th-grade students than general math, giving them an option to enroll in Algebra 1 in 10th grade. The Puerto Rico SSI has been developing a series of year-long curricula in science. Although such state-specific courses or curricula are more the exception than the rule, they do demonstrate that it is possible to innovate on a large scale and to use the curriculum as one way of implementing a state's vision of what mathematics or science education should be.[4]

Other SSIs, such as New Mexico's, have promoted existing high-quality instructional materials. Full Option Science System (FOSS) is an example of one set of elementary science materials promoted in New Mexico and in a number of other states. (FOSS, distributed by Encyclopaedia Britannica, was developed with NSF funds.) New Mexico is a textbook adoption state, but it is probably not necessary that a state be one for state education agency staff to recommend specific curriculum materials to schools and districts.

Over the past decade, the National Science Foundation, a few private foundations, and some commercial publishers have invested many millions of dollars in the development of various curriculum alternatives in mathematics and science.[5] Increasingly, it should be possible for states, districts, and schools to choose and use instructional materials that differ from the mainstream in important ways—if they wish to do so. Ideally, professional development for teachers should be part of the effort to change curriculum and instruction, because new curricula typically require that teachers learn a great deal both new mathematics or science content and new teaching techniques, such as using technology) before they can use the instructional materials effectively.

---

[4] The development of a full-year or multiyear curriculum demands a high level of quality control, and is therefore a task that not all states will want to take on. In Montana, for example, the development of the SIMMS curriculum has involved dozens of writers, several sets of reviewers, year-long pilot tests with students, revisions, professional editing, and other steps.

[5] In the area of elementary and secondary education, one of the major goals of NSF "is to provide the field with high-quality instructional materials that incorporate the best research on teaching and learning, include accurate science and the active participation of scientists in the development process, and have undergone an extensive pilot and field test process" (NSF, 1997). As a result, in recent years, NSF has spent tens of millions of dollars supporting the development of instructional materials in mathematics and science. For example, NSF recently published results of an expert-panel review of 19 full-year and multiyear curricula for middle school science that have been supported with NSF funds (*ibid.*). Most instructional materials supported by NSF are published and distributed by commercial publishers.

Teaching and Professional Development

The TIMSS data show not only that American curricula need to be reexamined but that typical patterns of instruction should change to be better aligned with standards of good practice. TIMSS suggests that professional development for teachers is a necessary, but not sufficient, priority if current U.S. student achievement patterns in mathematics and science education are to be substantially improved.

SRI found that professional development is the most common SSI strategy (a high priority in 18 of 25 SSIs), and in our view the majority of the SSIs using this strategy can be rated as strong or very strong in the way they conduct professional development. Delivering high-quality professional development is something that we as a nation know how to do—at least for those teachers who volunteer and when there are sufficient funds.

The SSIs used three general approaches to professional development: local human resource development, local system capacity building, and state system capacity building. The SSIs typically used a mix of these approaches, and at least nine employed all three approaches. California provides an example of a very strong professional development strategy.

- **California's teacher networks.** California has established two teacher networks: the California Science Implementation Network for elementary science, and Mathematics Renaissance for middle school mathematics. Both networks were created before the state applied for an SSI award, and both are aimed at putting into classrooms the kind of mathematics and science curriculum and instruction envisioned in the California curriculum frameworks. The quality of the professional development is high; the programs are open to all teachers in the state; and tens of thousands of teachers have been served. Funds have been secured to maintain the programs at some level after SSI funding ends, and there is clear evidence of positive impacts on classroom practices.

Nonetheless, in spite of the strong efforts made by most of the SSIs, SRI found that the professional development *system*, such as it is—including state, district, and school policies related to professional development—is in need of restructuring in most states. Only a few SSI states are making efforts of this kind.

- **The Michigan Statewide Systemic Initiative: An example of an effective strategy for creating an infrastructure for building teachers' capacity.** Michigan's SSI has focused on improving the system through which high-quality professional development is available to all local school districts. The MSSI has conducted professional development for providers of professional development, developed guidelines and taken action to restructure the state's system of professional development, and helped revise professional development standards.
- **Massachusetts is trying to change its professional development system.** A new law in Massachusetts (not directly tied to the SSI) has radically altered its

recertification policies by requiring all teachers to write individual professional development plans. The state also specified the types of professional development activities teachers need to participate in to receive credits toward recertification. (The jury is still out in terms of how much impact these changes will have on teachers and teaching.)

These two examples are the exceptions. As long as the professional development systems in the states remain unchanged, policy-makers will face difficult trade-offs between using available funds to work with large numbers of teachers superficially or with small numbers (usually volunteers) intensively. The SSI evaluation team believes that professional development should be better embedded in the work life of all teachers, as part of their job. A variety of new technologies (e.g., interactive CD-ROMs, the World Wide Web) may make this integration more feasible than in the past, but it is still necessary to find time and money within the system to support professional development for teachers and administrators.

Assessment Systems

The TIMSS reports (like many earlier ones) suggest that other components of the education system need to change, besides curriculum and instruction. Testing and assessment systems are a component of particular interest to the Goals Panel and to the National Governors' Association.

One basic premise in designing a system to assess students' learning is that there should be a good match between what is being tested and the important goals established for what students should know and be able to do. (In other words, performance standards established for state tests should be aligned with the goals for students that are typically expressed in state standards or curriculum frameworks.) There are numerous examples of states making significant changes in state tests or assessments to reflect changes in their goals for student learning, some of which began many years ago.

- **Changing the assessment system in New York.** About a decade ago, predating the SSI by many years, the state of New York began using a performance-based assessment of elementary science at the fourth grade. There is evidence that this approach increased attention to the teaching of science in elementary schools, including the use of hands-on science instruction of the type promoted in the national science education standards. New York is also proposing that all students, not just those who are college bound, take the Regents examinations. Those examinations are now being revised to better reflect the state's new curriculum standards.

In spite of examples like this, many state assessment programs still do not include science, which has not been considered a "basic" subject. Moreover, in many states there is a mismatch between the goals established for students in state standards or curriculum frameworks and the content of state-mandated tests. In 1994, when SRI studied the assessment systems in the 25 SSIs, we were able to find only 6 state assessment programs

in mathematics and 4 in science that met our criteria for suitability in evaluating the progress of the SSIs. Although a number of states have improved the alignment of their assessments and standards since that time, it is clear that much work remains to be done to improve state assessment systems. The commitment of Governors and business leaders a year ago to develop appropriate assessments provides a boost to these efforts (National Governors' Association, 1996).

Changing assessment systems is difficult work. In California, an innovative state testing system (the California Learning Assessment System, or CLAS) was abandoned under political pressure. One underlying reason appears to be that the standards the state established for mathematics and science education reform were not widely enough supported to sustain the assessment system (which was also expensive). There are important lessons here about mobilizing public support for reform to which we will return.

Other Strategies For Supporting Standards-Based School Improvement

As part of the SSI evaluation, SRI identified eight strategies that account for the great majority of the activities supported by the SSIs (see Exhibit 1). These can be clustered into two groups, loosely corresponding to what are known as "bottom up" and "top down" strategies for school improvement (Zucker, Shields, Adelman, and Powell, 1995; Zucker and Shields, 1997).[6] Several of the strategies—including support for teacher professional development; developing, disseminating, or adopting instructional materials; and aligning state policy—have already been discussed because they correspond to topics (such as standards, curricula, and textbooks) emphasized in TIMSS publications.

Exhibit 1
EIGHT STRATEGIES USED BY THE SSIs

Strategies focused on teachers, classrooms, and schools:

1. Supporting teacher professional development
2. Developing, disseminating, or adopting instructional materials
3. Supporting model schools

Strategies focused on districts, regions, and states:

4. Aligning state policy
5. Creating an infrastructure for capacity building
6. Funding local systemic initiatives
7. Reforming higher education and the preparation of teachers
8. Mobilizing public and professional opinion

The most common strategy the SSIs have used to support standards-based reform, as noted above, has been to provide teachers with additional professional development

[6] The eight strategies were derived empirically, based on data collected for the SSI evaluation. This set may or may not be a complete list of possibilities. Even if it is not complete, it seems to include the great majority of actions that states have supported. (Note that efforts to increase equity in mathematics and science education cut across the eight strategies; we do not identify those efforts as a separate strategy.)

opportunities, often during the summer. In addition to professional development, two other common strategies used by the SSIs focus resources on activities at the school and classroom level ("bottom up" change strategies): developing, disseminating, or adopting instructional materials (see the Montana example above); and supporting model schools.

In addition, five strategies used by the SSIs aim primarily at effecting change in districts or at the state level ("top down" change strategies). These five are: aligning state policies (which includes developing or revising standards, curriculum frameworks, and state assessment systems); creating an infrastructure for building the capacity of local schools; funding local systemic initiatives; reforming higher education and the preparation of teachers; and mobilizing public and professional opinion in support of school improvement efforts.

Examples of effective use of four of the strategies have already been provided in this paper (supporting teacher professional development in California; developing, disseminating, or adopting instructional materials in Montana; creating an infrastructure for capacity building in Michigan; and aligning state policies in New York and Massachusetts). Below are examples of effective uses of the remaining four.

Supporting model schools. Just five SSIs use a model schools strategy. Members of the SSI evaluation team believe that this is a high-risk strategy. It requires a very careful plan for dissemination and scaling up. If such a plan is not well designed and well implemented, the result is, at best, improvement in a handful of schools statewide. In the states that we believe have strong model schools strategies, that effort serves as part of a much broader reform strategy.

- **Puerto Rico: Successful model schools.** The Puerto Rico SSI established model sites in each of the seven education regions of the island. The sites were test beds for Puerto Rico's ambitious curriculum development efforts and for site-based management ("school empowerment"). In addition, they became dissemination centers in the successful process of scaling up to more schools. These efforts are all closely tied to education reform legislation that predates the SSI.

Funding local systemic initiatives. Nine SSIs, mostly in local-control states, chose to support local systemic initiatives. The key factors in building strong local initiatives are sufficient support for participants at the local level and some kind of quality control mechanism. An example of a successful use of this strategy can be found in Maine.

- **Beacon Sites: Strong local initiatives.** The Beacon Sites in Maine (some of which are schools and some districts) have been a core element of the SSI. By keeping the number small (seven or eight), it was possible to provide substantial support to each. Support for full-time math and science specialists at each site has helped assure the effectiveness of the strategy. The specialists have served as classroom-level coaches and have acquired, reviewed, and established libraries of curricula and instructional materials. As planned, the Beacon Sites have also been an

important component of scaling up reform, gradually establishing reputations as regional centers for learning about high-quality mathematics and science instructional materials and as places that provide models of effective classroom practices.

Reforming higher education. Although 14 of the SSIs have adopted this strategy, none of the efforts can be rated as very strong for reform of teacher preparation programs. Changing teacher preparation has been a challenge, in part because of the difficulty of changing institutions of higher education and in part because of the fact that relatively few of the SSI resources have been used for this purpose. One fairly strong effort is found in Arkansas.

- **The Arkansas "crusades": Involving higher education.** All of Arkansas' 14 institutions of higher education are involved in the math and science "crusades" that are the centerpiece of its SSI. Although progress has not been uniform in all 14, there have been changes in liberal arts courses (mathematics and science) in both public and private colleges and universities.

Mobilizing public and professional opinion. Many surveys and studies provide evidence that public and professional opinion is critically important for education reform. A total of 10 SSIs place a significant emphasis on mobilizing opinion. One that is worth noting is in Louisiana.

- **Louisiana: Mobilizing public opinion in local communities.** One member of the Louisiana SSI staff devotes all his time to helping local districts inform their communities about reforms supported by the SSI. On the basis of a strong theory of change that involves altering the generally low opinion of education held by the public in Louisiana, the SSI responds to local media requests for information and provides custom audio, video, and written information about how the SSI is improving math and science education in the state. The SSI has helped local entities to develop high-quality presentations that are reported to have had a positive impact in their communities.

Each of the eight strategies shows certain strengths and weaknesses (Zucker and Shields, 1997). For example, several of the strategies (especially aligning state policy, reforming teacher preparation, and mobilizing public and professional opinion) typically require political, technical, and financial resources beyond the reach of a 5-year initiative funded mainly with "soft" money. One result is that few SSIs have invested heavily in the reform of teacher preparation, and progress in this area has been limited.

A key point is that the SSIs use *several* strategies in combination (typically about four of them), basing their selection of strategies to use on the state context (e.g., whether the state has a strong tradition of local control of schools or more centralized control), the perceived needs in the state, the strengths of the staff, and other factors. Good strategic thinking seems to be an essential component of standards-based education reform, and

knowledge about how to think and act strategically in the context of state education systems has grown very considerably within the past decade.

It is interesting to consider two governance issues with respect to the SSIs. First, in many of the SSIs, institutions outside of state government have taken on leadership roles. For example, in Connecticut, the Connecticut Academy for Education in Science, Mathematics and Technology was formed specifically to lead the SSI, and similar organizations were formed in Vermont and Maine. The involvement of strong institutions outside of government can be a considerable asset (e.g., by providing a leverage point that is insulated from state politics and state agency hiring restrictions or that may be able to work more readily with business groups), but what arrangement is best varies by state.

On the other hand, with limited exceptions (such as in Arkansas), few school superintendents, school board members, or other district representatives have been actively involved with the SSIs. Since many key policy decisions are made at the district level, this lack of involvement can lead to problems.

To sum up, virtually all the states receiving support from the SSI program have put into place new or improved standards for what students should know and be able to do in mathematics and science. Once that has been done, "implementing the standards" in a state means designing and effectively carrying out a *coherent* and *strategic* set of activities that support school improvement efforts based on the state's standards and its traditions. There is no formula that describes the steps that are needed, since no one knows exactly what they are. The strategies in Exhibit 1 identify the varied types of activities that are being used to support state education standards.

Reflections and Conclusions

TIMSS is a massive study; five books are already in press to report on TIMSS findings, and more are scheduled. Similarly, the findings from SRI's evaluation of the SSI program, including the state case studies, will fill hundreds of pages. Many other excellent sources of information about standards-based education reform can be found (and some are cited here). Distilling all this information into recommendations for the Goals Panel would be a daunting task for anyone. Therefore, the title of this paper, as well as of this section, refers to "reflections" about standards-based reform. These reflections, which are based on research, are intended to stimulate debate and conversation, but certainly do not represent all the pertinent studies or all points of view.

The section begins with a discussion of the overall support that TIMSS provides for continuing efforts in the U.S. to carry out standards-based education reform. The next two sections discuss components of the education system about which TIMSS has a great deal to say, namely, curriculum (including textbooks) and instruction. Finally, the concluding section discusses a topic that undergirds all efforts at standards-based reform: mobilizing public and professional support for changes in the education system.

The need for standards-based reform

By documenting deficiencies in several components of the American education system, TIMSS provides additional reasons for believing that it is important to carry out standards-based reform. Those who are not satisfied with current levels of student achievement in the U.S. can (again) find evidence that improving the situation is likely to entail, at the least, a clarification of goals for students' learning, revisions in curricula and textbooks, and better instruction by teachers. By implication, even though TIMSS does not present evidence about state assessment systems, preservice teacher preparation programs, teacher certification and recertification requirements, state education infrastructures (such as regional centers and teacher networks), or many other features of education systems, one can conclude that these components, too, should be aligned with goals for students' learning. This is an ambitious agenda.

Research conducted by SRI, and by other groups, suggests that both "top down" and "bottom up" strategies are needed to bring about the kinds of improvements that are desired.[7] Creative and strategic thinking is necessary to design and carry out a series of linked strategies that support changes in state education systems.

The starting point for standards-based reform in many states is creating a set of ambitious standards for what students should know and be able to do. Although it is clear that most states have been actively working on their standards, it should not yet be taken for granted that the standards are uniformly of high quality across the states. Research conducted by SRI and others shows that in some states the standards are clear and readable, but in others they lack internal coherence, are poorly formatted, are susceptible to misinterpretation, or are otherwise of lower quality. (To monitor the quality of state standards, the Goals Panel has supported creation of an independent entity to review them.)

Just as there are variations across nations and states in the nature and the quality of goals set for students' learning, there are important variations in curriculum, teacher professional development, assessment, and other components of the education system. One can—and should—learn from these differences across the states, just as one can learn from different nations' practices.

However, we know that a national education system can best be understood as a constellation of different features embedded in a particular culture, not just as a logical outgrowth of some particular feature (such as the nature of the textbooks in use). Thus, at the same time that we have much to learn from the TIMSS data, we must be thoughtful in

---

[7] For example, New American Schools—formerly known as the New American Schools Development Corporation—began with the assumption that an improvement strategy focusing exclusively on individual schools would be powerful enough to change whole systems. More recently, however, a set of published lessons learned about their efforts concluded that "whole-school designs and design-based assistance are limited vehicles to reform and must be coupled creatively with other efforts," including district and state policies, public support, testing, and other elements (Bodilly, 1996).

reaching conclusions about what features of other education systems we wish to adopt and how those features would work in an American context. Similarly, state practices don't always travel well. Some practices are more particular to local-control states, or small states, or textbook adoption states, or states with many low-enrollment high schools (where teachers more often must be generalists), and so on. Again, this fact underscores the importance of good strategic thinking, based on the state context.

What is common across the states is widespread public support for ambitious standards and good instruction. Yet it cannot be taken for granted that educators and the public will support specific changes in the schools that state policy-makers support. We will return to this topic in the concluding section of the paper.

Reviewing textbooks and curricula

The TIMSS publications cited at the beginning of this paper heavily emphasize issues related to mathematics and science textbooks and curriculum. Although many efforts are under way to change and improve textbooks and other instructional materials, the texts used in most classrooms are as described in TIMSS publications.

Some people believe that districts, schools, or even individual teachers should be largely responsible for creating their own instructional materials. The fact is that creating a high-quality curriculum is difficult, specialized work. Some teachers have a talent for such work, but most do not—nor do they necessarily have an interest in writing curriculum, or the time to do so. Expecting most teachers to create their own curricula is like expecting most musicians to compose the music they play or most actors to write the works that they perform.

Ambitious plans for having local agencies write their own curricula are usually doomed to fail, particularly in the absence of rigorous quality control mechanisms. Such unsuccessful attempts have been a problem that SRI and NSF have documented in some of the SSIs. Other, independent studies have reached similar conclusions. A corollary of this finding is that it proves unrealistic to expect that general state standards or curriculum frameworks will provide sufficient guidance so that district or school staff can "fill in the blanks" to create their own curriculum (Massell, Kirst, and Hoppe, 1997). In simple terms: most teachers will continue to rely on textbooks most of the time.

In light of the undisputed importance of textbooks in shaping curriculum and instruction, it is surprising that there are virtually no publicly available reviews of textbooks, or other sources of information about their features or their quality—at least in mathematics and science. It is far easier to find both objective information and expert reviews about cars, restaurants, and many other products and services than it is to learn about the variations in coverage or the perceived quality of different textbooks. (In at least two SSI states, Ohio and Delaware, information about some instructional materials is being made available through the World Wide Web. However, the focus is on short units and modules more than on full textbooks or multiyear text series.) Although it makes sense to

think that experts should be involved in researching and creating reviews and product descriptions, it also seems appropriate that the information should be easily available to school board members, teachers, parents, or anyone else with an interest in curriculum. This is an area in which independent, nongovernmental groups might make a contribution.[8] Increasing the amount of information about products doesn't eliminate variation in preferences, nor does it guarantee that low-quality products will disappear. Nonetheless, increasing the number of sources and the accessibility of credible, well-designed information about textbooks could prove useful to many people.

Improving instruction

In practice, textbooks, curriculum, and instruction are closely intertwined. Changing textbooks often requires that teachers learn new instructional practices. In any event, TIMSS, NAEP, and many other studies suggest that it is important to change current patterns of instruction.

The TIMSS authors claim that there is a "characteristic pedagogical flow" that varies from one education system to another. One TIMSS publication, *Pursuing Excellence*, reports the results of a study that used videotaping to examine mathematics teaching in more than 200 classrooms. The findings are not encouraging.

American teachers of 8th-grade mathematics rarely developed concepts; instead, they focused their efforts on having students develop and practice individual skills. When experts reviewed the videotapes and rated their quality, 87 percent of Japanese lessons and 60 percent of German lessons were judged to be of medium or high quality, compared with only 13 percent of American lessons. Exhibit 2 reproduces a figure from *Pursuing Excellence* that illustrates the different approaches in these nations.

The TIMSS findings about instruction are important, and they provide some useful guidance on how instruction in U.S. classrooms might be improved. TIMSS reminds us what a central role the teacher plays in orchestrating instruction. Videotapes of typical lessons in different countries might be quite instructive to teachers—and, in fact, the U.S. Department of Education has produced a CD-ROM showing 8th-grade mathematics lessons from the U.S., Japan, and Germany (with subtitles in translation). However, we must also keep in mind that instruction balances a great many variables. Efforts to change instruction to align better with national and state standards will involve not just focusing on key topics (a major focus of research in TIMSS) or increasing the emphasis on teaching for understanding of concepts (instead of simply memorizing facts or drilling on skills), but attending to a wide range of other variables, such as using materials (including computer technology) effectively, organizing some instruction so that small groups of students work

[8] The authorizing legislation for the U.S. Department of Education (P.L. 96-88) includes protections for state and local control of education, including prohibition of federal "direction, supervision, or control over ... the selection of ... textbooks." Reviews are not control, but it seems to the author that nongovernmental agencies are on firmer ground publishing information that could tread on publishers' toes.

Exhibit 2
COMPARISON OF THE STEPS TYPICAL OF EIGHTH-GRADE MATHEMATICS LESSONS IN JAPAN, THE U.S., AND GERMANY

The emphasis on understanding is evident in the steps typical of Japanese eighth-grade mathematics lessons:

- Teacher poses a complex, thought-provoking problem.
- Students struggle with the problem.
- Various students present ideas or solutions to the class.
- Class discusses the various solution methods.
- The teacher summarizes the class's conclusions.
- Students practice similar problems.

In contrast, the emphasis on skill acquisition is evident in the steps common to most U.S. and German math lessons:

- Teacher instructs students in a concept or skill.
- Teacher solves example problems with class.
- Students practice on their own while the teacher assists individual students.

together, increasing the number of lessons with an interdisciplinary focus (e.g., combining mathematics and science), spending more time on challenging material, making students more active learners (e.g., engaging them in the classroom discourse), etc. Teachers need a considerable amount of time to learn to teach in ways that are significantly different from their current practice, particularly when instruction involves topics that the teachers are still learning to understand themselves, as is often the case.[9] It would be an error to underestimate the magnitude of the task.

The good news is that there are many successful efforts to provide teachers with high-quality professional development. Policy-makers can increase the opportunities available to teachers and better integrate professional development into teachers' normal work lives. Also, much is already known about how to make professional development effective (Corcoran, 1995). But some of the issues highlighted by TIMSS are seldom addressed in the U.S. For example, according to the TIMSS authors,

> U.S. teachers lack the long and carefully mentored introduction to teaching that Japanese and German teachers receive. ... [Also,] U.S. and German teachers do not have the rich informal opportunities to learn from each other and to share questions about teaching-related issues that are enjoyed by their Japanese colleagues. (Peak, 1996)

[9] Elementary teachers, for example, often have poor backgrounds in mathematics and, especially, science. Also, a significant number of middle and high school teachers are teaching out-of-field. Inadequate teacher preparation is a particularly serious problem in many poor urban and rural areas.

Somehow, time needs to be found for teachers to work together to improve instruction. When time and money are available, well-designed professional development can have an impact.

A number of the SSIs have been able to demonstrate that classroom practices have changed as a result of their efforts. The changes may be more modest than had been hoped for and typically involve a specific set of classrooms heavily involved with the SSI, not whole states, but the improvements are real. Linking professional development explicitly to instructional materials that teachers will later use in the classroom is one practice that many of the SSIs have used successfully. Efforts to change instructional practices need to be systemic in other ways, too. Focusing on one teacher or classroom at a time is unlikely to succeed (because textbooks, tests, state standards, and other factors need to be aligned with and support good instruction). What is more, there needs to be strong public support for the changes in curriculum and instruction about which teachers are learning. This is an issue of continuing importance.

Mobilizing Public and Professional Support For Change

Standards-based reform has motivated thousands of talented individuals and many dozens of different agencies and institutions across the U.S. to improve education for elementary and secondary students. The development of standards, learning goals, and curriculum frameworks is receiving much greater attention now than a decade ago. Setting higher standards has also produced tangible gains for students. For example, the percentage of graduating high school students completing the minimum academic program recommended by the National Commission on Excellence in Education increased from 2.7 percent in 1982 to 29.2 percent a decade later—a 10-fold increase[10] (National Center for Education Statistics, 1995).

At the same time, it is evident from a great deal of research that standards-based reform is difficult, slow work. The difficulty of standards-based reform stems from the fact that it presents not only technical but also political challenges.

In the political arena, it is critical to obtain substantial public and professional support for change. The "vision" that TIMSS speaks about must be carefully and patiently articulated by policy-makers. Some SSI states have found that it takes years to create a vision for change and obtain "buy in" from teachers and the public. Yet, without patience, there is a real risk of backlash, as has happened in a few states.

One clear lesson is that policy-makers should not try to swing the pendulum to extremes, because if people have a perception that new standards or classroom practices are too extreme, they won't support the new approaches. Research shows that good teachers will integrate old and new practices—and appropriately so (see, for example,

[10] The Commission recommended that all students take 4 years of English, 3 years of social science or history, 3 years of mathematics, 3 years of science, and ½ year of computer science.

Knapp et al., 1995; Massell et al., 1997). The public needs to understand that setting new goals (such as having much higher proportions of students successfully solve challenging problems in mathematics and science) does not mean abandoning all the old goals (such as having students memorize certain key facts). Some of the improved approaches to instruction that are called for in national and state standards, such as use of educational technology by teachers and students, will be altogether new to many parents. As older education goals, standards, and practices are replaced by new ones, it is important that the public not believe the baby is being thrown out with the bathwater.

Work done in some of the SSI states illustrates one way a synthesis can be created. In Montana—the same state that is trying a bold, distinctively different high school mathematics curriculum—policy-makers are aware that public support is vital. Montana's draft Framework for Improving Mathematics and Science Education states that:

> Montanans include inquiry-based learning in their accreditation standards because they believe students best acquire scientific and mathematics knowledge when they learn in ways that reflect how mathematics and science actually work. However, Montanans are very clear about their belief that basic facts, basic skills, and basic technologies are essential tools in inquiry-based learning.

As noted earlier, many of the SSIs have set about mobilizing public and professional support for change. The SSIs have use dmany communication channels, inlcuding newspapers, television, and other media; public relations profesionals; public forums; print publications; and even placemats in fast-food restaurants.

Public support seems to be more difficult to obtain in some areas than others. At certain levels in certain disciplines (e.g., elementary mathematics), there are many schools and classrooms where a new vision for educational practice is being implemented, to one degree or another. However, in other areas there are fewer examples of a new vision. Among the SSIs, for example, very little effort is expended in aggregate on changing curriculum and instruction in high schools, especially in science. It would be wrong to conclude that there isn't a need for change in high schools. It simply appears to be more difficult to effect change at that level. Both educators and important segments of the public appear to resist many proposed ideas for changing high schools. For example, SRI's research suggests that changing the curriculum for students in high schools' lower tracks is more acceptable to many parents[11] than changing the curriculum for college-bound and honors students (even though state and national standards call for curriculum changes that would affect all students).

[11] A recently published case study of the ChemCom chemistry curriculum (developed by the American Chemical Society) also highlights issues related to its acceptance and use with high school students in different tracks (Rowe et al., 1997).

Conclusions

The release of the first several of many TIMSS publications is a stimulus to consider the strengths and weaknesses of standards-based education improvement efforts. SRI's evaluation of the SSI program provides a rich database of pertinent information.

There is evidence that many of the SSIs have been able to have a positive impact on student achievement. The numbers of students involved and the magnitude of the gains are both probably smaller than one would wish. Still, these data provide more evidence that sustained attention to standards-based reform pays off. Furthermore, many of the SSIs have changed state education systems in ways that are likely to have lasting impact, even after NSF's funding for them has ended. The legacies will include revised state curriculum frameworks, improved instructional materials, continuing teacher networks, new nonprofit institutions advocating school improvement, business partnerships, attentive legislatures, and some creative, strategic thinking.

However, we have not been able to discover any simple recipe for success. The evidence shows that standards-based reform requires a variety of strategies, involving both "top down" and "bottom up" activities conducted by many different agencies and institutions. Teacher professional development is clearly a necessary part of the mix. Public and professional support for change is essential, and strategies for mobilizing such support are therefore important. The fact that changes in many different components of the education system must be addressed was stated clearly by the Governors and business leaders at last year's National Education Summit:

> We recognize that better use of technology, improved curriculum, better-trained educators, and other changes in the organization and management of schools are necessary to facilitate improved student performance. (National Governors' Association, 1996)

Both state governments and the federal government have demonstrated remarkable staying power on the issue of raising education standards. A number of indicators demonstrate that progress is being made. However, TIMSS reminds us that what we are really talking about is a major cultural change involving the behavior of tens of millions of Americans. It is not surprising that the work is slow. Continued persistence is the key to success.

References

Blank, R. K., and Gruebel, D. (1995). *State indicators of science and mathematics education, 1995.* Washington, DC: Council of Chief State School Officers.

Bodilly, S. (1996). *Lessons from New American Schools Development Corporation's demonstration phase.* Santa Monica, CA: RAND Corporation.

Consortium for Policy Research in Education. (1995, July). *CPRE Policy Briefs. Tracking student achievement in science and math: The promise of state assessment systems.* New Brunswick, NJ: Rutgers (CPRE).

Corcoran, T. C. (1995). *Transforming professional development for teachers: A guide for state policymakers.* Washington, DC: National Governors' Association.

Knapp, M. S., and Associates. (1995). *Teaching for meaning in high-poverty classrooms.* New York: Teachers College Press.

Massell, D., Kirst, M., and Hoppe, M. (1997). *CPRE Policy Briefs. Persistence and change: Standards-based systemic reform in nine states.* Philadelphia: University of Pennsylvania (Consortium for Policy Research in Education).

National Center for Education Statistics. (1995). *Digest of education statistics, 1995.* Washington, DC: U.S. Department of Education.

National Governors' Association. (1996). *National Education Summit policy statement.* Washington, DC: Author.

National Science Foundation (Division of Elementary, Secondary, and Informal Education). (1997). *Review of instructional materials for middle school science.* (NSF publication #97-54.) Washington, DC: Author.

Peak, L. (1996). *Pursuing excellence: A study of U.S. eighth-grade mathematics and science teaching, learning, curriculum, and achievement in international context.* Washington, DC: U.S. Department of Education.

Rowe, M. B., Montgomery, J. E., Midling, M. J., and Keating, T. M. (1997). ChemCom's evolution: Development, spread and adaptation. In: Raizen, S. A., and Britton, E. D. (eds.). *Bold ventures, volume 2: Case studies of U.S. innovations in science education.* Boston: Kluwer Academic Publishers.

Schmidt, W. H., et al. (1996). *Characterizing pedagogical flow: An investigation of mathematics and science teaching in six countries.* Boston: Kluwer Academic Publishers.

Schmidt, W. H., McKnight, C. C., and Raizen, S. A. (1997). *A splintered vision: An investigation of U.S. science and mathematics education.* Boston: Kluwer Academic Publishers.

Weiss, I. R., Matti, M. C., and Smith, P. S. (1994). *Report of the 1993 National Survey of Science and Mathematics Education.* Chapel Hill, NC: Horizon Research, Inc.

Zucker, A. A., and Shields, P. M. (eds.). (1995). *Evaluation of the National Science Foundation's Statewide Systemic Initiatives (SSI) Program, Second-year case studies: Connecticut, Delaware, and Montana.* Menlo Park, CA: SRI International.

Zucker, A. A., and Shields, P. M. (1997, February). *SSI strategies for reform: Preliminary findings from the evaluation of NSF's SSI Program.* Menlo Park, CA: SRI International.

Zucker, A. A., Shields, P. M., Adelman, N., and Powell, J. (1995). *Evaluation of the National Science Foundation's Statewide Systemic Initiatives (SSI) Program: Second-year report, Cross-cutting themes.* (NSF publication #96-48.) Washington, DC: National Science Foundation.

Zucker, A. A., Young, V. M., and Luczak, J. M. (1996). *Evaluation of the American Association for the Advancement of Science's Project 2061.* Menlo Park, CA: SRI International.

CLARIFYING QUESTIONS ABOUT PERSISTENCE AND CHANGE: STANDARDS-BASED REFORM IN NINE STATES

By: Diane Massell

May 1997

MEMORANDUM

TO: National Education Goals Panel
FROM: Diane Massell
RE: Clarifying Questions about *Persistence and Change: Standards-Based Reform in Nine States*
DATE: May 9, 1997

The attached report, *Persistence and Change: Standards-Based Reform in Nine States,* (Attachment A) is hereby submitted for the consideration of the National Education Goals Panel. This report looks at the progress of standards-based reform initiatives undertaken by California, Connecticut, Florida, Georgia, Kentucky, Minnesota, New Jersey, South Carolina and Texas as of the 1994-95 year. CPRE studied the evolution of state policy and its impact in a sample of districts in each state.

In response to this report, your staff posed additional clarifying questions. This memorandum is an attempt to respond to those inquiries. I draw from our knowledge of reform in the above-mentioned nine states, as well as other CPRE research undertaken for other purposes.

Regarding Curriculum and Textbook Materials

You asked: *"What provision are states making to support the development of curriculum that reflect their new state standards? Are they either developing such curriculum themselves, or helping local districts develop or adopt such curriculum? Are state's offering grants, creating resource centers or clearing houses, sponsoring curriculum-related meetings, institutes, training sessions, networks, technical assistance, or undertaking other activities? Are local districts taking the initiative to develop curriculum based on their own state standards? Please describe. Are districts developing curricula for the standards? How and to what extent are they doing so? Is it fair to say that there is an important step in standards implementation missing here?*

Are states doing anything to encourage local district use of textbooks and instructional materials that reflect the standards? What do textbook adoption states such as California and Texas do to ensure that textbooks approved for use in their states express their state standards? How do they do it? What, if anything, do other states do to encourage the development, adoption, and use of good textbooks or other instructional materials geared to help students meet the state standards? Do the state's encourage the use of NSF-funded or other independently developed instructional materials? To what extent are local districts themselves selecting high quality, standards-based textbooks?"

The strategies states use to influence and support curriculum that meets the standards varies widely, depending on a number of factors. One primary influence is the ways in which state and local policymakers negotiate the terrain of "local control" over

education. Most state policymakers proclaim the importance of local control as a factor that constrains their ability to input the school curricula. However, what this means in Connecticut, for example, is very different from what it means in Iowa. In Iowa, for example, the state does not even mandate a statewide assessment—a common practice for other states in the union. While less than half the states adopt lists of recommended or required textbooks, many other states are prohibited by law from mandating any particular curriculum. State strategies for enabling curriculum reform must toe the line of these different political cultures.

In addition, variations in state strategies for supporting curriculum development also arise because of differences in the resources, knowledge, and numbers of staff available both within state departments of education and across other organizations in the state. For over ten years, the dollars and numbers of staff at State Departments of Education have been steadily declining (Massell and Fuhrman, 1994). In California, for instance, the Department has lost nearly 50 percent of its staff since 1991, leaving it with just one math and science specialist (Carlos and Kirst, 1997). These changes raise the importance of other institutions and externally-funded projects as facilitators of curriculum development. We found that projects like the multiple Systemic Initiatives supported by the National Science Foundation, or local foundation efforts, were providing critical resources for curriculum development and implementation. But the extent to which states have independent, external sources of institutional support for curriculum development varies. Comparatively speaking, for instance, California is rich in the types and numbers of external organizations involved in curriculum development and reform.

Having explained <u>why</u> approaches to curricular support vary, let me now go on to describe specific ways in which states try to leverage curriculum change. One common strategy has been for states simply to provide the incentives, and key data, for schools and districts to make decisions about revising their curriculum to meet state standards. In this model of change, for example, Connecticut and Kentucky established a new student assessment program tied to higher standards, and designed approaches to accountability that they believed would spur alignment and provide locals with the information they needed to change their curriculum.

While Kentucky is a materials-adoption state, in the earliest years of Kentucky's reform (the early 1990s), curriculum specialists and others were reported to have strongly discouraged teachers from using textbooks. In the constructivist spirit that the best curricula is tailored by the teachers to the specific educational needs of their students, many Kentucky officials believed that it would undermine reform to use textbooks, or to provide teachers or districts with highly specific curriculum programs. As mentioned in the *Persistence and Change* report, however, teachers and local administrators were at a loss as to how to develop or carry out the kinds of comprehensive curriculum changes that was necessary to meet the demands of the high-stakes reform climate. They demanded more guidance from the state, and later did receive it in the form of more detailed core content standards. Kentucky has also encouraged independent efforts that had curriculum

components that were in line with Kentucky's standards. For example, they provided some support for the Galef Institute-Kentucky Collaborative for Elementary Learning, which has a primary school curriculum (Different Ways of Knowing) aligned to their reforms.

More recently, officials in Kentucky have begun discussing ways to evaluate and disseminate information about existing curricula to help locals make the leap from data on student and school performance to specific curriculum and instruction that can help them make improvements. Similarly, Connecticut officials believe that their next major task is to build local awareness of how to select well-matched and high quality curricular material, of which they feel there is a good supply. Like many states, they are, for example, sharing information about the new curricula coming from the National Science Foundation.

California undertook a more multi-layered approach to the challenge of helping local educators develop and implement curricula aligned to its standards. While the state has a long tradition of textbook adoption, officials did not rely exclusively on that strategy. In part they realized that getting the industry to reconceptualize their materials in the way the new curriculum frameworks required would not happen easily. Many were also aware that textbooks alone would not be sufficient to bring about the broad kinds of curriculum changes they wanted to see. Thus, the state supported multiple strategies for curriculum change.

Let us look at the case of mathematics reform. After developing its new mathematics framework in 1985, the State Board of Education used it to try to push publishers to develop more innovative curriculum. Although they rejected many texts—much to the publishers surprise at the time—officials were not satisfied with the outcome. At that time California decided to sponsor the development of "replacement units," which were new curriculum modules focused on specific mathematical topics in the state framework. Similarly, when the state received a Statewide Systemic Initiatives grant from the National Science Foundation in 1991, they funded a Mathematics Renaissance initiative, a network aimed at replacing traditional computation and drill curriculum with new framework-based lesson units for middle schools[1].

At the high school level, California introduced a new transitional course consistent with standards reforms called Math A. Math A is designed to upgrade general math courses and serve as a bridge to get more lower-achieving students into college preparatory math courses. It replaces general math with a course that stresses powerful content, an emphasis on problem-solving, real-world applications, empirical reasoning, and the use of questioning strategies, manipulatives, calculators, and cooperative learning. A CPRE study found that transition math courses resulted in many improvements in practice. After taking this class, students ended up taking more challenging math in later years. Students learned more and more challenging as well as practical (real-life) material, and had a better

[1] Keep in mind, however, that the relatively few numbers of replacement units did not represent a comprehensive mathematics curricula, and thought it should ultimately be complemented by aligned textbook materials (Goertz et al., 1995). Over the years, there evidence that the publishing industry is accommodating reform, though perhaps not as thoroughly as some reform advocates would like.

opinion of math and a higher sense of self-esteem than students in lower-level math courses (White, Porter, Gamoran, and Smithson 1996).

Perhaps the most central piece of California's strategy to align classroom teaching and curriculum with the frameworks, however, was the use of teacher networks. While there are many of these, the Subject Matter Projects (SMPs) stand out as well-established and exemplary. The origins of the SMPs can be traced to the Bay Area Writing project (BAWP), first established over twenty years ago. Building on this model, the Subject Matter Projects were created to expand the number of teachers and teacher leaders knowledgeable about curriculum. The legislature provided them with funding in three-year cycles, which both provided stability and enabled interested teachers to make a long-term commitment and evolve into a cadre of teacher leaders. By 1994, the SMPs were running in 90 sites as of 1994, and represented work in 11 curriculum areas. Through several-week summer institutes and follow-up training through the year, participating teachers have had the opportunity to reflect on and develop instructional and curricular strategies and projects.

These types of efforts seem to have been effective in beginning the transformation of teaching towards more ambitious standards. In a 1994-95 CPRE survey of California elementary school teachers' response to state mathematics reforms, researchers found that teachers' participation in workshops[2] centered on the new student curriculum had important impacts on teachers' behavior and classroom practices. Compared to teachers who were involved in more generic types of workshops, these experiences prompted teachers' involvement in reform-related activities and reform-related instruction. Better yet, the study found that these changes seemed to translate into students' success on the statewide mathematics test (then, the California Learning Assessment System) (Cohen, Wilson, and Hill, 1997). Some observers also believe that these networks of teachers will help stabilize and protect reform from shifting political winds in education policy (Loucks-Horsley, 1997).

Certainly, as these examples demonstrate, states have not ignored the important issue of bridging the gap between standards and local practice via curriculum. Yet clearly local educators want and need more external guidance and support for curriculum and instruction than they receive. What support they get frequently comes from the commercial publishers whose textbooks they have adopted, on a one-shot workshop basis. While some states have taken some important steps to help districts and schools "flesh out" the curricular implications of the standards, it would be fair to say that an enormous amount needs to be done. Some of the California efforts, for example, had only scratched the surface of the teaching population. By 1994, only 2 percent of its teachers were estimated to have been involved in the Subject Matter Projects. States' strategies—ranging from efforts to leverage change in the commercial publishing industry, sponsorship of curriculum development, or sponsorship of curriculum development as part of professional

[2] These workshops were Replacement Unit Workshops or Marilyn Burns Institutes. The latter provided workshops focused on specific math topics in the framework, and included Math Replacement Units that Ms. Burns herself developed. Again, they are consistent with the California reforms.

development, evaluation and dissemination of knowledge about existing curricula—need more focus and support from state policymakers.

Whatever path is taken, state policymakers must also be reminded of the lessons learned about the National Science Foundation's efforts to develop and implement state-of-the-art curricula from the late-1950s through the 1970s. That lesson was, and is, that curricula is not teacher-proof, and that long-term professional develop and support is critical to effective change in classroom instruction. For example, supporting teachers to implement a new textbook can be as minimal as a district curriculum specialist providing a sequencing guide for teachers pace their instruction in the new textbook to match up to the topics covered in the statewide exam. Such support does nothing to help teachers understand new, richer content or more appropriate instructional strategies. In the astute observation of Richard Elmore about the NSF curriculum reforms of the 1950s through 1970s:

> "The reformers saw the problem of change in a charmingly simple way—get some teachers to try out a new approach to teaching by exposing them to it in a summer workshop and then provide them with the materials they need to teach it on a regular basis. The reformers failed to understand..the multitude of forces that operate on the seemingly simple problem of why teachers teach the way they do. The biggest determinants of how teachers teach are factors like how they themselves were taught, what they actually know about the content they are teaching, how knowledge is defined by individual teachers and by the organizations in which they work, and what access teachers have to new knowledge and to models about how to teach differently. Trying to change teaching by changing curriculum is a bit like trying to improve one's writing by changing the word processing software in one's computer...An incompetent, poorly educated teacher, without access to the support necessary to think and teach differently, will turn the best filet mignon curriculum into meatloaf." (Elmore, 1993, pp. 48-49).

In addition to professional support for teachers, policymakers must not neglect the often critical brokering role played by state and local central office staff in interpreting, and deploying resources, for schools to undertake curricular change.

Regarding Instruction and Professional Development

You asked: *"Have states or state universities made any effort to encourage pre-service teacher education programs to prepare new teachers with the knowledge and skills to help students meet state education standards? How do states encourage in-service professional development opportunities for classroom teachers to acquire the knowledge and skills called for in state education standards? Are there instances where teachers, teacher educators, or others have identified what teachers need to know to teach students to meet the standards, and have they tried to design pre-service or in-service experiences to do so? Please describe."*

State policymakers, and increasingly university officials, are aware of the critical need to improve teacher education and state teacher policies, and move them in line with the more demanding instructional goals embedded in state standards. One important goal reformers have identified is to expand teachers' knowledge of the subject areas in which they teach. Some states have consequently tried to improve the disciplinary learning that occurs in teacher preparation programs by requiring more credits in academic subject areas, imposing discipline-based tests of entry-level teachers, and expanding interactions between faculty in the liberal arts and sciences and faculty in teacher education programs.

Connecticut is a state that has undertaken change in several of these areas. For example, in 1989 the state first implemented its Beginning Educator Support and Training (BEST) program. BEST pairs beginning teachers with veteran classroom teachers trained as mentors in peer coaching, team teaching, and using instructional resources, and new teachers must successfully complete the BEST program to receive a provisional certificate. Through its participation in the national Interstate New Teacher Assessment and Support Consortium (INTASC)[3], Connecticut developed and piloted new, discipline-based teacher performance evaluations in BEST which uses teaching portfolios and is congruent with state instructional reform goals.

Secondly, the Connecticut SSI initiative provided grants to university faculty to redesign teacher education curricula. Through what they called "co-teaching partnerships," K-12 and college faculty jointly taught content and pedagogy courses, and college faculty visited and co-taught in K-12 classes to see how standards were being implemented. Studies found that these efforts had laid the groundwork for the restructuring whole degree programs in mathematics, science, and teacher education in several of the institutions. However, as could be anticipated, change was not universal; inertia or poorly conceived designs for the grants caused some initiatives to fall short (Bruckerhoff and Bruckerhoff, 1996).

Kentucky provides an interesting example of a state that has done much to encourage in-service professional development for classroom teachers, and has provided the resources and the time that has stimulated strong support for change. Unlike many states, Kentucky provided new, dedicated funds for professional development to districts and, most importantly, have continued to provide these resources over time. Too

[3] Indeed, there are many national initiatives now underway that are helping states improve the range of teacher preparation policies and programs. INTASC is a consortium of state education agencies, higher education institutions, and national educational organizations which promotes standards-based reform through the development of model standards and assessments for beginning teachers. To carry out this mission, INTASC helps states work jointly on formulating model policies to reform teacher preparation and licensing, and provides a mechanism for states to collaborate on developmental projects such as crafting new instruments to assess the classroom performance of a teacher. In addition, INTASC has developed model core standards for licensing teachers which are being translated into standards for discipline-specific teaching in math, English language arts, and science, with other subjects to follow. Similarly, 11 states (IL, IN, KS, KY, ME, MD, MO, MT, NC OH, OK) have established partnerships with the National Commission on Teaching and America's Future to improve their teacher policies in ways which would support standards-based education.

frequently, these investments have been seen as short-term fixes and have been the first target of budget cuts. Kentucky provided $1 per pupil in 1990-91, and by 1995 was sending $23 per pupil to districts. For a four-year period, Kentucky also extended the number of instructional days that schools could use for professional development. The extensive nature of Kentucky's standards-based instructional reforms, coupled with a high stakes accountability system, stimulated a demand for professional development specifically focused on improving student performance and instruction. Rather than a more traditional structure, where central office staff decide on a set of professional development offerings for the entire local system, most professional development in Kentucky has been decided by school-level professional development committees that are involved in all phases of school planning. In some schools, teachers collaborate to identify the curricular weaknesses revealed by KIRIS and plan improvements.

Several states wed professional development to policy-making initiatives. For example, Minnesota made teachers an integral part of assessment development for the state in ways which also had benefits to teachers' knowledge and understanding of reform. California, South Carolina, and other states also brought teachers into assessment development activities.

Among other things, state policymakers considering changes to improve teacher preparation and professional development policies should develop ways to tie reforms in meaningful ways to the academic and pedagogical knowledge teachers need, without being so prescriptive that professional development becomes a mandate that fits poorly with teachers' particular needs. Connecticut, like Kentucky and many other states, eliminated permanent educator licenses and required teachers to earn a particular number of continuing education units (CEUs) for relicensure. However, these policies usually do not require that credit hours be linked to reform goals or to the content areas that teachers teach. Furthermore, many observed that once teachers satisfied these CEU requirements, teachers ceased to participate in professional development activities. In other words, they worked against the goal of promoting teachers' understanding of themselves as professionals needing continuous professional improvement. Changing that mindset is an important next step. One way to do this is to reconfigure the school day and school year to build in time for professional development on a regular basis.

In Closing

I hope these responses provide some concrete examples of ways in which states have approached the tasks of curriculum reform and teacher change. Much remains to be done, and the work of the National Education Goals Panel can play an important role in guiding state policymakers to take the next steps in standards-based reform.

References

Carlos, L. and M. W. Kirst (1997) California Curriculum Policy in the 1990's: "We don't have to be in front to lead." Draft paper presented at the 1997 American Education Research Association annual meeting, Chicago, IL.

Cohen, D. K., S. Wilson, and H. Hill (1997) "Teaching and Learning Mathematics in California," draft paper presented at the 1997 American Education Research Association annual meeting, Chicago, IL.

Elmore, R. F. (1993) "The Development and Implementation of Large-scale Curriculum Reforms." Paper prepared for the American Association for the Advancement of Science.

Goertz, M.E., R.E. Floden, J. O'Day (1995). Studies of Educational Reform: Systemic Reform. Volumes I and II. Philadelphia, PA: CPRE.

Loucks-Horsley, S.(1997) "The Role of Teaching and Learning in Systemic Reform: A Focus on Professional Development," draft paper presented at a meeting of the LRDC and the Consortium for Policy Research in Education, March, 1997.

Massell, D. and S. Fuhrman (1994) Ten Years of State Education Reform, 1983-1993: Overview with Four Case Studies. Philadelphia, PA: CPRE.

White, P.A., A.C. Porter, A. Gamoran, and J. Smithson (1996) Upgrading High School Math: A Look at Three Transition Courses. Consortium for Policy Research in Education Policy Brief RB-19-June 1996. Philadelphia, PA: CPRE.

PERSISTENCE AND CHANGE: STANDARDS-BASED REFORM IN NINE STATES

By: Diane Massell
Michael Kirst
Margaret Hoppe

March 1997

CONSORTIUM FOR POLICY RESEARCH IN EDUCATION

The Consortium for Policy Research in Education (CPRE) unites five of the nation's top research institutions in an exciting venture to improve student learning through research on education reform, policy and finance. The members of CPRE are the University of Pennsylvania, Harvard University, Stanford University, the University of Michigan, and the University of WisconsinMadison.

CPRE conducts research on issues such as:

- education reform
- student and teacher standards
- state and local policymaking
- education governance
- school finance
- teacher compensation
- student incentives

To learn more about CPRE, please call (215) 573-0700, and then press 0 for assistance.

In addition to conducting research as described above, CPRE publishes reports and briefs on a variety of education issues. The Consortium also sponsors regional policy workshops for state and local policymakers. CPRE's home page can be found at: http://www.upenn.edu/gse/cpre/

CPRE Research Report Series

Research Reports are issued by CPRE to facilitate the exchange of ideas among policymakers and researchers who share an interest in education policy. The views expressed in the reports are those of individual authors, and are not necessarily shared by the U.S. Department of Education, CPRE, or its institutional partners. This publication was funded by the National Institute on Educational Governance, Finance, Policy-Making and Management, Office of Educational Research and Improvement, U.S. Department of Education, grant numbers OERI-R117G10007 and OERI-R308A60003.

Copies of this report are available for $10.00 each, pre-paid. Prices include book-rate postage and handling. Quantity discounts are available. Write:

CPRE
University of Pennsylvania
Graduate School of Education
3440 Market Street, Suite 560
Philadelphia, PA 19104-3325

Attention: Publications
Phone (215) 573-0700,

TABLE OF CONTENTS

Biographies.....C-1
Acknowledgment.....C-1
Overview.....C-1
National Policy Trends.....C-7
The Politics of Reform.....C-9
The Evolution and Status of Content Standards.....C-13
Progress on Assessment Reform.....C-25
Building Professional Capacity for Reform.....C-35
Equity.....C-41
Fiscal Climate.....C-47
In Closing.....C-52
References.....C-54
Appendix.....C-60

Biographies

Diane Massell is a Senior Research Associate at the Consortium for Policy Research in Education, located in the Graduate School of Education at the University of Pennsylvania. In the last few years, her work has focused on the evolution of standards-based reform, and the development of national, state and local standards policies, resulting in such publications as Setting National Content Standards, a special issue of Education and Urban Society. More recently, her work has focused on the efforts of a national consortium, the New Standards initiative, to create alternative ways of student assessment, and on a new study of the impacts of policy on local practice in 8 states.

Michael Kirst has been Professor of Education and Business Administration at Stanford University since 1969. Kirst has authored ten books, including Schools in Conflict: Political Turbulence in American Education (with Frederick Wirt, 1992), Federal Aid to Education, and his trade book Who Controls Our Schools (W.H. Freeman, 1984). As a policy generalist, Kirst has published articles on school finance politics, curriculum politics, intergovernmental relations, as well as education reform policies. Kirst is Co-Director of Policy Analysis for California Education (PACE), a California state education policy research group.

Margaret Hoppe is a consultant to CPRE. She has provided support on several CPRE projects including the evaluation of the Merck Institute initiative to reform science in four districts and an analysis of the linkages between state and urban initiatives in science and mathematics.

Acknowledgments

The authors would like to give special thanks to Stanford Brown, who assisted in the analysis and preparation of this report. We also thank our many colleagues whose high quality case studies in the nine states were invaluable: Howard Block, Catherine Clark, Tom Corcoran, Jane David, Noemi Donoso, Carol Freeman, Margaret Goertz, Carolyn Herrington, Linda Hertert, Theresa Luhm, Chris Mazzeo, Tim Mazzoni, Larry Picus, Sheila Rosenblum, and Terry Schultz. And, finally, we wish to thank Patrick Shields and Robert Palaich for their helpful reviews.

Overview

This report focuses on the development and progress of standards-based reform in 9 states and 25 districts during 1994 and 1995. It is called "Persistence and Change" because it tells of the continued momentum of standards-based reform. The reform persisted at the same time that political challenges, lack of public understanding and the sheer burden of the work involved occasioned delays, revisions, and modification. We begin this report with an introduction focusing on state education policy, a discussion of our previous work on state reform, and a summary of our current major findings.

Introduction

Although public education is a constitutional responsibility of state government, state policymakers historically delegated this authority to local school districts, particularly in matters of curriculum and instruction. District policymakers, in turn, usually entrusted the curriculum to teachers or textbook publishers, and hired few district staff to develop or provide instructional guidance (Walker, 1990; Rowan, 1983; Crowson and Morris, 1985). Typically, when state or district policymakers did provide direction, they limited it to bare listings of course requirements or behavioral objectives. Few systems prescribed topics within courses or curricula; guidelines about teaching pedagogy were even rarer (Cohen and Spillane, 1993).

In marked contrast to this long historical pattern, states and districts have made unprecedented forays into curriculum and instruction during the last twenty years. Even within this short period, however, their policy approaches have changed rapidly, shifting both in terms of student learning objectives and the kinds of strategies they used to encourage local instructional innovation. Whereas in the late 1970s, state policymakers instituted minimum competency tests to ensure that students learned a modicum of basic skills, by the early 1980s they began to expand both the subjects and grade levels tested. They also pushed through increases in credit requirements for core academic subjects as prerequisites for graduation.

In the late-1980s, state and district policymakers (along with many professional subject-matter associations and private foundations) turned their attention from the number of academic courses to the quality of the core academic content being taught in public schools. They undertook this effort primarily in response to international test results and domestic studies, which indicated that even our academic courses were relatively weak and offered students little opportunity to apply knowledge (Porter et al., 1993; Elley, 1992; Organization for Economic Cooperation and Development, 1992; Kirst, 1993; National Center for Education Statistics,1992). Proponents of more rigorous instructional guidance strategies called for three key reforms:

(1) establishing challenging academic standards for what all students should know and be able to do;

(2) aligning policies such as testing, teacher certification, and professional development and accountability programs to standards; and

(3) restructuring the governance system to delegate overtly to schools and districts the responsibility for developing specific instructional approaches that meet the broadly-worded standards for which the state holds them accountable (Smith and O'Day, 1991).

Known as *standards-based systemic reform*, the overarching objectives of this policy approach are to foster student mastery of more rigorous, challenging academic content and

to increase the emphasis on its application. Business and industry executives, as well as many educators and researchers, have espoused these broad goals.

CPRE's Studies of Reform

Since 1985, the Consortium for Policy Research in Education (CPRE) has been studying the design and architecture of state and district school reform. By conducting longitudinal case studies first in six states (from 1985-90), and then in nine (1990-95), we sought to document the evolution and broad impact of public education policy. During the past five years, we explored the policy reform initiatives primarily focusing on standards-based reforms in California, Connecticut, Florida, Georgia, Kentucky, Minnesota, New Jersey, South Carolina, and Texas. We developed district case studies through a regular cycle of field visits and telephone interviews, as well as the collection and review of pertinent documents[1], in 25 districts within these states. At each level, we spoke with between 12 and 20 policymakers, political observers, and interest-group representatives, as well as school administrators and teachers (see Appendix 1).

In earlier reports on the nine states, we described and analyzed the many variations in state approaches to standards-based reform. (Fuhrman and Massell, 1992; Massell and Fuhrman, 1994; Fuhrman, 1994b). Differences from state to state reflected the interaction of policy ideas with each state's political traditions and structure; its leadership, economic climate, political issues, and interest groups; and the activities of national and other non-governmental groups in the state, among other issues. These elements interact to make an approach to change acceptable in one setting and heretical in another.

Our earlier reports on this project also identified several persistent issues, reforms, and challenges that state and district policymakers were confronting as they tried to implement reforms. Among them were questions about how to develop appropriate and useful standards, curriculum frameworks, and assessments for schools and districts; connect these reforms to teacher education and professional development; build public and professional support for reform; integrate top-down standards with bottom-up restructuring; create schools with the capacity needed to help students achieve ambitious outcomes; and promote more equitable opportunities for learning (Fuhrman and Massell, 1992; Massell and Fuhrman, 1994; Fuhrman, 1994b; Massell, 1994a; Hertert, 1996).

Major Findings

In this report, which draws upon the most recent CPRE field research in states and districts, we look at how these issues have been addressed and explore new issues that have emerged or are on the horizon. The following 12 points highlight our major findings.

[1] When we first began our work, 30 districts planned to participate. For a variety of reasons, ranging from political turbulence in district environments to research saturation and overload, five of our districts withdrew from the study. Over this period, we conducted a total of three site visits at the state level (in 1990-91, 1991-92, and 1994-95) and two at the local level (in 1993-94 and 1994-95).

(1) **In 1994-95, versions of standards-based, systemic change remained a key feature in all our states' education policies, and an integral part of at least eight states' future plans. Twenty of our 25 districts have been using standards-based reforms as elements of their strategies for improving curriculum and instruction.** At the same time, we witnessed an acceleration of policy talk about market-based reforms such as charters, school choice, and vouchers, and sustained attention to deregulation and decentralization. Charter school laws were expanded or introduced, some extraordinary decentralization measures were passed, and several states downsized their central state and local educational agencies. Yet, despite the growing prominence of market-based reform at the state level and increased criticism of state and federal roles in standards initiatives like Goals 2000, the elaboration and implementation of standards-based instructional guidance policies moved steadily forward.

(2) **Discussion in 1994-95 of state-level education policy or the broad framework of standards-based reform was not as partisan as might be expected given political turnover in the states.** Perhaps the explanation lies in the fact that education was not regarded as a top policy priority in most states in 1994-95. Partisanship did emerge over intergovernmental authority issues, such as the dispute over whether the federal Goals 2000 law infringed on state autonomy. However, many state and local respondents also suggested that the Goals 2000 law was so flexible that it provided almost no constraints on their own reform designs. State policymakers often asked for and received waivers from procedural requirements.

(3) Since the beginning of these reform efforts, the pace of standards development has been rather variable. Each state experienced periods of rapid or slow progress depending upon the policy environment at the time and the particular subject-matter area under consideration. In some of our states, efforts to create standards and other instructional guidance documents had been underway for more than five years. Others had completed the work in roughly three years. **When standards development was slowed, it was often due to difficulties in achieving professional and/or public consensus over the nature and design of particular standards, as well as to turnover in leadership and resource constraints. The apparently open-ended nature of the development process and the perceived slow pace of change generated frustration and skepticism about the reforms in some states.**

(4) **The nature of the standards, as reflected both in the documents delineating what students should know and be able to do and in statewide testing programs, altered considerably since these reform movements first began.** Over the past several years, policymakers who included the kinds of affective goals often associated with an approach known as Outcomes-Based Education (OBE) received substantial criticism from religious and conservative groups, but also from the general public and educators. Such goals as 'students should demonstrate high self-esteem' or 'students should work well with others' were challenged as value-laden, intrusive, and difficult to assess. After removing affective goals, policymakers in several states and districts then confronted growing public and

professional concerns about the kinds of constructivist practices and new performance-based assessments often touted by reformers as best for teaching problem-solving and critical thinking skills. But these practices and goals came under sharp criticism for de-emphasizing or even rejecting basic skills instruction. **Thus far, however, state and district policymakers have responded by seeking greater balance between new and older approaches, rather than calling for a wholesale return to conventional practices.**

(5) **For both political and pedagogical reasons, state policymakers defined their standards broadly, intentionally leaving the operational details of curricula to districts and schools. However, district administrators and teachers often wanted *more* guidance and support than the states offered.** This need became most acute for districts that were held accountable for performing well on high-stakes tests tied to the standards. Local respondents frequently felt that state standards were beneficial because they focused attention on instructional issues, but complained that they were too broad and general.

(6) Concerns expressed by some conservative interest groups that standards-based reform represented intrusive governmental interference in local instructional matters did not seem to be widely shared by local respondents. In fact, our finding from the first five years of CPRE research (1985-90) that an expanded state role in education stimulated more, not less, policy at local levels (Fuhrman and Elmore, 1990) is replicated in the case of standards-based reform. **Many districts attempted to match or exceed state initiatives in instructional guidance, and high-capacity districts continued to be strong sources for state policy design. But state policy activities also stimulated and focused local initiatives. More than half of the districts located in states with standards in place reported that the standards initiatives had influenced their own instructional guidance efforts.**

(7) **However, state governments were not the only and sometimes not even the most important source of ideas for standards-based reform at the local level.** Non-governmental and other governmental efforts contributed to the momentum for change by providing alternative sources of ideas and helped to build capacity at the local level. For example, teacher, school, and district networks were created by such national projects as the American Association for the Advancement of Science's Project 2061 and the New American Schools Development Corporation. National standards documents developed by subject-matter associations supported and influenced the development of state standards documents. Participation in projects such as the National Science Foundation's various State, Urban, and Rural Systemic Initiatives expanded the capacity and reach of state standards-based reforms, sometimes acting to maintain momentum and support for reform goals. **Together, these projects and initiatives brought isolated groups into the dialogue of broader reform communities.**

(8) Thus, in 1994-95 we perceived many more voices supporting standards-based instructional change than we did in the mid-to-late 1980s. While one motivation for systemic reform was to reduce the fragmentation in education and clarify the mixed signals being sent to teachers and schools, **this expanded array of actors, each with its own variant of standards-based reform and with its own resources and influences, raises anew**

our earliest questions about the coherence of the messages local officials receive about good practice. While some of their activities reinforced common curricular and instructional themes, there were also considerable differences among the projects. Highly entrepreneurial districts that solicited and won project moneys from different sources received different directives about what to do and how to do it. And, as in the past, state lawmakers continued to layer new policies on old ones, sending mixed and at times incompatible signals to districts and schools (see Fuhrman, 1993).

(9) Earlier studies noted that developing the organizational capacity for districts and schools and the individual capacity for teachers to carry out new, challenging kinds of instruction was the most significant issue confronting reform but was being given the least attention. **Several years into the reform, policymakers have begun to address these capacity questions and tie licensure and professional development activities to reform, although the numerous steps they have taken are still, at best, incremental.** A few states adopted performance-based teacher certification and licensure programs, with evaluations of teacher performance that were at least philosophically congruent with the new standards. But funding constraints and issues of professional and local autonomy made connections between standards and professional development episodic. Linkages were often procedural (i.e., "use this process to define professional development needs"), rather than specific and substantive. Some notable exceptions were state and other national or university efforts to create teacher or school networks built around substantive reform goals. Also, some states used teachers to develop assessments or standards, activities that also served as professional development.

(10) **While all of our states made some attempt to address equity issues, their efforts for the most part were fragmented or loosely connected, if at all, to standards reforms.** Major initiatives, such as desegregation and finance equity, often preceded curricular and were seldom integrated with curricular reform except when state test results were used to identify inequities. State policymakers were requiring or encouraging more students to be included in their testing programs as a primary way of fulfilling the ideal that all students should be held to high standards. Yet, there were disagreements and concerns about the potential impact of this strategy on special needs students, particularly on schools and districts who have large numbers of such students, and about the best way to realize this goal. Representatives of special needs students or programs were often only marginally involved in the development of standards and assessments. Finally, the majority of our states had not yet attempted to develop opportunities to learn standards.

(11) **While our states increased revenues for schooling, they only kept pace with inflation at a time when local educational responsibilities and costs were growing.** These funding levels reflect national trends, which show that inflation-adjusted revenue per pupil has remained relatively unchanged since 1991 (Odden et al., 1995). In some cases, larger fiscal burdens on local districts soured the climate for state-led educational reforms, perceived to be unfunded mandates. The twin pressures of state-level tax cuts and devolution in other arenas of government in addition to education were likely to exacerbate these problems for districts. Although state policymakers have tried to address

this problem by providing districts with greater flexibility in the use of dollars, several were also requiring cuts in, or reducing funding for, district administrative staff. Thus, local officials were struggling under the combined weight of resource and personnel shortages.

(12) **Lack of public support and understanding of standards-based reforms remained major obstacles to the stability of standards.** While all states and many districts had developed mechanisms for professional and public feedback during the development of their standards, in practice these efforts were of relatively short duration and tended to look more like public information campaigns than attempts to establish ongoing, reciprocal dialogues in the pursuit of mutual understanding and agreement. Broad public and professional input was even less apparent in the development of new assessment programs, in part due to technical needs to keep items secure and prevent cheating. In 1995, a few of our states took strong measures to address this problem and provide greater access and scrutiny. While some districts attempted to mobilize local support for standards-based reform, these were often isolated efforts. Most policymakers were at a loss over how to create real and sustained dialogue with the public and tended to rely heavily on polls for their information about public sentiment. These polls have some important limitations, because opinions expressed about education in general can generate different reactions than those concerning one's own children or community. In short, the nationwide concern about inadequate public engagement is well-founded. To sustain reform, policymakers will need to learn how to better engage the public.
The remainder of this report will expand upon these key issues.

National Policy Trends

Standards-Based Reform

The idea that common and ambitious standards should be developed to provide direction to education has dominated the national education policy conversation throughout the 1990s. National surveys suggest that efforts to establish standards-based systemic change have become an integral feature of states' plans to improve instruction and student learning. A 1995 report by the American Federation of Teachers (AFT) listed 49 states as having engaged in some version of standards-based reform (Gandolf, 1995). While the approach to systemic reform varies along substantially across the states, one key, common strategy was to develop new assessments linked to the new standards. The same AFT study finds that 31 states have or plan to develop statewide testing programs coordinated with their content standards (Gandolf, 1995). Many are incorporating forms of performance-based test items into their exams to make them more congruent with their standards' instructional and learning goals. The number of states using performance-based, non-multiple choice exercises in their assessment programs grew from 17 in 1991-92 to 39 in 1994-95 (Bond, et al., 1996). And, many state policymakers are continuing to link teacher licensure and training, accountability programs, and other policies to standards reform, while at the same time devolving responsibilities and authority for the specifics of curriculum and instruction to local districts and schools. States increasingly have been joined by districts striving to put a standards-based system in place. Prominent examples

include New York, NY; Chicago, IL; Philadelphia, PA; San Diego, CA; Pittsburgh, PA; Beaumont, TX; and Edmonds, WA. However, the strength of standards-based reform as a policy idea should not imply that these initiatives did not face very serious problems and challenges they did, as we discuss in later sections of this report. But, it was also true that, overall, this reform idea enjoyed broad stability and incremental progress in 1994-95.

Deregulation, Decentralization and Market-based Reforms

As in other domestic public arenas, a discernible feature of education policy in 1994-95 was the high volume of policy talk and attention given to decentralization and deregulation initiatives, as well as market-based reforms. Policymakers promoted decentralization and deregulation efforts that included transfers of responsibility from federal to state and from state to local authorities, waivers of rules and regulations, regulatory reductions, cutbacks in central education bureaucracies, school-based management and decisionmaking, and other efforts that aim to stimulate local decisionmaking and responsibility. For example, a dozen states considered legislation to abolish state boards of education. Texas cut the state education code by one-third, allowed for "home rule" charters that would release districts from many state regulations, and provided grant entitlements for students to transfer without charge if they attend low-performing public schools or districts. Similarly, deregulation and decentralization was a major, expanded theme in South Carolina, New Jersey, and California, and a continuing part of Minnesota's and Florida's reform initiatives. Thirty states considered reducing or reorganizing their departments of education (National Association of State Boards of Education, 1995). Many of our states continued a trend begun in the early 1980s of sharply reducing their state education agency staff.[2] In addition, Georgia and New Jersey either cut or set limits allowable expenditures for district central office personnel.

Although there is clear overlap with decentralization and deregulation reforms, market-based reforms go one step further by stimulating competition among schools and putting decisionmaking authority more directly into the hands of parents. Many advocates of this reform strategy propose that the discipline of the market, the spur of competition, and the inducement of more or less revenue tied to student enrollments will lead to change and innovation in public education. Specific market-based reforms include policies such as open enrollment laws permitting parents to select any public school for their children; charter schools allowing different agents (parents, teachers, and others) to set up public schools free from some regulation; enrollment options enabling qualified high school

[2] In both the 1980s and 1990s, we found reductions-in-force of approximately 25 percent in the states we tracked. Then, as now, the arguments for these reductions arose out of mistrust and the perception that these agencies were self-interested bureaucracies representing the "education establishment" rather than students, parents, or the public. In Georgia, for example, the state department lost 89 of 450 positions in 1992 (Massell and Fuhrman, 1994). Minnesota abolished its department of education and merged education functions into a new Department of Children, Families, and Learning Created by the governor. The long-term impact of these changes and cuts on state leadership could be profound, particularly if federal resources are cut and if the federal government devolves more responsibilities to the states.

students to attend postsecondary institutions; and vouchers allowing public moneys to follow students to any public or private school. Also included in this category are "privatization" measures districts' use of private firms to handle certain responsibilities or even run entire schools.

Market-based reforms grew significantly in the past few years: by the end of 1994, 11 states had passed charter school legislation, and by 1995 that figure nearly doubled when nine states took similar action (Education Commission of the States, 1995). In our sample, California, Georgia, Minnesota, New Jersey, and Texas had laws permitting charter schools. In 1988, when Minnesota passed its statewide open enrollment program allowing parents to select the public school of their choice, it was the first one to do so; by 1995, 16 states had passed similar legislation (Center for Education Reform, 1995). Voucher initiatives were introduced in several states in 1994-95, including Connecticut, Minnesota, New Jersey, Oregon, and Pennsylvania, but none of these states was successful in joining the limited voucher programs already underway in Wisconsin and Ohio. Although these bills were less successful in transforming policy talk into action, they were often defeated by slim margins. They were reintroduced in Minnesota and are likely to reappear in other states. In addition, a number of districts including Baltimore, Hartford, and Miami, among others undertook privatization initiatives that involved private companies taking over entire schools.

Many state and local policy initiatives for standards-based reform have included decentralization, deregulation, and market-based policies in their overall plans. However, attention to these components accelerated, in part because a Republican majority came to power in Congress and in many states after the 1994 elections. These initiatives have great appeal for many Republicans, who promote smaller government and a more unregulated economy. But decentralization, deregulation, and market-based reforms also have been attractive to many Democrats, increasing support for these reforms even further. Advocacy does not fall neatly along party lines.

The Politics of Reform

Political Stability for Standards-based Reform in a Climate of Change

In the nine states studied by CPRE, 1994-95 was characterized by a disjuncture between change-oriented political rhetoric and a steady, incremental focus on the kinds of state instructional guidance policies that have evolved over the past five to ten years. At the federal level, new Congressional majorities strongly challenged the 1994 Goals 2000 law that promotes standards-based reform. These majorities particularly targeted elements that seemed to infringe on state authority, like national certification of state standards. They did not challenge the standards framework of the Improving America's Schools Act (the reauthorized Elementary and Secondary Education Act), although they asked ultimately unsuccessfully for deep cuts to the long-running federal programs funded under this act. These groups and others led criticisms against the substance of initiatives like the

national history standards, and renewed an older proposal that called for the dismantling of the U.S. Department of Education.

The rhetoric that urged smaller government, deregulation, decategorization, and greater free-market choice at the federal level was mirrored by similar discussions at the state level. Again, while political leaders in states such as California and Texas directed attacks on Goals 2000, their concerns were primarily over intergovernmental authority and control issues, not the framework of standards-based reform. Even when strong antigovernment sentiment did question the idea of state standards or the federal role in education, actual policy changes were modest, and our states, for the most part, stayed the course with standards-based reform.

In fact, standards-based reforms persisted despite a high rate of turnover in political leadership. New Jersey's chief changed in 1994, and in 1995 new chief state school officers took the helm in Florida, Minnesota, Kentucky, Connecticut, Georgia, Texas, and California. Only Barbara Nielsen in South Carolina maintained her seat. In addition, there was considerable turnover in party control in the nine states (see Table 1). In 1993-94, Republicans captured the governorships of Texas, Connecticut, and New Jersey from the Democrats, as well as one house of the legislature in South Carolina and Connecticut. In California, the Assembly was evenly split between Republicans and Democrats, and had a Republican Speaker. While Minnesota Democrats maintained control of the House, there was an increase in new Republicans who were distinctly more socially conservative and constituted a voting majority on some issues. The chief state school officers in Florida and Georgia were Republican, and Republican governors selected new chiefs in New Jersey, Minnesota, and Texas.

Table 1
Political Profile of the Sample States, Post-1994 Elections

STATE	SENATE	HOUSE	GOVERNOR
California	D (6)*	Even split, plus 1 independent	R
Connecticut	R (2)	D (29)	R
Florida	R (2)	D (6)	D
Georgia	D (16)	D (50)	D
Kentucky	D (4)	D (28)	D
Minnesota	D (22)	D (8)	R
New Jersey	R (8)	D (24)	R
South Carolina	D (12)	R (8)	R
Texas	D (3)	D (22)	R

Source: Adapted from the *National Conference of State Legislatures (1995)*

* Figures in parentheses are the number of seats by which the party maintains a majority. These numbers include independents and others, but not vacancies.

Standards reforms did not become the primary focus of campaign rhetoric in most races for elected chief state school officers. In several of our states, particularly Georgia and Texas, new leaders' agendas focused instead on reducing state control over local education through deregulation and decentralization, and market-based initiatives. In addition, in 1994-95, education reform was of relatively low saliency in state electoral races, and took a back seat to new leaders' more immediate concerns over health care, taxes, and crime. Only in Kentucky was education at or near the top of the agenda in gubernatorial races, with criticisms over the state assessment program and other aspects of the 1990 Kentucky Education Reform Act (KERA) in the foreground of debate. The Republican candidate's platform called KERA a failure, but the Democratic gubernatorial candidate, who supported maintaining KERA with some modest modifications, won. Consequently, Kentucky reforms will likely undergo incremental midcourse corrections, but not be completely overhauled.

Why, despite party shifts and the preponderance of policy talk about other reforms, was standards-based reform able to maintain substantial political momentum? Certainly, the support of various state interest groups contributed to the stability of standards reforms. Large business organizations, like the Business Roundtable, remained major backers, even though in some states they played a quieter, behind-the-scenes role when public criticism arose. For example, in several states they focused their attention on trying to understand grassroots sentiment. Also, education groups including teacher unions continued to back state standards reforms. In Texas, for example, business administrators, school administrators, and other education groups lobbied to keep the state test-based accountability system in place, even in a climate of strong legislative support for deregulation and decentralization that could have provided freedom from such mandates. California teachers supported a successful attempt to initiate authorization of a new state assessment system, and Minnesota teachers were supportive of the general idea of increased graduation standards. On the other hand, teacher unions strongly resisted such market-based initiatives as vouchers and opposed any attempt to repeal past gains in such areas as tenure and scope of bargaining. For instance, in Connecticut teachers fought efforts to change state tenure laws, and New Jersey teachers lobbied against changes in state certification laws. Finally, the reach of national initiatives, such as those sponsored by the National Science Foundation, had a stabilizing influence on standards reforms being designed and implemented in the states. Middle-level administrators at the state level were involved in these projects and continued to support and promote them. The continuation of administrative cuts in the state agencies, however, may affect the infrastructure for reform in the future.

In our states, as elsewhere, we found small but well-organized opposition to standards-based reforms from traditional Christian and conservative groups. These were not the only groups criticizing or opposing standards-based reform, but they were one of the most vocal and influential. In general, these groups opposed federal or state control over education and supported deregulation, choice, charter schools, and local flexibility. They opposed state acceptance of federal Goals 2000 grants as an example of expanded governmental authority. They also rallied against OBE, standards, and performance-based

assessment, often perceiving them to be both an extension of government influence and vehicles for liberal philosophies. Over the last few years their influence expanded substantially at the state level in Kentucky and Minnesota. They were active in each of the CPRE study states except New Jersey, and were most influential in Georgia and South Carolina. But, while traditional Christian and conservative groups exerted a growing influence within the Republican party at the state level, their fear of federal control and opposition to OBE did not necessarily lead to partisan battles about the basic idea of standards. And, at the local level, these groups rarely exerted a dominant presence.

While standards-based reform remained on the agenda, no one in the nine states advocated a major expansion of state instructional guidance policies or state authority in this sphere. California restored an assessment program after vetoing an earlier one in 1994, and Kentucky implemented a prior policy decision to provide fiscal rewards to local education agencies that made significant gains in student achievement. To pass the new California assessment, a coalition of the Republican Governor, Democratic chief state school officer, and the Democratic Senate had to overcome opposition in the Republican-led lower house. Measures that stripped the state department of education of some of its authority and responsibility for assessment were critical to successful passage. In their stead, the bill created a new external performance standards group, with a majority of the members appointed by the Governor.

Public Support for Reform

Lack of public support and understanding of standards-based reforms remained a major political obstacle. Only Kentucky and South Carolina had well-developed plans for mobilizing public awareness and a grassroots political support network. The other states mounted public information efforts, but they often relied on building support among professional educator groups. Meetings with professional educators about standards reforms were widespread in all nine states, but policymakers relied on professional elites to support reform and to deliver information to the general public. Some members of the public had been briefed on, or included in, state curricular framework formulation, but plans for building deeper public understanding and support were rare. Some district education agencies mobilized local support for standards reform, but their strategies were not linked effectively to an explicit state strategy and the public, for the most part, was not demanding reform. In short, the nationwide concern about inadequate public engagement is well-founded.

More will have to be done if state reforms are to engender the necessary public support. Yet, many policymakers are uncertain about how to inform people of the changes, much less build the kind of interactive, sustained dialogue and understanding believed to be necessary. For example, despite strong and sustained efforts to inform the public about Kentucky reforms, a 1994 poll showed that nearly half the respondents had not heard about them (Kentucky Institute for Educational Research, 1994). In Minnesota, although a well-funded public campaign to clarify the state's efforts on the Graduation Rule was successful in reducing the perception that it was the same thing as OBE, the public

appeared to know very little about the specifics of the Graduation Rule itself. On the other hand, Florida's school improvement councils, which include non-parental public representatives, seemed to have raised public awareness about what schools do and how they are run because smaller media markets have covered them. The school provided a tangible and logical unit upon which to focus.

In sum, the politics of standards-based reform during late 1994 and 1995 remained generally favorable overall and allowed for a surprisingly high level of stability. Nevertheless, a skeptical and uncertain public and a weak education bureaucracy may yet affect the course of these reforms.

The Evolution and Status of Content Standards

In 1994-95, all of the nine states in our study California, Connecticut, Florida, Georgia, Kentucky, Minnesota, New Jersey, South Carolina, and Texas continued to develop or revise their academic content standards (see Table 2), as did many districts in these states[3]. As noted in the previous section, the education and business communities remained supportive of standards-based reform. External stimulus for reform also came from national associations and projects and other levels of government. Despite this assistance, developing and revising standards was not a smooth or easy process, but instead was characterized by repeated delays and decisions to start anew.

The Pace and Progress of Standards Development Establishing standards has proceeded at a variable and slower-than-expected pace over the life of these initiatives. In most of the states, development was deferred in some or all discipline areas. For example, standards documents in Minnesota and New Jersey were in process for over five years. While New Jersey's State Board of Education finally adopted new standards, Minnesota was still in the process of development. Although Florida's more general standards were adopted several years ago, matching curriculum frameworks were only adopted recently. New curriculum frameworks were authorized in South Carolina in 1990, but work on five of their eight frameworks was postponed.

Delays occurred for many different reasons. In South Carolina and Connecticut, budget constraints contributed to deferrals. Turnovers in political or administrative leadership in states such as Connecticut, New Jersey, Minnesota, and Texas created turbulence in the process. Certainly, political mobilization against Outcomes-Based Education (OBE) or against the inclusion or absence of particular goals, such as basic skills and traditional pedagogical approaches, led policymakers in the majority of states (CA, CT, KY, GA, MN, SC, and TX) back to the drawing board. In addition, Connecticut and South Carolina experienced difficulties in achieving professional consensus in particular subject

[3] We use the term "content standards" to refer to the collective body of documents that policy makers use to guide curriculum (see the next section). Some states do not use this term. For example, Texas calls them essential skills. We have taken the liberty, for the sake of simplicity, of referring to these documents generically as standards.

matter areas. For example, South Carolina encountered significant challenges in building bridges across professional divisions in their English language arts and science communities, but not in mathematics, foreign languages, or visual performing arts. Minnesota, on the other hand, had difficulty securing acceptance of the broad vision and conceptual organization of their standards. It began with an OBE approach, which was eventually discarded, and then devised a two-tiered approach to standards, one focused on basic skills, and the other on more challenging thinking skills.

When leaders in states such as California, New Jersey, and Minnesota determined that the quality of draft documents was poor or that additional time was needed to win support for the initiative, they intentionally extended the period of development and review. Also, the sheer magnitude and complexity of a broad review and feedback process was time-consuming. States used iterative processes that involved several stages of agenda setting, development and review intended to encourage professional and public participation. These processes are necessary to assure input and build support, but they are very time-consuming and difficult to manage. (Massell, 1994a). In many states, administrators were struggling with sharply reduced staffing levels at the department of education. In addition, administrators were trying to learn how to accomplish new tasks often within organizational structures that impeded them (see Lusi, 1994).

While time might have improved the quality of standards, the slow pace generated political opposition (in states such as Georgia, Florida, and Minnesota) or skepticism that standards would ever be meaningfully implemented (New Jersey and Minnesota). Said one Georgia official, "People have wanted change, and they haven't seen it coming fast enough. The only barometer is what they see and hear in the press, 90 percent of which is negative." Even when the development process was not especially slow, it could have been perceived as such by politicians who, under the pressure of reelection campaigns, tended to demand speedy results (Fuhrman, 1993).

Yet, despite some of these impeding factors, it was also true that standards initiatives continued with a momentum that extended beyond state policy activity. As noted earlier, there has been a tremendous amount of external, non-governmental activity nurturing standards reform. People in all of our states reported drawing upon the resources and efforts of associations like the National Council of Teachers of Mathematics and the American Association for the Advancement of Science, as well as other national initiatives such as the Secretary's Commission on Achieving Necessary Skills (SCANS), which developed employment-related skills standards. State policymakers reported that Goals 2000 provided fiscal support for their ongoing reform agenda. Mathematics and science standards were being developed and supported by the National Science Foundation's Statewide Systemic Initiative in seven of our states (CA, CT, FL, GA, KY, NJ, and TX). Even in states like Georgia, where revisions in most areas had been stalled for years, efforts in science and mathematics forged ahead independently. However, as other research on school reform has demonstrated, the institutionalization and broader use of the standards will ultimately require some level of active state or district-wide support (see Fullan, 1991; McLaughlin, 1991; Massell and Goertz, 1994).

Table 2
EVOLUTION OF CURRICULUM STANDARDS DOCUMENTS IN THE 9 STATES

CA	• In the mid-80s, state leaders focused on turning pre-existing state curriculum frameworks into more challenging, innovative documents. Revised frameworks in five subject areas were phased in over the next several years, and by 1994-95 were well-established. But that year the frameworks came under increasing scrutiny because of the state's poor performance on the mathematics and reading portions of the National Assessment of Educational Progress test, among other things. In 1995 the department established task forces to revisit the frameworks. • A 1995 law, Assembly Bill 265, required the development of a new approach to guidance. It called for content and performance standards at every grade level, rather than just grade-level clusters as their current frameworks do. These standards will be developed by a new commission, using a different review process. Plans are to submit the standards for adoption by the state board of education by January, 1998.
CT	• In 1987, the state adopted the Common Core of Learning, which is a set of voluntary, general skills and outcomes for K-12 schooling. Connecticut has produced voluntary guides for curriculum development since 1981. • In 1994, a major report called for the development of content and performance standards, but the mandatory nature of this recommendation generated significant opposition and legislation failed. Currently, the SDE is revising its voluntary guides, which are scheduled for release in 1997.
FL	• The 1991 School Improvement and Education Accountability Act called for the revision of the state's pre-existing curriculum frameworks, following the development of more general state goals and standards in 1993. • In 1996, after some delays, the state adopted frameworks in seven content areas.
GA	• In 1988, Georgia adopted the Quality Core Curriculum (QCC), laying out 72 basic competencies needed for graduation from high school. While law required periodic revisions, these were frequently delayed. However, in 1992 English language arts standards were updated and adopted, as were science and mathematics standards in 1995-96. • Efforts to revise the QCC continued in 1996, and new standards are scheduled for publication in 1997.
KY	• In 1990, the Kentucky Education Reform Act authorized the development of measurable state learning outcomes, and set the state on its course of developing 3 major curriculum guidance documents. Its "57 Academic Expectations" identifies broadly what students should know and be able to do. It is a pared down version of an earlier document containing the kinds of affective[4] goals that critics felt intruded into personal values. • "57 Academic Expectations" became the foundation for a second guidance document, the Transformations curriculum framework. However, in part because of KERA's high stakes accountability system, local educators felt that Transformations did not provide sufficient clarity and guidance. As a result, in 1996 the SDE published the third piece, more specific guidelines known as Core Content for Assessment.
MN	• Minnesota began its move towards a more results-oriented system in the 1980s. The structure and format of its standards altered many times, beginning at first with Outcomes-Based Education (OBE) and over times bringing in other standards elements. Opposition mounted to the more affective goals of OBE as well as its high degree of prescriptiveness concerning local instructional practices. By 1993 this piece of the reform agenda was abandoned. • The Graduation Rule is the current state standards initiative, and contains 2 components: 1) the Basic Requirements, which are minimum skills required of all students for high school graduation, and 2) the Profile of Learning, which are more challenging standards. Students must demonstrate achievement on a portion of the 64 Profile of Learning standards.

[4] Affective goals can include such items as students shall learn to respect themselves and others, or work well in groups. They are often associated with Outcomes-Based Education approaches.

Table 2 (Continued)
EVOLUTION OF CURRICULUM STANDARDS DOCUMENTS IN THE 9 STATES

NJ	• New Jersey began the process of developing standards in the late 1980s, but changes in state reform strategies as well as leadership prolonged the process. The current approach was established in a 1991 monitoring law requiring K-12 content standards. While drafts were completed two years later, an election with turnovers in the governor's and commissioner's office led to postponements and more revisions. • Finally, in 1996 the state board of education adopted content standards in eight areas, and they have become the centerpiece of the governor's response to the state's long-running school finance suit.
SC	• In 1990 the SDE launched an effort to create curriculum frameworks. Math, visual and performing arts, and foreign languages were approved first, in 1993, since consensus for these subjects had been built on a variety of long-term national and local projects. Controversies, as well as resource constraints, led to delays in other subjects, but by 1996, English-language arts and science were adopted, and the last 3 frameworks (social studies, physical education, health and safety) are scheduled for completion in 1997.
TX	• In 1984, Texas adopted a set of "essential elements" representing 12 core areas of knowledge that must be included in instruction. They also developed curriculum frameworks to support instruction based on those elements. • The law authorizing the "essential elements" called for a regular cycle of revision, a process begun over the last few years by curriculum clarification committees. While turnovers in state leadership led to a pause in the process, efforts to draft new standards are back on track and are scheduled for completion in 1997.

Substantive Changes in the Standards

From the outset, the standards documents of all nine states varied in their description of what all students should know and be able to do. Elsewhere, CPRE and other researchers have analyzed the major points of variation in the standards (Fuhrman and Massell, 1992; Goertz and Friedman, 1996; Gandolf, 1996). One general difference is found in the simple assortment and types of documents linked together under the rubric of "standards." For example, Kentucky has several sets of documents, both general and specific, that provide guidance, while others like Connecticut have only curriculum guidelines that undergird subject areas in their testing program. Other differences in approaches to standards include the following.

- **Knowledge framework.** While most of the standards documents make some reference to subject-area knowledge, interdisciplinary goals, and generic academic or job-related skills (for example, 'students should be able to communicate well'), the extent to which they emphasize one or another of these three approaches to content knowledge varies greatly. For instance, Florida's new standards strongly emphasized job-related skills. Minnesota's Profile of Learning standards were not tied to subjects. California and South Carolina, on the other hand, focused heavily on disciplines.

- **Level of knowledge and skills.** Although most standards included both basic skills and elemental knowledge as well as rigorous academic content and problem-solving skills, some emphasized one set more heavily than the other. For example, Georgia's standards primarily focused on basic skills, while California's frameworks

stressed challenging disciplinary knowledge and critical-thinking (although recently they have taken steps to balance the two). As we shall see, an effort to more explicitly discuss and emphasize traditional basic skill elements in the standards has been growing, but not to the exclusion of problem-solving or more challenging content.

- **Specificity.** The level and type of detail about what students should know and be able to do varies enormously. States like Kentucky have several standards-related documents, with the first one outlining broad goals. Subsequent documents provide greater levels of detail and specificity. The level of detail depends in part on the document's purpose whether to guide curriculum writers, to support teachers, or to provide information about general goals to the public and policymakers. For example, California has prepared many supplementary documents to support and clarify its frameworks. Several years ago, the state developed three documents "It's Elementary," "Caught in the Middle," and "Second to None" that illustrated the implementation of the standards in school settings. Some states identified academic expectations by grade levels or grade spans (California, Texas, and Kentucky), while other states more generally described the outcomes for the K-12 system as a whole (South Carolina). Determining the appropriate level of detail for the standards has been one of the most sensitive decisions facing states. The conundrum is that if standards are too specific and detailed, critics charge the state with trying to exert undue influence over local schooling. On the other hand, if they are too general, they provide little guidance to teachers and administrators or others who may be trying to link pertinent policies to the standards (see Massell, 1994b).

- **Making connections among content, teaching, and descriptions of student performance.** Another variation in the level of detail is the extent to which policymakers incorporate notions about appropriate teaching strategies and student performance. Within the profession, debates rage over whether content can in fact be divorced from notions of good instruction (see Massell, 1994a and 1994b), but many would agree that performance standards, which describe at some detail what should be expected of student work, offer a critical link between standards theory and classroom practice.

As we followed these nine states over this five-year period, we found that they made several significant alterations to their standards documents. The most significant changes occurred in the substance and level of the standards, but policymakers also struggled with other design issues that raised questions about how to foster effective change in practice.

Early challenges from parents, religious conservatives, and educator groups led several of our study states (and others) to eliminate the kinds of affective goals often associated with OBE reform approaches. Critics of OBE argued that goals such as "students should work well in groups," "have high self-esteem," or "be tolerant of others" were

difficult, if not impossible, to measure. They argued that such goals inappropriately intruded into the personal lives and values of students and their families. In 1993, Kentucky responded to these concerns by reducing its "75 Valued Learner Outcomes," which included these kinds of goals, to "57 Academic Expectations," which were based on a more tightly construed notion of academic knowledge. In Minnesota, the changes were more dramatic. OBE, once a cornerstone of its reform initiative, was expected to become a mandated requirement. After much criticism and confusion, OBE became a voluntary initiative but retained substantial state backing in the form of additional resources for the districts undertaking it. When criticism continued, the state completely abandoned this piece of its standards agenda.

By the end of 1995, states like California and Kentucky, which had adopted far-reaching constructivist approaches to academic content knowledge, moved closer to the middle of the change spectrum. Policymakers sought to balance more explicitly the constructivist visions of teaching and learning with a mix of more conventional pedagogies and basic skills. For example, California, whose frameworks in English/language arts and mathematics were tightly wedded to new approaches, set up task forces to review these documents after the state fell to 39th place in reading in the National Assessment of Educational Progress (NAEP). Some of the frameworks' chief designers frankly acknowledged that these documents had underplayed the role of phonics, math facts, calculation skills, and other basic skills.[5] The task force reports called for maintaining the new approaches but incorporating more traditional learning strategies and reemphasizing basic skills and teaching approaches.

Another impetus for policymakers' reconsideration of strict constructivist approaches in Kentucky, California, and elsewhere was the growing recognition that teachers must be very well-prepared to use these new, more demanding styles of teaching and learning. Among other things, in order to work well these strategies require that teachers have a solid grounding in their subject-matter knowledge, be tolerant of ambiguity, be masterful at directing open-ended discussions, and be attentive to the unique learning needs of a diverse array of students. Furthermore, education research provides more information about where and why traditional techniques fail than about how new ones succeed. In the field of mathematics, for example, reformers have actively promoted the use of blocks, sticks, or other concrete materials to enable students to "see and touch" numbers and to add, subtract, and build fractions in a hands-on way. But understanding does not come automatically through the fingertips, and the relative effects of different kinds of teaching techniques need to be explored further (Ball, 1992). In the press to embrace the new techniques, many came to believe that too often, to use an old

[5] Bill Honig, former superintendent of public instruction, wrote that the 1987 English/language arts framework created under his watch "makes important points about the need for literacy-rich classrooms, and integrated language arts program, the necessity of being well-read, the potency of literature, and the ability to understand and discuss ideas. While it does state that phonics and skills are important, it is neither specific enough nor clear enough about the essential beginning-to-read strategies for pre-school, kindergarten, and early primary grades. Consequently, as most people now realize, the framework must be supplemented in these areas." He also warned against allowing the pendulum to swing too far back to focus solely on phonics or basic skills (Honig, 1995).

expression, the 'baby was thrown out with the bath water.' For example, some advocates of stricter versions of constructivism encouraged teachers to dispense with the use of textbooks, arguing that most provide dull, superficial information, and emphasize facts at the expense of deep knowledge, exploration, and understanding. But frequently, many teachers' disciplinary knowledge is weak; as a result, for example, teachers often do not know enough about the underlying scientific concepts to use hands-on, science kit experiments very effectively. In these cases, students do not receive any systematic explanation of or understanding of science.

On the other hand, states that had maintained a strictly basic-skills approach to standards were not faring any better than those who faced criticism for developing standards that were considered too innovative. Georgia's basic-skill oriented Quality Core Curriculum was perceived to be old and outdated; for this and other reasons, it was in danger of being eliminated. In South Carolina, one-quarter of the districts were no longer required to take the state basic skills test because they performed well on the exam. This formally placed them outside the accountability system, though some districts continued to administer the test to maintain continuous data on student performance. But respondents saw the basic-skills goals as undemanding and ill-suited to the goal of challenging content. Similarly, many in Minnesota have been critical of the state's decision to require only the basic-skills component of its Graduation Rule, allowing all students to show a record of progress on only a portion of the more demanding Profile of Learning at their own discretion. State policymakers split the basic-skills component off from the high standards piece partly due to concerns about lawsuits and potential declines in the graduation rate. The resulting compromise was a political and practical one. Said one respondent, "We don't want to be caught up in court over this and lose, and then have the whole system collapse."

For many, alterations in the substance of the standards represented a disappointment they no longer saw the reforms as promoting the most innovative approaches to teaching and learning. Instead, they perceived compromises on standards or assessment practices as a slip back to old, detrimental ways (e.g. Noble and Smith, 1994). To others, these changes represented a positive outcome for what was intended to be an interactive dialogue among state policymakers, the profession, and the public over the content of knowledge and the scope of student performance. An as yet unanswered question is whether recent efforts to achieve greater "balance" between more innovative and more traditional approaches will result in coherent standards striking a middle road or in less thoughtful and more contrived aggregations of the old and the new.

District-Level Standards Development

A majority of the districts in our sample were actively pursuing standards-based curricular and instructional change. Twenty of the twenty-five districts included in this round of field research had undertaken their own efforts to develop curriculum frameworks or guidelines.

District standard-setting was not merely a response to state leadership in standards development. To be sure, some districts were more reactive than proactive, but in every state there were some districts that acted in advance of the state, to be prepared for or to anticipate the state reforms. In addition, districts sometimes became a source of guidance and leadership to the state. As in the 1980s, districts conducted a substantial amount of policymaking on their own, substantially leading or elaborating upon state efforts and proving that the extension of governmental authority at one level is not necessarily a "zero sum" game (Fuhrman and Elmore, 1990). Rather than stunting local initiative and decisionmaking, state action often stimulated (see also Spillane et al., 1995) or at least did not inhibit districts' and schools' own curricular and instructional activities.

Indeed, the impact of state standards initiatives on local policies was often more subtle and indirect than what critics who were fearful of aggressive state or federal control over instruction often pictured. Contrary to their concerns that standards-based reforms would overextend state and federal authority, in practice these policies followed well within the constraints of the decentralized American tradition.[6] For instance, local staff in nearly all the sites typically regarded the state's standards as only one of many resources they used to generate their own, more detailed curriculum guidance policies and programs. They reported turning to multiple sources the state, but also national standards groups, other districts, and their own communities for input to develop their own, tailored guidance documents. One California district asked its high school staff to elaborate state frameworks and create a workable local curriculum.

Some of the more entrepreneurial district educators sought external funds or sources of technical support for reform from foundations, national organizations, and other groups. These multiple projects provided assistance in fleshing out the reforms, but they could also pull the district in many different directions. Sometimes these directions were complementary and reinforcing, but sometimes they were competing. Similarly, the general flexibility stemming from the broad detail of state standards documents raises ancillary questions about how well local efforts cohere with state policymakers' intentions. After all, one of the primary motivations for standards-based reform was to build some general congruence across a typically fragmented educational system (see Smith and O'Day, 1991).

Local curriculum standards were usually more specific than ones produced by the state or other groups. For example, while the California framework documents were organized by grade-level clusters (K-3, 4-8, 9-12), three out of the four districts we visited were expanding on them to develop standards for each grade level. States intentionally provided standards that were broadly-worded enough to allow significant room for local

[6] The founding fathers called for deference to the states in educational matters, and fears that government would infringe religious liberty and thought have led states throughout American history to devolve most matters of curriculum content to local authorities. The fragmented nature of our political institutions and school organizations also have prevented higher authorities (even district administrators and principals at the local level) from taking strong control over the curriculum, even local district administrators and principals.

curricular decisionmaking. Politically, state policymakers did not want to exacerbate the kinds of fears and concerns just mentioned i.e., that they were going to exert a heavy, controlling hand over local curricula. Equally compelling for many state administrators was a strategic theory about motivating meaningful local change. Some of our state respondents expressed the belief that, for the standards to truly take hold, local educators would need to elaborate upon them and make them appropriate for their own contexts. In addition to this empowerment and buy-in strategy, state policymakers also believed that the very constructivist goals they were trying to foster required that they not provide overly specified curriculum guidance documents, lest they lead to the kind of lock-step, rote instruction that many reformers were trying to change.

Ironically and, again, contrary to most conservative critics' concerns, most educators wanted more not less external guidance and support for instruction than they received from the state or other groups. For example, the most frequent complaint about state standards centered on their broad, general nature and the implicit or explicit assumption that district and school staff would have the capacity, resources, time, and expertise to flesh them out into a local curriculum. Local educators in Kentucky felt that they lacked the time or knowledge to create the kinds of curricular and instructional programs they needed to meet the new state expectations; consequently, they demanded that the state provide them with more specific guidance and support.[7] This criticism launched the state department of education onto the task of creating yet another (fourth) set of standards documents that would be more detailed than the state Transformations framework. Finding the right balance between specificity and flexibility has been a persistent challenge for policymakers. Said one California administrator about his state's frameworks which, comparatively speaking, were more detailed than most "The state stuff is full of fluff and sweeping general statements, and is not much help."

Many others talked about a need for more time and resources to perform up to the challenges laid out by new standards and assessment policies. District staff felt that meeting these needs were particularly difficult given the fact that local central office personnel were being reduced in many sites. And reform strategies have often ignored the role of central agencies. Furthermore, restructuring initiatives were decentralizing curricular guidance and responsibilities to the school site, thus amplifying the need to prepare even more people to conduct new and different tasks. In fact, historically, local administrators and teachers have not had the kind of expert knowledge and skill necessary to develop curricular programs and materials, leading them to depend heavily on textbook and testing publishers for structure and guidance (Walker, 1990).

In recognition of the stringent demands of the new reforms and usually limited local capacity to perform the development work, many states such as Kentucky and California attempted to provide additional support and more varied kinds of guidance to teachers and administrators. Over the years, for example, California developed curriculum replacement units, developed lists of additional curricular materials and resources, and supported

[7] Local administrators and teachers also felt that, although the sentiment was unofficial, the state was discouraging them from using textbooks as part of their efforts to provide more constructivist teaching.

summer institutes and teacher networks, among other things. Nevertheless, district staff expressed the need for more and more varied assistance. Indeed, district staff in most states were often struggling to patch together temporary solutions to help teachers meet the challenges of reform, but these could be very traditional and piecemeal solutions. For example, a curriculum specialist in one Connecticut district devised a scope and sequencing guide that matched pages in the textbook to the statewide tests. Such approaches to improving test performance do not address the gaps in teachers' content knowledge or instructional strategies.

Like their counterparts at the state level, the theme of the day for district policymakers was balance both in terms of new curriculum and instructional goals, and governance reforms like site-based management. Administrators in several districts, for example, talked about reassuring their publics that they were embracing the basics as well as more challenging goals.

In sum, we found that the concept of standards-based reform in general served to frame many districts' approaches to instructional guidance, even if they perceived their own states' particular standards documents or policy approaches as insufficient or weak. The states' standards documents and related reforms helped to focus district attention on curriculum and instruction, but they were neither the only nor sometimes even the most important sources of information for districts. For other reasons, such as the broadly worded nature of the state documents, the slow pace of reform in some states, and the presence of other external players in standards reform, district staff felt they had a lot of freedom and flexibility to pursue their own path to change. Yet, they also felt they needed much more support than they were getting to enable instructional change to proceed. Finally, at the district level, as at the state level, an emphasis was placed on balancing new and old approaches to instruction.

Conclusion

We have noted the differences among states in their approach to the substance and specificity of standards. These variations in part reflect the relative influence of professionals and the public in the standards development process. In the late 1980s and early 1990s, California established an agenda-setting strategy which maximized the participation and control of leading educators over framework development, which then became known for their cutting edge vision within specific disciplines. In contrast, Kentucky started with a citizen survey, a populist agenda-setting approach which yielded a broader, largely skill-based set of standards. The public emphatically pushed for a greater correspondence between student activities in school and work (Massell, 1994a). Do such differences among standards matter when it comes to teaching and learning? As the standards are completed, and elaborated and interpreted by local educators, the relationships among different approaches and changes in classroom practice and student performance will be important topics of study.

States also varied in the extent to which they tackled multiple aspects of standards-based reform at once, and tried to implement far-reaching, progressive visions, or pursued

change more incrementally. In some states, such as Kentucky, policymakers undertook an aggressive, comprehensive reform strategy, addressing all central policy areas in one reform law. They also pushed for very progressive kinds of standards as well as assessments. Kentucky had the unique impetus of a court order invalidating its entire education system as the result of a school finance equity suit. But at the beginning of this decade, the more comprehensive, wholesale approach seemed attractive to other states as well. For example, Florida's 1991 reform law dealt with standards, assessment, accountability and school-based management all at once, and California moved far ahead of the curve in trying to establish policies and practices that reflected constructivist ideals.

The comprehensive approach had the political value of striking while the iron was hot, and it was a strategy that built on state legislative tradition. Many of the school finance and equity related reforms of the 1970s and the post-A Nation at Risk reforms of the 1980s were incorporated into omnibus packages that combined the specific interests of many individual legislators and hence were able to garner majorities (McDonnell and Fuhrman, 1985; Fuhrman 1994a). In addition, many worried that if policymakers took an incremental approach, states would fall behind on reform and lose the "political moment" of consensus for change.

In the nine states in our sample which restricts broad generalization we found that those states that moved incrementally did not end up significantly further behind the more comprehensive states in terms of building the basic policy infrastructure for standards-based reform. For example, as political and public opposition to standards surfaced, some of the more aggressive states like California were forced to backtrack and regroup. Alternatively, states like Connecticut and New Jersey that moved more slowly on developing standards documents, and made incremental improvements in assessments, continued to make steady progress. In those states, the assessments were well-accepted instruments of state policy; state involvement in curricular guidance was less so. Policymakers consequently relied on state tests to "ratchet up" expectations of student performance gradually over time, a strategy which seems to have fared them relatively well politically.[8] It may be that the relative absence of press, and public attention and engagement, will yield problems in implementation down the road, but for the moment it seems that low-key, slower approaches were well-suited to the political environment in these states.

In contrast, Kentucky managed to sustain its comprehensive and wide-reaching efforts. However, it is important to recognize the very unique features of that state's political and social environment. It has had a large and stable cadre of reform leaders, both inside and outside of government, who even predate KERA. The gubernatorial candidate most supportive of KERA prevailed in the last election, and all institutions of government have remained under one party. As a southern state, Kentucky educators and

[8] When Connecticut policymakers tried to extend the state's authority to mandate curricular standards they received a lashing from conservative groups in 1994. They retreated from this effort and turned back again to relying on incremental improvements in their state tests to lead reform. The state continues to prepare voluntary curriculum frameworks.

the public have been accustomed to a strong central authority, and the KERA reforms did not represent a large extension of the state's mandate over educational affairs. Importantly, school finance reform preceded instructional guidance initiatives, and equalized resources to the point where this is no longer a key issue. And finally, the state has a homogeneous population, and racial divisions do not predominate. Thus, while Kentucky holds many important and valuable lessons about engaging in standards-based reform, its uniqueness must be acknowledged as well.

As interesting as such state-to-state differences are, the similarities across them are even more striking. All of our states used iterative standards development processes that involved rounds of professional and public consultation; all made revisions in their initial plans and documents; all took longer than originally expected; all struggled with how to organize their standards and how specific to make them. In each of them, many districts embarked on standards development as well, and most local educators we spoke to were interested in more, not less, guidance from states. Most of our sites attempted to strike a better balance between innovative approaches to curriculum and instruction and more traditional strategies.

The progress of standards-based reform, as well as the agenda and goals it promotes, has become a national event, with many commonalities across the states. The nationalization of education reform initiatives is not a new story. The school finance equalization initiatives of the 1970s and the excellence reforms of the 1980s swept from state-to-state with remarkable speed and consistency. (Kirst and Meister, 1983) Improved communications and the increasing interest of national policymaker and educator associations in education policy are important influences. It appears that the prominent role of national funders and "third sector" groups in the current reforms has enhanced nationalization even further. As noted above, both states and districts drew upon federal programs, such as the National Science Foundation's systemic initiatives and Goals 2000. The Statewide Systemic Initiatives were particularly influential, providing a continuing source of ideas and of policy development, and promoting standards reform even in states like Georgia where political leadership was not strongly supportive. National disciplinary and professional associations supplied ideas and models; foundations lent additional monetary support; and policymaker associations facilitated the sharing of lessons about the process of standards development.

The opposition to standards reforms also took national channels. Conservative groups shared literature and tactics across state lines, just as policymakers and educators from various states helped each other respond to the challenges. One of the strengths of our system is that the various "laboratories of democracy" at the state and local level can learn from one another. The differences among them produce contrasts that shed significant light on alternative options. It may be, however, that learning and adaptation is occurring so swiftly in the modern age that the variation which provided the natural experiment is becoming narrower.

Progress on Assessment Reform

For the past several years, state efforts to improve assessment programs have been intensive and widespread. Policymakers concentrated their attention on several major design goals, which included among other things: the creation of tests aligned to new content standards, the elimination of norm-referenced tests, and the replacement of more traditional multiple-choice assessments with performance-based exams. As was the case with the standards documents, progress in assessment reform was steady and incremental over time, though the speed of change varied from state to state. In this section, we concentrate most of our attention on the effort undertaken with performance-based assessment. However, we will first very briefly mention progress and issues regarding test alignment to new standards, and efforts to remove norm-referenced testing.

From the beginning of the standards-based reform movement, a key objective was to create compatible, linked policy instruments that mirrored new, more demanding learning goals. State policymakers also demanded customization and alignment of commercial tests to their own content and performance standards because of the care they had taken to craft a consensus among state stakeholders for their new standards. By 1994-95, Connecticut, Kentucky and Texas reported that their each component of their assessment program was matched to existing content guidelines or standards, and Georgia and Florida reported one aligned component (see Table 3). The extent to which states had achieved these linkages depended upon many factors, including the progress they had made on developing their standards documents, but also because of their overall development design strategy. For example, states such as Florida waited to make any major assessment changes until they had completed the standards development and adoption process a process which was delayed and which subsequently slowed any progress in the testing arena. But others states such as Connecticut and Kentucky really started with reforms in assessments, and moved towards expressing their curricular expectations in standards documents later, over time. In these states, alignment between assessments and standards was more of an iterative process than a linear one. One alignment issue of concern in several states in our sample, and generally across the country, was the gap between the content areas in which standards were developed, and the subjects that states would actually assess. For example, Florida developed standards in seven areas but planned to test students only in communications, writing and mathematics. Similarly, Kentucky developed standards but not assessments in the arts and humanities and vocational studies. The absence of statewide testing in these subjects may lead to their neglect in the school curriculum, as well as a potential loss of resources for these content areas at the local district and school levels.

Secondly, in a number of states, policymakers wanted to eliminate the use of norm-referenced tests. In norm-referenced testing, individual student scores are compared to the performance of other students in the testing pool, not to an absolute standard of knowledge. Conceivably, then, a student who knows little about a subject could get a

Table 3
STATUS OF STATE TESTING PROGRAMS IN CPRE STATES, 1994-95

State	Assessment Component	Grades/Subjects Tested	Item Format	Scoring	Aligned to Standards	Other
CA	• *California Assessment of Academic Achievement (CAAA)*	• 4 - 5, 8, 10 Math, reading, writing, science, history/social sciences.	• Planned	•TBA	• Planned	CLAS vetoed in 1994. Plan is to implement CAAA statewide testing component by 1999.
	• *Pupil Incentive Program* State provides $5/pupil if districts use norm-referenced test of basic skills.	• 2 - 10 Reading, spelling, writing, math	• Local Option	• NRT	• No	
CT	• *Connecticut Mastery Test*	•4, 6, 8 Math, language arts	• Mixed	• CRT	• Yes	
	• *Connecticut Academic Performance Test*	• 10 Math, language arts, science, integrated multidisciplinary	• Mixed	• CRT	• Yes	
FL	• *Florida Writing Assessment Program*	•4, 8, 10 Writing	• PB	• PL	• Yes	RFP issued for new grades 4, 8, and 10 test to be field tested in 1997. Will primarily be multiple choice but will also include performance items. The Grade 10 Assessment Test will be eliminated. The High School Competency Test will be realigned to the standards, and the Writing Assessment will continue.
	• *Grade Ten Assessment Test*	• 10 Math, communications	• FR	• NRT	• No	
	• *High School competency Test*	• 11 Math, communications	• FR	• CRT	• No	
	• *District Norm-Referenced Tests* Districts must administer and submit results to the state.	• 4, 8 Math, reading	• Local option	• NRT	• No	
GA	• *Iowa Test of Basic Skills/TAP*	• 3, 5, 8, 11 Math reading with science and social studies	• FR	• NRT	•No	Proposal to eliminate Curriculum-Based Assessments was defeated, but they were made voluntary. Issue of elimination will be revisited.
	• *Curriculum-Based Assessment*	• 3, 5, 8, 11 Math, language arts, science, social studies, writing	• Mixed	• Mixed	• Yes	

Table 3 (Continued)
STATUS OF STATE TESTING PROGRAMS IN CPRE STATES, 1994-95

KY	• *Kentucky Instructional Results Information System*	• 4, 8, 12 Math, reading, science, social studies, writing	• PB and Portfolios in math and writing	• PL	• Yes	Changes in KIRIS for 1995-96 will include 1. CTB Terra Nova in math (3, 6, 9) 2. Multiple choice items 3. KIRIS spread out across more grade levels 4. Performance events out 5. Math portfolios experimental.
MN	• *Graduation Rule* Two components: a) Basic Requirements, districts can select any minimum competency test to meet these basic skills standards b) Profile of Learning, districts can select which of these more challenging standard to assess, and use any assessments they wish • *Planning Evaluation and Reporting Process (PER)* Districts must assess sample of students in 3 grades.	• a) Basic Requirements: Reading and math in the 9th grade b) Profile of Learning: interdisciplinary, anytime between grades 9 and 12 • Local Option for both grade levels and subjects.	•Local Option • Local Option	• Local Option • Local Option	• Planned • No	Graduation Rule to be implemented in 1998. State designed test districts can use for Basic Requirements. State sponsored development of performance-based assessment that can satisfy different profile of Learning standards. Writing and science will be added to the Basic Requirements. PER set to expire in 1996 and be replaced with the Graduation Rule
NJ	• *Early Warning Test (EWT)* • *High School Proficiency Test*	• 4,8 Math, reading, writing • 11 Math, reading, writing	• Mixed • Mixed	• PL • CRT	• Planed for 4th Grade	Tests are evolving from basic-skill, multiple-choice format to include more performance-based elements; 4th-grade EWT under development.
SC	• *Basic Skills Assessment Program* • *Metropolitan Achievement Test 7*	• 3, 6, 8, 10 Math, reading, science, with writing samples • 4, 5, 7, 9, 11 Math, reading, language arts	• Mixed • FR	• CRT • NRT	•Planned • No	K-3 Continuous Assessment Project piloted, 36 sites piloting performance assessments.

Table 3 (Continued)
STATUS OF STATE TESTING PROGRAMS IN CPRE STATES, 1994-95

TX	• *Tesas Assessment of Academic Skills* (TAAS)	• 3-8, 10 Math, reading, writing, science, social studies	• Mixed	• CRT	•Yes	1995 TAAS released to allow public scrutiny.
	• *TAAS End-of-Course Exams*	• 9-12 Algebra 1, Biology I	• Mixed	• CRT		End-of Course assessments will be piloted for English II, U.S. History in 1996.

KEY: Item Format: FR = fixed response; PB = performance based. Mixed Scoring: NRT = norm-referenced; CRT = criterion-referenced; PL = performance level. 1

decent score on the test if their peers perform poorly as well. In addition, norm-referenced tests have long been criticized for being ill-matched to the actual curricula that students receive in school.

But efforts to remove norm-referenced tests in California and Kentucky met with resistance from parents and educators who demanded information about how their children's scores compared to others. In addition, local administrators often wanted to use norm-referenced tests to evaluate instructional programs. Thus, even after Kentucky had removed norm-referenced testing from its statewide testing program, 40 percent of its districts reintroduced or maintained such tests locally. In response to these kinds of pressures, Kentucky and California reinstated norm-referenced test components. While Kentucky's KIRIS exam itself is not normed, state policymakers added a portion of a commercial mathematics test, the CTB Terra Nova, which they believed was reasonably aligned to their standards. California's new assessment law authorized a $5/pupil incentive for districts to administer commercial, norm-referenced tests in grades 2-10. Texas, which removed its norm-referenced test component in 1993, sought to norm its criterion-referenced TAAS exams. When the impracticality of this approach became apparent, the state called for TAAS to be aligned with a norm-referenced test, although this project was not funded as of 1995. Unlike the other states, Georgia, Florida and South Carolina maintained their norm-referenced components throughout the period, although Florida planned to drop one normed piece of its system (the 10th grade Assessment Test).

Performance Assessment

The most prominent and widespread goal of assessment reform has been to change the nature of test items away from common, multiple-choice and fixed-response formats towards more open-ended, authentic learning tasks. The latter, often called performance-based assessments, ask students to apply their learning to such tasks as writing a paragraph or essay in response to a question, writing a research paper, conducting scientific

experiments, or engaging in computer simulations of scientific activity (Pechman and Hammond, 1991). Collecting and evaluating student work from the classroom over an extended period of time and placing it into portfolios is another new assessment strategy that some advocate as providing a more complete picture of students' knowledge and understanding. Performance assessments in general tend to prompt students to use more analytical thinking skills. In addition to better gauging students' understanding and thinking abilities, advocates argue that performance-based assessments would have repercussions for teaching in the classroom, moving it away from rote drill-and-practice techniques towards more problem-based, hands-on kinds of pedagogues (Wiggins, 1993; Flexer, et al., 1994).

All nine CPRE states experimented with performance assessment to some degree over the course of the past five years, but the extent to which this strategy was included in testing programs varied. By the end of 1995, six states California, Connecticut, Florida, Kentucky, Minnesota and New Jersey incorporated or planned to incorporate some type of performance based testing in their statewide assessments. Three had no plans to do so. The South Carolina legislature, while supporting experimentation with performance assessment in 36 districts, maintained its statewide basic-skills test and did not accept any proposed alterations. While Texas piloted performance assessments statewide, these were not included on the Texas assessment. Georgia policymakers took little action on performance assessment reforms.

Performance assessment initiatives were of different character and scope across the states. Kentucky implemented and maintained the most comprehensive performance-based system of all the states. Over the past several years, the Kentucky Instructional Results and Information System (KIRIS) evolved into a completely performance-based assessment. In 1993, state policymakers decided to exclude multiple choice items from accountability calculations, when analyses suggested that they were not needed for technical reasons, and once teachers had time to get used to performance types of items. Uniquely among our states and indeed, most states around the country KIRIS also used mathematics and writing portfolios and included those results in its accountability index. As a result of some expert reviews of the program, policymakers planned several changes in 1995. For example, Kentucky will once again use multiple choice items in its accountability index in order to broaden subject coverage and increase reliability. While writing portfolios will be retained, math portfolios will be changed to pilots not included in the index, and group performance tasks (performance events) will be eliminated. Despite these changes, policymakers intended to retain the largely performance-based character of the KIRIS system.

California also developed and administered a primarily performance-based statewide assessment in 1992 and 1993, but unlike Kentucky this system did not survive the technical, political and other challenges it encountered. Among other things, expert reviews found that the California Learning Assessment System (CLAS) did not produce technically-sound school level scores. Further, the department focused on producing school level results, and scored only a sample of individual student responses. But providing individual-level results had been the governor's key policy objective for CLAS.

The lack of individual scores spurred parents' discomfort with the exam, as did the outcry of religious groups that perceived of the test as an imposition of liberal values. Concerns about test security meant that items were not publicly reviewed, and this exacerbated religious groups' concerns. Thus in 1994 the governor vetoed continued funding for CLAS. But in 1995, A.B. 265 was passed which authorized the development of another state assessment program. While it reestablished a place for traditional testing it provided an incentive to districts to use norm-referenced, basic skills tests in grades 2 through 10, and reintroduced multiple choice items in a new statewide test it also allowed room for measures of applied learning (i.e., performance assessments).

Some state policymakers adopted a more incremental strategy for introducing performance assessments into the statewide testing program. Partly due to resource constraints, Connecticut added performance-based tasks to their basic-skills Connecticut Mastery Test (CMT) gradually over time. By 1994-95, approximately 30 percent of the CMT was performance-based, while the remainder consisted of multiple-choice items. Policymakers planned for the next iteration to contain a higher percentage of performance-based tasks. Its 10th grade exam, the Connecticut Academic Performance Test (CAPT), had more performance items as well as an innovative, integrated knowledge component. Similarly, New Jersey slowly added performance items to its more traditional format.

Policymakers in a few states adopted a slower, more wait-and-see attitude towards performance-based testing. Policymakers in these states provided support for experimentation and piloting, and planned to decide later whether to incorporate these assessments into the state exams. For example, Texas conducted statewide pilots of performance assessments, but these were discontinued in part because of difficulties in administering them on a large scale basis, and in part because of political challenges from conservative groups that perceived performance assessments as akin to Outcomes-Based Education. As a result, the 1994-95 assessment was a more challenging, but still multiple choice, test. Similarly, South Carolina policymakers supported locally-developed performance assessments, which some hoped would be integrated into a new statewide exam. Ultimately, however, the legislature rejected changes in its statewide basic skills test. Florida, which also provided funding for experimental efforts, eventually included a modest proportion of performance items in its programs. While this was less than originally envisioned by many state reformers, performance assessment had come under intense political attack during the elections, so its persistence at all could be seen somewhat as a victory for the idea. Minnesota provided resources and assistance for over 1,000 teachers in 14 districts to develop performance assessments deliberately connected to the Profile of Learning component of the state's Graduation Rule. In this case, the state planned to allow districts to select from these assessment models or others of their own choosing to demonstrate progress on the Profile of Learning. [9]

[9] While Minnesota was also preparing a statewide test for measuring the Basic Requirements component of its Graduation Rule, districts similarly will be allowed to use any aligned assessment of their own choosing. The options are in keeping without he state's long tradition of local control.

Clearly, reforms to introduce performance-based assessments ran into a number of obstacles in the states. Here we address two. The first is the policy objective of using performance assessments to serve multiple purposes, and the technical and practical issues associated with that goal. The second is the challenge of building a base of understanding and support among the public and educators.

Multiple Purposes

Assessments can be designed to serve many different purposes, ranging from diagnoses of individual students' learning strengths and weaknesses, to improving curriculum and instruction, to evaluating programs, to holding schools and districts accountable for student performance. Different test designs can serve these different purposes. For example, to be most useful to a classroom teacher, tests need to be highly detailed and closely aligned to the classroom curriculum in order to provide rich, accurate information about individual students' thinking (Resnick and Resnick, 1992). But policymakers and the public do not need such detailed information to produce accurate accountability reports; in fact, such detail hampers cost-effective and efficient analyses. Similarly, while performance tasks may support better instructional techniques in the classroom, multiple-choice items are adequate to provide an accounting of school or district performance. And, finally, while norm-referenced tests may not provide good data on how or why individuals think the way they do, they have arguably performed well on predicting future student achievement, and ranking students for college selection, course placement, or jobs (Pechman and Hammond, 1991).

Such tensions have long been recognized in the research community. Advocates of performance-based formats have argued that these assessments could be designed in such a way as to close the gap between tests that are useful for accountability and ones that support good instructional practices in the classroom. They stressed that the technical issues confronting performance assessment, like reliability and validity, could be resolved to make such tasks useful for holding students, schools and districts accountable.

To tackle such issues, state policymakers pooled their intellectual and fiscal resources by participating in collaboratives to collectively develop and pilot performance-based assessments, such as the New Standards Project or the State Collaborative on Assessment and Student Standards (SCASS) initiative of the Council of Chief State School Officers. They also hoped that by working together they would reduce the developmental time and expense associated with creating performance tasks.

Many of the technical problems were resolved. For example, the open-ended nature of performance tasks, which require students to evaluate situations and solve problems, and draw on a range of thinking strategies and skills, produce highly variable student responses. To address these variability issues and to ensure that activities were linked to common standards, Kentucky introduced "on-demand" elements in its portfolios common, specific questions or tasks to which all students must respond. To make sure reported results were reliable, they also established a system of auditing scores, and

provided extensive teacher training to improve the inter-rater reliability of scoring on portfolios.

But some issues, such as validity of some kinds of performance assessments over time (i.e., obtaining longitudinal data), or producing reliable and cost-efficient scores for individual students using wholly performance-based methods, remain difficult challenges. So, for example, research shows that when a substantial number of performance tasks are used, one can produce accurate and fair estimates of student achievement (Shavelson, Baxter, and Pine, 1992; Shavelson, Gao, and Baxter, 1993). However, such a strategy considerably inflates the expense and time associated with performance assessments, factors that weigh in policymakers' decisions. California policymakers had restricted the testing time per subject area to no more than one or two hours, a limitation which produced unacceptable measurement errors on individual results from the 1993 California Learning Assessment Program (CLAS) (Cronbach, Bradburn, and Horvitz, 1994). If students had performed more tasks over a longer period, these problems would have been avoided. Similarly, when Texas attempted to pilot statewide science and social studies tasks, reports came back from teachers in schools without the necessary basic equipment or materials. Making sure all students have access to the resources needed to do these kinds of performance tasks is essential to produce valid and reliable results, but also costs time and money. Without these guarantees, using wholly performance-based assessments for accountability purposes is difficult.

As a result, an increasingly popular strategy for resolving the technical issues, as well as the practical ones of testing time and reducing costs, was to mix performance assessment formats with multiple choice items. As mentioned, such a strategy was adopted early on by New Jersey and Connecticut, and later embraced by Florida and Kentucky. And, as we shall see, this mixed model also became a way of resolving political problems with the public.

Public Support

Policymakers confronted a number of challenges in developing and maintaining public support for assessment reform. In some cases, schools with strong scores on more traditional assessments did not always rank well on new exams. For instance, in California, Kentucky, and Connecticut, some suburban communities that performed poorly on new assessments voiced anger and opposition to the new assessments. In Texas, conservative groups charged that performance assessments were "soft" and less demanding than multiple-choice items which require yes-or-no, right-or-wrong answers. Also, conservative groups in California and elsewhere grew suspicious of the kinds of liberal values and critical thinking skills they perceived in the new exams.

Because test development is typically an "insider's" activity involving technical specialists and teachers but rarely the public these kinds of public concerns and suspicions deepened. In response, California's new assessment law called for a high level of public scrutiny in test development. A six-person Statewide Pupil Assessment Review Panel will review the tests to ensure that they do not contain questions about students' or parents'

personal beliefs about sex, family life, morality, or religion and questions that evaluate personal characteristics such as honesty, sociability, or self-esteem. Legislators and local board members can also examine the content of any approved or adopted test if they agree to maintain confidentiality (EdSource, 1995). The law also takes some responsibility for test development out of the hands of "insiders" at the state department of education. Texas enacted a similar policy to address the public's concerns and plans to publicly release exams after each administration. Since releasing the test prevents its reuse, this policy poses a considerable expense for the state at a time when some legislators are already complaining about the high cost of test development. The estimated cost of releasing TAAS is $6 million. But another strategy for addressing these political issues was for states like California, Florida and Kentucky to adopt the mixed assessment model that contains both multiple choice and performance-based items, and that explicitly targets basic as well as higher order thinking skills. For parents and the public, multiple choice tests provide a comfortable, familiar metric using what at least on the surface seems an objective format. Thus, in 1994-95 the status of change in state assessment programs mirrored what we saw in standards a shift back to a more moderate, and in some policymakers' views, more balanced approach to reform. Not all original policy objectives were achieved. But the new strategies were not dismissed, and were mixed in with old practices.

Districts and Assessment Reform

Many districts, like states, sought to reform their testing programs by improving alignment with standards and incorporating new, performance-based assessments. They faced similar issues in terms of coordinating policies and handling the technical, political, fiscal and intellectual challenges of performance assessment. But the challenges of alignment and implementation were often more complex. For example, districts needed to create horizontal alignment between local assessments and emerging districtwide standards, but also to generate vertical alignments to state standards and assessment policies. In decentralizing districts, issues also emerged about building vertical connections down to the multiple school sites making their own decisions about curriculum and instruction. Site-based decisionmaking makes implementation a greater challenge.

The nine districts in our sample that were most extensively experimenting with performance-based assessments were primarily high capacity districts. Following the model of standards-based reform, they wanted to develop tests that meshed well with their own curriculum standards and goals for improving teaching. In one of the nine districts that was low capacity, a modest performance assessment project had been undertaken at the initiative of a local university, but these efforts were unconnected to other district plans.

Many of these nine districts leveraged support to undertake performance assessment initiatives when their state policymakers were planning or already incorporating performance assessments in the statewide exam. Local movement in this direction, then, was politically justified as being coordinated with state goals. By 1994-95, some were

concerned about the backsliding they perceived in their state's commitment to performance assessment, at least in terms of broad use. District policymakers feared that their own efforts to innovate would be isolated and lose political momentum if their states moved back to traditional assessments.

Concerns about vertical alignment of local with state assessments led most of the other 16 districts in our sample to simply serve or to wait to serve what the state had to offer. But the high level of local reliance on state testing in these districts was also associated with their being volatile, fragmented and low capacity sites without the financial resources or political capital[10] to move more independently. In a few cases, especially in Connecticut and Texas, district administrators used state tests almost exclusively because they perceived them to be good and/or extremely high stakes exams which limited their willingness to look at other measures of student performance.

The nine districts using new forms of performance assessment shared many of the states' lessons and experiences. Districts that moved rapidly to adopt new assessments quickly learned the importance of balancing these with the kinds of traditional methods and practices better understood by the public and teachers. For example, in one Georgia district that had tried to implement Outcomes-Based Education and faced a conservative backlash, an administrator said:

> *We realized that we had created the perception that we had abandoned the basics for untried educational experiments. A major theme emerged that had to do with balance: performance assessment and traditional assessment, cooperative learning, and independent learning.*

They felt mixed models were important, too, because it would take time to acquaint teachers with performance assessment. Respondents in half the districts talked about the importance of professional development not only for administering performance assessments but for understanding what the results mean and how this information could be translated into instructional changes and improvement. While early advocates of performance-based assessments claimed that their meaning to teaching and learning is more obvious and self-evident than a number on a norm-referenced, multiple choice test, experience has shown that the meaning of performance-based assessments for instruction is not always clear to parents and educators. In fact, training programs have been notoriously weak in helping teachers understand how to use even traditional tests to diagnose instructional needs (see Massell, 1995). Some states, like Minnesota and Kentucky, involved teachers in the development and/or scoring of state exams to begin to enhance teachers' understanding of assessment. While teachers frequently cite the value of these experiences, such activities do not necessarily answer teachers' questions about how to translate the results of performance-based assessments into improved student instruction. In addition, district administrators and school staff spoke about the importance of mixed models to calm public concerns about moving too quickly with "new-fangled" reforms.

[10] Low political capital here derives from many of these districts' poor performance on states.

Another CPRE study looking more closely at local (as well as state) decisions about use of performance assessment found that locals were often concerned about the impact of such testing on teachers' time and schools' capacity. Many believed that portfolios, for example, had to be simple and easy to use, and, especially at the elementary level, cover more than one subject. Teachers simply found it overwhelming to maintain two or more portfolios. Similarly, Kentucky decided to spread its current KIRIS exams across more grade-levels to reduce the burden on teachers at the benchmark grades. And finally, as at the state level, costs and budgetary constraints played a key role in whether and to what extent performance assessments were adopted. While these issues were not always the primary explanation for policy decisions, financial considerations weighed more heavily when policymakers believed that the technical and practical challenges of reform were not satisfactorily resolved (Massell, forthcoming).

Conclusion

Since the early 1990s, state and local efforts to improve assessment systems were strongly motivated by the ideas about best practices circulating across broad, and often non-governmental, reform networks. Policymakers were convinced of the logic of aligning standards and assessments, and the value of performance assessments. In fact, like standards, the importance of these reform goals has persisted, and implementation has proceeded, if not always in a rapid, linear, or all-encompassing fashion. Policymakers mixed the new with more traditional assessments to solve the range of technical, political, feasibility and financial issues that emerged with these assessment reforms. What remains to be answered are lingering questions about the impact of these innovations on instruction. Teachers need long-term professional development to aid them in the use of alternative assessments in the classroom, and in interpreting its meaning for instruction. In addition, some have argued that assessments which blend traditional features and items with performance-based formats in effect undermine the substantive and pedagogical goals of reform (see Noble and Smith, 1994; Nolen, et al., 1989). It may be that such solutions end up sending confusing signals to educators. Yet it may also be that these approaches will produce incremental, and sustained, changes in teaching and learning.

Building Professional Capacity for Reform

Recent education reform initiatives have the potential to greatly extend and transform the roles of teachers and administrators. With an increase in academic standards for students and the devolution of decisionmaking to schools under site-based management initiatives, teachers and administrators are being asked not only to teach more challenging curriculum to all students, but also to establish new relationships with each other and with parents. These new roles require a set of skills and knowledge that are unfamiliar to many teachers and administrators.

In our research, we examined how the nine states were changing policy and practice to build professional capacity for standards-based reform, centering our attention

on two specific areas of teacher-related policy: licensure and certification, and professional development (see Table 4).[11] We focused on identifying major trends and changes and on analyzing the broad connections between professional development activities and the state's reform agenda.

Licensure and Certification

At the beginning of the standards movement, policymakers focused their energies on developing new instructional guidance instruments, such as curriculum guidelines and frameworks, and assessments. They paid less attention to building the capacity to enact reform in classrooms and schools (Massell and Fuhrman, 1994). Now, several years into reform, these questions are being addressed more systematically, especially in the area of initial licensure.

During the 1980s, most states pursued revisions in their teacher certification requirements. They required new teachers, for example, to pass basic-skills and subject-matter tests to ensure minimal qualification; many states also revised the certification process to include peer support for beginning teachers. But by 1994-95, many of our state policymakers viewed their teacher certification systems as poorly synchronized to the new, more challenging instructional goals of standards-based reform. In some instances, their teacher tests screened only the very poorest performers. In South Carolina and Georgia, for example, 99 percent of teacher certification candidates passed state tests. As a result, Georgia decided to eliminate them; other states began to develop new, more challenging assessments for entry-level teacher certification. Performance-based teacher assessments were adopted in Florida, for example, and our respondents perceived an impact on the nature of instruction in teacher training institutions. Texas developed performance standards for initial certification in anticipation of a proposed performance-based test. Connecticut tried to make its initial certification congruent with the philosophy and approach of its overall reform effort. Specifically, the state was in the process of revising its Beginning Educator Support and Training (BEST)

Efforts to professionalize the governance of teacher certification met with greater success. Approximately half of the nine states had established or were establishing new structures to foster greater professional input and oversight. One strategy was to decentralize the process. For example, in Florida the legislature shifted responsibility for certification renewal from the state to local districts. Similarly, Texas decentralized the administration of certification to its regional service centers. In 1996, Texas also authorized an independent professional educator licensure board, in which teachers will

[11] During the 1980s and early 1990s, raising pay was a strategy used to attract higher quality teahcers, but this year teacher compensation was not a major initiative in the majority of our states that maintained a minimum salary schedule. (Texas was the exception to this trend.) In Connecticut, where raises in therapy scale made their teachers the highest paid on average in the nation, public opinion on this subject had became quite negative in part because the state's economic health declined a few years after the salary increases were made. Districts were squeezed by the state's raising salary levels on the one hand and declining fiscal support on the other. This situation created somewhat of a backlash against any major new state reform proposals.

comprise over half of its membership. Finally, Georgia expanded the authority of their preexisting Professional Standards Commission to include both teacher testing and certification processes.

Professional Development

Over the past decade, most state policy regarding professional development focused on increasing access to training, providing funds to support these activities, or mandating professional development in specific areas (Corcoran, 1995). States took some initiative in providing professional development that was aligned to new reform goals, often by offering direct technical assistance and support, or authorizing the creation of specific training programs by others. For example, Connecticut offered summer institutes for teachers, with theme workshops centered around specific instructional philosophies tied into state reform goals. For example, in 1994-95, they held workshops to help teachers and administrators on the new state assessments, on aligning local curriculum, instruction and assessment to the state Common Core of Learning, and on the national standards documents. These more thematic and aligned approaches was a shift from what one respondent called their formerly "shotgun" strategy, which chose activities based on newest trends. Connecticut, Texas and other states also used regional service delivery providers to offer districts' training which was often harnessed to particular state instructional reform objectives.

These networks occurred in addition to a wide variety of national projects which provided extensive staff training as part of their approach to reform, such as the Accelerated Schools Program and Equity 2000. In other states (CT, GA, NJ, SC, and TX), the National Science Foundation's Statewide Systemic Initiative (SSI) spurred the creation of networks that, among other things, provided access to training in mathematics and science. In South Carolina, for example, the SSI was organized to set up training in regional hubs. District policymakers also pointed to national professional organizations, universities, and teacher unions as sources for professional development.

Many states seized the policy moment by inviting teachers to participate in the development of new state policy instruments. Teachers and other educators participated in the development of content standards in every state, while many became involved in the creation of assessment items and strategies in Minnesota and South Carolina, and in new certification procedures in Connecticut. In South Carolina, the state offered special multi-year incentive grants to encourage teachers to pilot developmentally appropriate practices in the primary grades. Teachers reported that the training accompanying the pilot enhanced their skills not just to change their own classroom practices but to support their colleagues as well. In addition to imparting new knowledge, these experiences contributed to the development of districts' own capacity to create standards, assessments, and other policy instruments at the local level. In addition to capitalizing on teachers' expertise, these experiences provided training and were opportunities for teachers to network with other professionals. But, all in all, states' professional development activities frequently reach only a small proportion of teachers. Even in the California Subject Matter

Projects, which have been running for a decade, it was estimated that only 2 percent of the state's teachers had actually participated by 1995 (Goertz, Floden, and O'Day, 1995).

Table 4
State Professional Development (PD) Requirements, Structures and Funding: 1995-96

State	Mandated Time for PD	Mandated Local PD Plans	State Funds for Local PD	State PD Standards	Licensure Renewal Required	State-Funded Infrastructure	NBPTS Incentives [12]
CA	No; 8 school improve-ment days may be used for PD	No	No categorical PD Allocation	No	Yes	Yes	Yes
CT	Yes; 18 hours of CEUs per year	Yes	No categorical PD allocation	No	Yes	Yes	No
FL	No; up to 16 non-instructional days may be used for PD	Yes	Yes	No	Yes	Yes	No
GA	No; 10 local use workdays may be used for PD	Yes	Yes	No	Yes	Yes	Yes
KY	Yes; 4 days	Yes	Yes	No	No	Yes	No
MN	No	No	No	No	Yes	No; regional teams	No
NJ	No	Yes	No	No	No	Yes	No
SC	Yes; 10 days	Yes; as part of 5-yr strategic plan	Yes	Yes; standards for SEA-sponsored PD only	Yes	No; SEA has Leadership Academy that offers PD institutes to school teams	No
TX	No; provisions available for districts to allocate up to 5 days	yes	No	No	No; but renewal requireme nts must be in place by Nov. '97	Yes	No

Data Source: CPRE State Professional Development Profiles, 1995-96

Despite these many positive initiatives, state financial support for professional development activities was typically weak, and was often the first target of cost-saving measures (also see Massell and Fuhrman, 1994). For instance, budget reductions led the Florida legislature to eliminate funding for summer teacher institutes, and Georgia's Institutes for Learning were reduced from a budget of $3 million to $500,000.

[12] NBPTS is the National Board for Professional Teaching Standards.

Connecticut's Institutes for Teaching and Learning once had a $3 million budget and served 5000 teachers, and included year-round follow up and support activities; by 1994-95, they had a budget of slightly more than $500,000. Over the past few years, Kentucky was the only state in our sample to sustain large increases in dollars earmarked to districts to conduct professional training activities (from $1 per student in 1990-91 to $23 in 1995-96). While Minnesota did not earmark specific dollars to districts for professional development, it had a rule requiring districts to set aside 2.5 percent of their budget for professional development. But this rule was eliminated under pressure from teacher unions and districts who had not seen any increases in their general fund appropriations for several years. In these Minnesota districts, development dollars competed with student programs, salary increases, and other areas for funding.

Thus, many of our states left primary responsibility and decisionmaking about professional development to districts, occasionally intervening in limited ways to control the supply of these activities, or to set incentives for teachers to participate in additional training through licensure and renewal requirements and the salary scale. Connecticut, Kentucky, and South Carolina mandated that districts and/or schools set aside time for staff development. Florida and Connecticut required locals to set up a planning processes to identify professional development objectives. While Florida attempted to connect these local planning processes to statewide goals, policymakers in Connecticut considered eliminating the requirement, arguing that it was little more than a paper exercise that had no positive effect on the design of professional development activities.

Districts and Professional Development

District staff in South Carolina, California, and Connecticut reported that state-aid cutbacks hampered their ability to provide the kind of extensive and long term professional development that research suggests is more effective in changing practice (Porter, 1993; Little, 1993). One-day workshops remained the most frequent way that districts provided support to their teachers. Schools or individual teachers typically select training they want, either from a "menu" produced by the district or an external provider. In contrast to the short-term and idiosyncratic approach to professional development, a few districts offered sabbaticals, supported teacher attendance at professional conferences, involved teachers directly in the development of curriculum and assessment, or supplied other more sustained opportunities for growth. One district in Florida redesigned its professional development strategy to give staff long-term support in one area of concentration, rather than short-term training on a series of new topics. As the superintendent noted, "Let's not train everybody on everything but longer on a few things. Don't jam anything down their throats identify certain areas and follow up." We also found districts in Georgia, South Carolina, and Minnesota providing more extended forms of training through the use of summer institutes, customized graduate courses, short-term sabbaticals, and teacher instructional centers.

While a few districts, like one we visited in Connecticut, tried to ensure that their menu of opportunities was tightly aligned to standards initiatives, these offerings often met

a diverse set of goals and objectives. Increasingly, schools were being given the responsibility for devising professional development plans and activities for their staff. While this was meant to improve the fidelity of services to school needs and contexts, questions arose about cost-efficiencies and whether the broader needs of the district were being met under these more decentralized arrangements. As one district administrator in Minnesota noted, "Staff development funds are up for grabs schools can do whatever they want; teachers can do whatever they want."

Since dollars were limited, several districts relied on turnkey training strategies in which one or two teachers were trained and then expected to share their new knowledge with others in the schools. In rural areas, turnkey training was often the only economical way to effectively train large numbers of staff in new pedagogy. As a result, more teachers were training teachers and taking ownership for their professional development. Other districts became more creative in using dollars from local, state, federal, and private sources. For instance, in several districts, federal dollars from Title II (Eisenhower), Title 1, Vocational Education, or Special Education legislation were used in conjunction with local or state dollars to support the training of teachers in special topics, such as inclusion (in Minnesota), higher-order thinking skills (in Georgia), or TechPrep (in Florida). One Florida district even established a public education fund with business and private contributions to support professional development. The district also encouraged schools to join national reform efforts to support additional staff training.

As noted in the section on standards, a number of district officials believed that the reform agenda posed challenges that exceeded their resources and capacities. They found that these initiatives, over the long run, excessively taxed teachers and exceeded their time or expertise for curriculum development. For example, teachers in one Georgia district who were asked to be curriculum writers argued that they could not fulfill that function that they were neither trained for nor had the time to do it. As a result, the district had to put the reforms on hold. Similarly, staff in Florida and Kentucky talked about the need for more in-depth and ongoing training for participants in site-based management. These problems suggest that capacity issues are critical to address when decentralization and/or standards-based reforms are pursued.

Conclusion

By 1994-95, policymakers had taken a number of positive steps to improve teacher certification and professional development activities, and attempted to link them to larger instructional reform initiatives. But, many professional development efforts were largely piecemeal and procedural, in part because of fluctuating financial commitments from state policymakers. In districts, staff development often focused on the individual as the unit of change, in contrast to what a great deal of research recommends: that individuals need larger networks to support their efforts to effect changes in practice. Thus the criticisms of professional development in recent years that it has been fragmented, episodic, and loosely related to overall systemic improvements remains too frequently applicable (Porter et al., 1993; Porter, 1993; Little, 1993). Similarly, we found only a few efforts to conceptualize

the training that central office administrators would need to carry out new mandates. In sum, while there have been many exemplary and positive developments in the area of professional development, in most of our states comprehensive change and widespread teacher involvement was modest.

Equity

One of the strong, motivating assumptions behind curricular and instructional reform in recent decades has been that all students should have the opportunity to study more rigorous academic content. Even prior to the publication of A Nation at Risk in 1983, reformers argued that public education offered a poor academic diet to the vast majority of American students and that all students could learn more challenging content if given the chance. The current standards-based reform movement continues to make this central claim, although it relies on different and more comprehensive policies for enacting change (see Smith and O'Day, 1991; O'Day and Smith, 1993). This argument derives from a chain of studies finding that, over time, students in the U.S. have undertaken less rigorous academically-oriented curricula, that teachers hold lower academic expectations for poor and disadvantaged students, and that in fact these students could do better if expectations for their performance were higher (National Commission on Excellence in Education, 1983; Mirel and Angus, 1994; Porter et al., 1993; Brookover and Lezotte, 1979; Purkey and Smith, 1983; Dorr-Bremme, 1990; Levine and Lezotte, 1990).

By focusing on raising academic expectations for all students, standards-based reforms interweave equity with academic excellence policies. This effort stands in contrast to many earlier U.S. policies, which often pursued one or the other independently. Indeed, sociologists and historians have often described equity and excellence as opposite and competing values in American education policy. For example, many of the large-scale curriculum reform projects sponsored by the National Science Foundation between the 1950s and 1970s sought to create highly challenging and competitive curricula for a select, elite group of students. At the same time, desegregation and school finance policies were being undertaken as distinct and separate initiatives; when equity efforts did target curriculum, it was usually as an add-on, pull-out program focused on compensatory education. But merging equity and excellence has become a tenet of recent reforms and has been consciously integrated into some state and federal legislation. For example, the reauthorized Elementary and Secondary Education Act (now, the Improving America's Schools Act) since 1965 the cornerstone of federal efforts to improve education for poor, minority, and disadvantaged students requires states to hold disadvantaged Title 1 students to academic standards as high as those held for all others. State courts hearing school finance cases in Kentucky and elsewhere have begun to embrace more specific notions of educational opportunity that include quality core curricula.

Nevertheless, our research over the last few years has suggested that, for the most part, state policymakers have not given sustained attention to equity issues within the context of standards reforms, nor have they carefully thought about the ways in which all children could achieve new, high standards (Fuhrman and Massell, 1992; Massell and

Fuhrman, 1994; Fuhrman, 1994b). In this round of fieldwork, we continued to ask questions about whether and how policymakers were planning for, and trying to promote, learning for all students including the poor limited English proficient, or disabled in standards-based policy initiatives. [13]

Equity and Standards-Based Reforms

Policymakers have taken several different approaches to providing all students with the opportunity to meet higher standards, ranging from regulations requiring that every student be tested with the same examinations to training for both regular and special educators on instructional strategies that can help diverse student populations meet new standards. Our review of the states suggests that, while many different ways of addressing equity in standards reforms have arisen, they are only used intermittently. Furthermore, many elements of the implementation of standards for special needs students have not yet been addressed or, if they have been considered, are not well-developed. These issues were left to districts and schools, whose staff in general were more focused on how to make the standards work for all students.

Standards for All

One strategy for incorporating equity in standards reforms was to try to make the academic standards themselves inclusive and reflective of the needs of diverse populations. One common way of doing so was to include representatives of special needs communities in the process of standards development. In general, the process of developing standards consisted of at least three stages: (1) identifying goals or standards; (2) drafting documents; and (3) reviewing and providing feedback on drafts (Massell, 1994a). In most of our states, special educators said they were only infrequently involved in the direct creation of content standards or frameworks, and participated primarily in the latter stages of review and feedback a situation which left them in a reactive rather than proactive mode vis-à-vis the standards. In Texas, respondents reported that special educators generally were not at all involved in standard-setting and assessment policy development at the state level. Higher levels of involvement in the process were obstructed by perceptions that special education constituted a separately functioning bureaucracy. In addition, special educators were sometimes viewed as not possessing a sufficiently high level of disciplinary knowledge to construct subject-matter standards, since many obtain credentials focused on the particular category of need (blindness, for example).

These processes were handled differently at the district level. District staff frequently noted that personnel from all special needs programs were actively involved in local standards development. Many districts were already moving to include more special needs students in regular programs using inclusion models and Title 1 schoolwide projects.

[13] In this study, we examined the process of establishing standards. Other studies are investigating the extent to which standards documents are sensitive to and inclusive of students with special needs.

As a consequence, there was a heightened sense that it was critical for representatives of special needs students to be part of curriculum and academic standards development.

The use of common standards for all students raises several important questions, not the least of which is how standards should be set for and applied to special needs students. Should different or supplemental standards be generated for special needs students, such as broader life skills standards for students with severe cognitive disabilities (Goertz and Friedman, 1996)? Are the underlying pedagogical assumptions appropriate for all categories of special needs students? Many standards directly or indirectly support more constructivist learning theories. However, based on research, special education practices often strongly emphasize behaviorist approaches to instruction, and many special educators think that the new pedagogical theories are inappropriate for their student populations. More data and evidence needs to be collected to evaluate the proposition that new instructional practices are effective for all students, expanding on studies which support the use of such practices for poor and disadvantaged children. (Shields et al., 1995).

Testing for All

Common testing for all students is another well-recognized strategy to ensure that students are held to the same standards and learn the same curriculum, and it is an approach reinforced by the new federal Title 1 legislation. Several of our states moved quickly to implement this approach, including Kentucky and California (under its previous CLAS test). These states passed uniform assessment policies requiring all students to take their statewide exams. All of the nine states allowed for some exemptions from the test for various categories of need (e.g., very limited English language ability and students with active Individual Education Plans). While Kentucky allowed exemptions for non-English speakers who have been in the U.S. for less than two years, it had very extensive requirements that everyone else be tested and that their scores be included in the accountability program and reporting system. For example, the state required that special needs students be tested with adaptations consistent with the normal delivery of instruction (and not adaptations solely for the purposes of the test). Students with severe disabilities who cannot function within the regular curriculum were to participate in "alternative portfolio" assessments, but their scores would still be included in the accountability program (Council of Chief State School Officers, 1996). Similarly, California took several steps to include all students in its assessment program by creating, for instance, Spanish-language CLAS tests. New Jersey planned to include special education students in their new fourth-grade test, noting the high level of exemptions in the state's high-stakes graduation test.

Yet, while some states were moving towards greater inclusion of all students in their assessment programs, the strategy still raises many issues that have delayed decisive action in others. One question is whether the identical test is truly appropriate for all students. Should the same test given to regular students be given to students with severe cognitive or emotional disabilities? Would this requirement be fair or even educationally appropriate (Goertz and Friedman, 1996)? For example, it may be more appropriate to test some

students with special needs toward the end of their school careers, giving them more time to meet goals rather than at each grade or level. Also, supplementary goals, such as life skills, may be pertinent to assess for these student populations. This issue raises a parallel question about the technical validity of the assessments. For tests to be valid measures, they must reflect students' knowledge and skills, not their ability to take the test (e.g., their physical ability to read or to respond within a specified amount of time). That is why state regulations allow special needs students to be excluded from mandated tests. If these students are now going to be included, it is essential that the tests be validated for all students, including those with special needs (Goertz and Friedman, 1996).

Assessing all students raises other issues of political and, ultimately, educational consequence. Certainly, the political pressures on state and district policymakers are acute when test results are poor. District and school administrators often worry that including the scores of special needs students in reported results will depress their scores and public support. Indeed the available evidence in our states and districts suggests that achievement gaps persist among racial, ethnic, and socioeconomic groups and across districts, particularly when new tests are introduced.[14] In Kentucky and Connecticut, where results were reported by socioeconomic levels, there was no appreciable closing of the performance gap on new, more demanding state tests. While in Texas the achievement differential between white and minority students was reduced when socioeconomic background was held constant, performance gaps remained.

For these and other reasons, many district and school administrators often favored lenient exclusion rules or pressed for reporting formats that show their efforts in a more favorable light. In some instances, the answer was to disaggregate the results[15], while in others it was to suppress differences across categories. After complaints from urban districts with low test scores, for example, one of our states discontinued public reports with racial and ethnic profiles.

Opportunity-to-Learn Standards

One of the central concerns about the imposition of more challenging standards on special needs students has been whether all schools and classrooms truly have the resources needed to achieve the designated standards. Are schools in urban Connecticut or Minnesota able to provide their students with the same kind of enriched materials, trained personnel, and support services as schools in wealthy suburban areas? If not, is it valid to compare their students' performances on assessments that in essence require students to learn in a more advantaged environment? For example, it would be unfair to assess the laboratory skills of a student who has spent a year conducting experiments with one who is in a school with no lab equipment at all.

---

[14] In states such as Georgia and South Carolina, where basic skills tests had been in place for several years, student passing rates had improved.

[15] The fact that some districts have very transient student populations, including students who have only been attending their schools for a short period of time, would cause the inaccurate assessment of their programs' effectiveness. To address this issue, some states and districts only reported the scores of students who entered a school prior to October 28, while others reported new students' scores separately.

Policymakers have discussed setting opportunity-to-learn standards to gauge the various learning opportunities to which students have access. But such standards were the subject of a much heated debate and controversy in Congress during the long struggle to pass Goals 2000. Proposed by Democrats as a way to ensure that students had the chance to achieve high academic standards, the measure was sharply opposed as unwarranted federal intrusion in state and local affairs. In addition to debates about what the standards might be, concerns were raised that these kinds of standards might become the framework for a round of court battles that would require the infusion of large sums of new money into schools. Given the controversies that occurred at the federal level, it was not surprising to find that in most of our states, as in most of the nation (see CCSSO, 1995), opportunity-to-learn standards were not on the policy agenda. South Carolina and Georgia saw opportunity-to-learn concerns as a states' rights issue and refused to address them in their Goals 2000 plan to the federal government. California's governor even refused to apply for Goals 2000 funds. In New Jersey, by contrast, the new state leadership openly embraced opportunity-to-learn standards as part of a strategic plan to improve education and address equity.

Desegregation, School Finance, and Standards

Since the U.S. Supreme Court's Brown vs. Board of Education ruling in the 1950s, courts have pursued various strategies to desegregate schools, programs, and personnel and to reduce the racial isolation of minority students. By 1995, many urban districts around the country were being released from court-ordered desegregation remedies (e.g., Denver, Buffalo, and Wilmington), and experts were predicting that in ten years relatively few districts would remain under court desegregation orders (Schmidt, 1995). However, in several of our states, desegregation was still a major issue being pursued not only by the courts but also by other arms of state government. It has remained an ongoing concern for some New Jersey districts, has been a major front-burner issue in Connecticut since the late 1980s, and is now being pursued in the Minnesota courts. For the most part, we found that none of these desegregation efforts were directly linked to standards-based reform initiatives with the exception of the use of standards-based state assessments in court arguments as gauges of school effectiveness.

In Connecticut and Minnesota, the litigants' approach has been to argue that the state has a responsibility to pursue an active role in desegregating minority-majority urban centers and their largely white suburbs. In Connecticut, the lawyers' proof of harm came directly from the state's standardized tests, on which Hartford students repeatedly ranked last and whose scores continued to fall. While Minnesota's court efforts have just begun, Connecticut plaintiffs were unsuccessful in the Sheff v. O'Neill case until recently.[16] In 1995, the state superior court judge cited a 1972 U.S. Supreme Court decision (Spencer v. Kugler) that "racially balanced municipalities are beyond the pale of either judicial or legislative intervention." He ruled that the Connecticut constitution did not obligate the

[16] A similar suite in Alabama was successful in the courts.

state to remedy school segregation that it did not cause and refused to consider the fact that Hartford schools are so overwhelmingly poor and minority that they are depriving students of equal educational opportunity. However, the state Supreme Court later overturned this decision.

The threat of court action stimulated both Connecticut and Minnesota to attempt to remedy some of the problems through legislative and bureaucratic avenues. Fears of regional bussing led the Connecticut legislature to pass the 1994 Quality and Diversity Act, asking local communities to devise their own voluntary desegregation efforts that would be supported by $11.4 million of state aid during the first year.[17] Again, no regulations explicitly called for standard-setting in these plans. Although magnet schools have been frequently used as a voluntary remedy for segregation, concern over their effectiveness led to a new 1995 law requiring the commissioner to consider whether a proposed magnet is likely to increase student performance on mastery exams, as well as enhance student diversity and awareness of diversity. The Connecticut State Department of Education also established a separate office to work especially with urban and priority school districts. Similarly, in Minnesota the 1994 legislature established a desegregation office in the state department and appropriated $1.5 million to facilitate inter-district desegregation.

Over the last several decades, traditional school finance cases have focused on reducing wealth-based disparities in education spending. But over the past seven years, several state courts have demonstrated an increased willingness to look at issues of educational adequacy as well. In one of our research states, Kentucky, as well as in Alabama and Massachusetts, the courts defined states' obligations in terms of broad curricular goals and outcomes, thus tying school finance to standards-based reform (Goertz and Friedman, 1996).

Market-Based Reforms

As noted earlier in this report, our study states proposed numerous market-based reform measures. In several cases, the arguments used for these reforms revolved around assisting poor and minority students and students in low-performing schools. Advocates argued that schools would be more responsive to the needs of poor or in other ways disadvantaged students if the system operated more as a marketplace than a public monopoly. The argument is if these populations had the opportunity to "vote with their feet," then the system would try harder to meet their needs.

In some cases, market initiatives were triggered if schools did not meet the standards measured by state assessments. Texas now allows students to transfer out of an assigned school if the school is low-performing or if 50 percent or more of its students failed the statewide TAAS tests for the preceding three years. Districts receiving these students get additional state and local funds. Similarly, Kentucky allows students to

[17] Stringent requirements for local passage of the regional plans led to the defeat of 8 out of 11 of them, despite the fact that more than 80 percent of the school boards and half the town governments had backed them. Many minority advocates remained skeptical of the work of these efforts at reducing racial isolation.

transfer to another school if performance drops by 5 percent or more. Florida proposed (but did not pass) a choice bill that would have permitted parents to transfer their children out of low-achieving schools. New Jersey's governor proposed a voucher initiative that, if it had passed, would have allowed students in one large urban district to transfer to private schools, given the long history of the public schools' low academic performance. But states did not always directly tie their market-reform measures to targeted groups or to academic standards issues. Minnesota's choice options were universal, and Texas also passed measures that would allow choice for the broader population. Texas' new district charter requirements permit choice within public schools in or outside a district if the locally-adopted charter calls for it.

On the other side of the debate about the effect of market-based initiatives on poor and disadvantaged students are those who believe they would contribute to greater segregation and discrimination, with schools coalescing more tightly around race and class. Would the better schools be able to accommodate the students asking for access? Would the abandoned schools further decline? Would more affluent students take greatest advantage of the choice options, leaving public and/or poorly functioning schools to the most dispossessed segments of society? Minority and union opposition to Florida's choice bill arose from the latter concern. However, in Minnesota, studies suggest that special needs students were participating in the choice options; in fact, about 26 percent of the high school students taking advantage of the Post-Secondary Enrollment Options law to attend Minnesota's technical colleges have special needs, including learning disabilities, developmental disabilities, or physical or visual handicaps (Nathan and Ysseldyke, 1994). But while special needs students have taken advantage of the opportunity, it is not clear what impact the laws have had on the composition of students across schools. Answers to these questions about impact require extensive research after the new policies have been in place for some time.

In sum, while it was certainly true that efforts targeting the educational opportunity of poor and disadvantaged students continued to be made, the initiatives were not high-profile and did not appear to be comprehensive or thoroughly integrated into standards initiatives, particularly those at the state level.

Fiscal Climate

As states try to reform their systems of education, they face numerous fiscal challenges. Though economic forecasts predict steady but slow growth in the economy, school enrollments continue to increase, as do the concentrations of students with special needs particularly poor students and students with limited English proficiency, and learning or physical disabilities. Concurrently, staff salaries rise along with costs for materials, transportation, and other items. Even with school revenue growing annually, inflation-adjusted revenue per pupil has remained unchanged since 1991 (Odden, Monk, Nakib, and Picus, 1995). More importantly, funding for elementary and secondary education has been faced with increasingly stiff competition in state budgets from Medicaid and corrections (National Governors' Association and National Association of State Budget

Officers, 1995, Gold, 1995) a trend that will likely continue as the federal government reduces support and expands the responsibilities it devolves to states. The result has been a slight reduction in the state's share of education revenues, with a push to rely on local communities for dollars to support the increasing costs of education.

The anti-tax sentiment sweeping the country had reached all of the states in our sample and resulted in considerable policy discussion about containing and even reducing the costs of education. However, in each of our states, education appropriations grew in 1994-95 and were projected to grow in 1995-96 although, again, in constant dollars (adjusted for inflation) there was a general decline. We found state fiscal actions were directed primarily at shifting financial resources from administration to instruction or technology, consolidating program categories, proposing block funding, revising special education formulas, and reducing state departments of education. For the most part, cost containment, redistribution, and reallocation strategies were the primary focus, with little attention or consideration given to retargeting and restructuring resources toward reform goals or to increasing the productivity of schools. In addition, the struggle over equalization continued with new court cases, and funding formulas to satisfy court rules emerged in several of our states.

Among the states in our sample, FY 1995 appropriations for K-12 education accounted for between 19 (in Connecticut) and 47 percent (in Kentucky) of a state's budget (see Table 5). Nationally, the average was 30 percent (Gold, 1995). All nine states were able to increase their appropriation for education in FY 1996. For most, this meant a slight increase or decrease of between 1 and 2 percent in education's share of overall state appropriations, although in Texas it grew 7 percent.

Table 5

FY 1995 and FY 1996 General Fund Appropriations for K-12 Education (Total and Percentage of General Appropriations)

State	FY 1995 State Appropriations (in Millions)			FY 1996 State Appropriations (in millions)		
	General	K-12	Percentage	General	K-12	Percentage
CA	40,941	12,178	32	43,421	14,759	34
CT	8,263	1566	19	8,837	1,622	18
FL	14,292	5,175	36	14,788	5,664	38
GA	9,785	3,361	34	10,701	3,644	34
KY	4,976	2,351	47	5,262	2,671	51
MN	8,596	2,743	32	8,912	2,750	31
NJ	15,281	4,396	29	16,003	4,751	30
SC	4,079	1,246	31	4,359	1,283	29
TX	19,522	6,110	31	21,615	8,144	38

Source: *Eckl et al, 1994 and Snellet al., 1995*
excludes funds earmarked for education

Table 6

Percent of Revenue Sources Supporting
Public Elementary and Secondary Education,
1990-91 to 1992-93

State	School Year 1990-91				School Year 1992-93			
	Local	State	Federal	Private	Local	State	Federal	Private
CA	25.6	66.0	7.2	1.2	28.6	62.2	8.0	1.2
CT	55.6	41.2	2.9	<1	54.9	38.9	3.5	2.8
FL	39.3	50.1	6.6	4.1	39.1	48.5	8.3	4.1
GA	38.8	52.7	6.5	2.0	39.9	50.4	7.7	2.0
KY	21.4	66.9	9.5	2.1	22.1	67.0	10.1	0.8
MN	36.9	55.3	4.2	3.6	43.2	48.1	4.8	3.8
NJ	57.0	37.8	4.0	1.2	52.1	41.1	4.2	2.3
SC	37.6	50.0	8.5	3.9	39.2	47.0	9.3	4.4
TX	46.6	43.9	6.6	2.9	49.6	40.0	7.5	2.9

Source: U.S. Department of Education, 1994 and 1995(a)

Despite the fact that the proportion of total state appropriations for education remained fairly stable in our sample, after nearly a half-century of growth, states' responsibility for the total costs of schooling declined as local communities assumed a greater share of educational expenditures (see Table 6). Based on data from 1990 to 1992 (1994-95 data were not available), in six of our states, local communities expanded their role in this area. In the next section, "Cutbacks and Efficiency Measures," we discuss how our states and districts responded to these changes.

Cutbacks and Efficiency Measures

All of our states, except California, were seeking to cut or contain educational expenditures and/or costs. Even states with healthy economies such as Florida and Georgia, were planning to reduce education budgets. For instance, in 1994 the Florida legislature restricted the growth of state funding in education and proposed allowing local communities to establish a half-penny sales tax for school expenditures. Over half of our states (GA, NJ, SC, TX, and FL) tried to restrict local expenditures for administration, although research suggests that districts, on average, spend only between 9 and 11 percent of their dollars on this function: 3 percent on central office and 6 percent on school site expenditures (Odden et al., 1995). Similarly, New Jersey, Georgia, South Carolina, and Texas also reduced state education budgets and/or the size of their central state and local

bureaucracies, continuing a trend that CPRE has noted for the past ten years (see Fuhrman and Massell, 1992).

Other states tried to increase the cost-effectiveness of their systems. For instance, Texas attempted to make its regional service centers more effective and efficient by transferring Title 1 technical assistance services to the centers, revising the funding approach, and allowing districts to choose services from any center as a way to spur competition and improve quality and efficiency. South Carolina proposed, but had not yet passed, block grants in an effort to improve efficiency, and states like Florida and Connecticut restructured funding for special education and Gifted and Talented programs (in Florida only) to contain the costs of fast-growing programs. A state-by-state synopsis of fiscal activities used to contain, reduce, or reallocate funds this past year is presented in Table 7, along with one-time funding appropriations.

In response to dwindling resources, districts were also trying to cut the cost of special education. For instance, in Texas, a school site committee elected not to mainstream a special education student because of the cost of adding personnel in the regular classroom. In fact, in districts across all our states, respondents perceived that the cost of serving students with disabilities had taken limited resources away from all students to support a few.[18] More importantly, even with the complaints of costs for special education, most officials were also quick to note that these targeted programs were necessary to ensure that students received services. "Without the dollars these kids would be treated like dogs," stated one local board member. Interestingly, as districts faced fiscal challenges to accommodate dwindling state dollars, very few were thinking about how to restructure and reallocate their resources toward attaining intended reform goals. For the most part, districts responded to state reductions by reducing staff or services.

Fiscal Equity

Since fiscal equity among districts has not improved in several years (Odden and Clune, 1995), it was not surprising to find most of our states still struggling with fiscal equity and adequacy issues. All of the nine states in our study had been involved in school finance litigation at one time or another during the past five years. While the long-running Texas school finance case was resolved, other suits were just beginning or were continuing.

New Jersey was once again redesigning its funding formula due to a court ruling that the Quality Education Act of 1990 did not correct funding disparities as intended. While the department of education was developing a new formula that would target state funding for a base program, the legislature must still address the court's mandate to equalize spending between the state's poor urban and wealthy suburban districts. Either approach will most likely raise local taxes in wealthy communities. In South Carolina, 42 districts were suing the state over inadequate education funding. This case has been in litigation for over five years and as of late 1995 had not yet been decided. However, the state

[18] However, we did not attempt to document evidence that special education had encroached on regular education.

Table 7

1994-95 Fiscal Activity in CPRE States: Cost Containment, Reduction, Redistribution, and One-Time Funding

State	Measure
CA	1. Increases in district funding to cover the COLA and growth in enrollment. Allocated on a per-ADA basis, regardless of categorical programs or student poverty. 2. Funding formula no longer favors metropolitan districts. 3. A one-time allocation of $75 per pupil from the CTA-Gould Proposition 98 settlement may be used for non-reocurring expenses.
CT	1. New formula for Special Education to contain cost. 2. New formula for establishing maximum state aid and local contribution. 3. Reductions in state-led activities, such as the beginning teacher certification process (BEST); reduction in regional education service centers
FL	1. A 1994 tax cap limits budget growth, and a local option half-penny sales tax proposed for local support for education. 2. A 1995 cap (30 percent above state average) on special education for the gifted and talented, emotionally handicapped, and learning disabled. 3. Lowered FTE appropriation for at-risk populations (dropouts, LEP) to cut costs and because many funds went unused in the past. 4. Summer school funds cut 15 percent. 5. Increase in transportation fund, with incentives for efficiency. 6. The 1995 legislature capped district administratives costs.
GA	1. State administration cut by $2.2 million. 2. Allocations to districts for achievement grants will be discontinued in FY 96. 3. District administration funds reduced
KY	1. Continued adjustments in the funding formula and increases in SEEK funds to offset disparity between districts.
MN	1. Discussion of school-based financing, but policy not authorized. 2. Continued large allocations to support graduation requirements. 3. Funding was a major political issue since most districts had not received an increase in four years.
NJ	1. Restricted administrative expenditures to encourage district consolidation. 2. State legislature froze 1994-95 funding. 3. New school funding formula under development to satisfy court ruling.
SC	1. Proposed consolidation of categorical funds for school improvement with foundation aid. 2. Funding for school councils was discontinued and reallocated to foundation aid.
TX	1. Reallocated unused fourth-quarter federal dollars from local schools to regional service centers. 2. Relocated central office services (Title 1) to centers. 3. Reduced SEA administration and district administration expenditures. 4. Permitted intermediate education service units to compete for statewide for district dollars. 5. Allocated dollars for facilities, but sum is projected to be below what is needed. 6. Basic allocation plans for 1996-97 will support assumed diseconomies in small- and middle-sized school districts.

superintendent was confident that if the legislature accepted the systemic reform package, adequacy criteria would be met and the lawsuit would be rescinded. Even in Florida, where funding has been equalized, a coalition of school districts, the state board of education, and the school superintendent's state association are suing the legislature and governor for inadequate funding due to the rising enrollment of special needs students, the cost of mandated improvement and accountability, and under-funded transportation services. Overall, about half the states in our sample were facing litigation over equalization.

To the relief of policymakers, in 1995 the Texas court ruled the 1993 school finance solution constitutional. This formula has two tiers: a foundation program and a guaranteed yield program, along with program and district weights to narrow disparities. High-wealth districts must reduce their wealth to a level at or below $280,000 per weighted student. Since the 1993 bill did not include a facilities component, new legislation proposed a formula that will equalize a program for facilities based upon district wealth, project cost, and tax rate. At the time of our research, the bill carried a $170 million appropriation, but the Texas School Alliance estimated needs at $8 billion.

As with the inequities that have emerged or may emerge from cost-cutting measures, several states' finance formulas may tilt resources to districts with fewer concentrations of special needs students. California and Connecticut proposed funding formulas that potentially provide fewer resources to their large metropolitan districts. In Florida, funding for summer school programs and other projects were reduced, and this may erode resources in urban areas.

In Closing

As this report strongly demonstrates, standards-based reform remained a key component of policy agendas in 1994-95. Indeed, policymakers on both sides of the political aisle and across all levels of government federal, state, and local broadly agreed on the merits and worth of this approach to school change, which persisted despite substantial turnovers in leadership, criticisms about the content of particular standards and assessment policies, and real cuts in educational spending. Policymakers blunted criticism, and overcame technical issues, by adopting more mixed reform models that balanced between newer and more traditional approaches to content, assessment, and instruction. This balance also allowed them to proceed, and incremental progress was made in standards, assessments, professional development, and other aspects of reform.

But policymakers must confront several immediate issues and challenges if they are to improve these reforms. One which came through repeatedly in our field work is the need to provide additional, and more sustained support to teachers. Standards reforms ask teachers to move beyond the status quo of teacher-talk and drill-and-practice activities, to know their subjects in greater depth, and to help all students master more challenging material. Teachers need access to richer opportunities on an on-going basis, and they need direction and support from central office staff. But policymakers in recent years have ignored the role of the district administrators and local boards, frequently conceiving of

them as impediments to be bypassed rather than partners in the change effort. Yet these administrators are often pivotal conduits for reform, interpreting its substantive and providing or not providing, as the case may be both organizational structures and resources that effect whether and how they are translated into school and classroom practices (see Spillane et al., 1995). Complicating their role is the decentralization occurring via site-based management and decisionmaking. One of the lessons of recent reforms is that it is not desirable to either teachers or administrators to completely recreate the wheel of curriculum or assessment. This begs rethinking the question of the districts' role in reform. What can districts do to facilitate exchanges, provide support, and fight the insularity that often plagues schools and teachers?

Second, as we have seen, equity strategies were often not well thought out, particularly in regards to the standards' reforms. If the goal of achieving higher standards for all students is not to be hollow rhetoric, resources and attention must focus on to how best to serve all students in a challenging academic environment. Equally important is addressing the problems that impinge on students' abilities to meet the academic goals, and that teachers and administrators in actuality cope with every day students who are poor, hungry, homeless, in violent neighborhoods or families, coping with drug dependencies, and more. These problems are growing greater, and are crowding out teachers', administrators' and students' capacity to attend to the very difficult educational tasks at hand.

Third, as noted in the preceding pages of this report, by 1994-95 the content of the reforms themselves had moved towards the middle of the change spectrum, with policymakers trying to balance between those forces calling for far-reaching and radical innovation with those forces calling for adherence to traditional practices. This more moderate stance may help the standards move forward politically. But questions remain about whether such balancing advances the instructional goals of reform, i.e., rigorous, demanding curricula that stimulates students' abilities to think critically and to problem-solve. Will standards policies that explicitly incorporate both new and old goals make sense in the classroom? Will they send mixed signals, and simply reinforce the status quo of past, unsuccessful practices?

Fourth, the commitment of nongovernmental and national change agents to the standards-based reform agenda has been remarkable and sustaining. Together these groups set in motion a dense array of professional networks that, if well-coordinated and conceived, could connect and provide important support to teachers and school administrators. But we also found that they could add an additional layer of complexity on the system, and send local educators in diverse and sometimes competing directions. Policymakers at the state and local level should seek ways to bring these various activities into concentrated focus.

Finally, state and district policymakers must learn not only how to listen to their publics but also how to teach them about reform efforts. In the end, such accomplishments require well-articulated messages and long-term efforts.

References

Ball, D. L. 1992. "Magical Hopes: Manipulatives and the Reform of Math Education." *American Educator*, p.14.

Bond, L. A., D. Braskamp, A. van der Ploeg,and E. Roeber. 1996. "State Student Assessment Programs Database: School Year 1994-1995." Oak Brook, IL: North Central Regional Educational Laboratory and the Council of Chief State School Officers.

Brookover, W. B. , and L. W. Lezotte. 1979. "Changes in School Characteristics Coincident with Changes in School Achievement." East Lansing, MI: Michigan State University Institute for Research on Teaching, Occasional Paper No. 17.

Center for Education Reform. 1995. "School Reform in the United States: State by State Summary." Washington, DC: Author.

Cohen, D. K., and J. Spillane. 1993. "Policy and Practice: The Relations between Governance and Instruction." In S. H. Furhman (ed.) *Designing Coherent Education Policy: Improving the System. San Francisco: Jossey-Bass.*

Corcoran, T. B. 1995. "Transforming Professional Development for Teachers: A Guide for State Policymakers." Washington, DC: National Governors' Association.

Council of Chief State School Officers. 1996. "State Student Assessment Program Database." Washington, DC: Author.

Cronbach, L. J., N. M. Bradburn, and D. G. Horvitz. 1994. "Sampling and Statistical Procedures Used in the California Learning Assessment System: Report of the Select Committee," July 25, 1994.

Crowson, R., and V. C. Morris. 1985. "Administrative Control in Large-city School Systems: An Investigation of Chicago." *Educational Administration Quarterly*, 21, 51-70.

Dorr-Bremme, D.W. 1990. "Culture, Practice, and Change: School Effectiveness Reconsidered." *Elementary School Journal.*

Eckl, C. L., K. Carter, and A. Perez. 1994. State Budget Actions, 1994. Washington, DC: National Conference of State Legislatures.

EdSource. 1995. *School Finance*, 1995-96. Menlo Park, CA: Author.

Education Commission of the States. 1995. "Charter Schools." Clearinghouse Issue Brief. Denver, CO: Author.

Education Week. 1995, November 25. "Teachers' Raises Lag Behind Inflation Rate," p. 4.

Elley, W. B. 1992. *How in the World Do Students Read?* New York: International Association for the Evaluation of Educational Achievement.

Flexer, R. J., K. Cumbo, H. Borko, V. Mayfield, and S. F. Marion. 1994. "How 'Messing About' with *Performance Assessment in Mathematics Affects what Happens in Classrooms.*" Paper presented at the Annual Meeting of the American Educational Research Association and the National Council on Measurement in Education, New Orleans.

Fuhrman, S. H. 1993. "The Politics of Coherence." In S. H. Fuhrman (ed.) *Designing Coherent Education Policy: Improving the System.* San Francisco: Jossey-Bass.

Fuhrman, S. H. 1994a. "Legislatures and Education Policy." In R. F. Elmore and S. H. Fuhrman (eds.) *The Governance of Curriculum. 1994 Yearbook of the Association for Supervision and Curriculum Development.* Alexandria, VA: ASCD.

Fuhrman, S. H. 1994b. "Challenges in Systemic Reform." CPRE Policy Briefs. New Brunswick, NJ: Consortium for Policy Research in Education.

Fuhrman, S. H., and R. F. Elmore. 1990. "Understanding Local Control in the Wake of State Education Reform." *Educational Evaluation and Policy Analysis,* 12(1): 82-96.

Fuhrman, S. H., and D. Massell 1992. Issues and Strategies in Systemic Reform. New Brunswick, NJ: Consortium for Policy Research in Education.

Fullan, M. G. (With S. Stiegelbauer). 1991. *The New Meaning of Educational Change.* New York, NY: Teachers College Press.

Gandolf, M. 1995. "Making Standards Matter: A Fifty State Progress Report on Efforts to Raise Academic Standards." Washington, DC: American Federation of Teachers, Educational Issues Department.

Goertz, M. E., R. E. Floden, and J. O'Day. 1995. Studies of Education Reform: Systemic Reform. New Brunswick, NJ: Consortium for Policy Research in Education, Rutgers University.

Goertz, M. E., and D. Friedman. 1996. "State Education Reform and Students with Disabilities: A Preliminary Analysis." Philadelphia, PA: University of Pennsylvania, Consortium for Policy Research in Education.

Gold, S. D., and E. I. Davis. 1995. Tax Cuts Slow Revenue Growth. Albany, NY: Nelson A. Rockefeller Institute of Government, Center for the Study of the States.

Gold, S. D. 1995. The Outlook for School Revenue in the Next Five Years. New Brunswick, NJ: Rutgers University, Consortium for Policy Research in Education.

Hertert, L. 1996. "Systemic School Reform in the 1990s: A Local Perspective." Educational Policy, 10(3), 379-398.

Honig, B. 1995. "How Should We Teach Our Children to Read?" Minutes of the Superintendent's Reading Task Force, May 19, 1995.

Kentucky Institute for Educational Research. 1994. Press release, October 3.

Kirst, M. W. 1993. "Strengths and Weaknesses of American Education." *Phi Delta Kappan 74*, 613-18.

Kirst, M. W., and G. Meister. 1983. "The Role of Issue Networks in State Agenda-setting." Stanford, CA: Institute for Research on Educational Finance and Governance.

Levine, D. U., and L. W. Lezotte. 1990. "Unusually Effective Schools: A Review and Analysis of Research and Practice." Madison, WI: The National Center for Effective Schools Research and Development, Board of Regents of University of Wisconsin System.

Little, J. W. 1993. "Teachers' Professional Development in a Climate of Educational Reform." *Educational Evaluation and Policy Analysis*, 15(2), 165-179.

Lusi, S. 1994. "Systemic School Reform: The Challenges Faced by State Departments of Education." In R. F. Elmore and S. H. Fuhrman (eds.) The Governance of Curriculum. 1994 Yearbook of the Association for Supervision and Curriculum Development. Alexandria, VA: ASCD.

Massell, D. 1994a. "Achieving Consensus: Setting the Agenda for State Curriculum Reform." In S. H. Fuhrman and R. F. Elmore (eds.) *The Governance of Curriculum*. 1994 Yearbook of the Association for Supervision and Curriculum Development. Alexandria, VA: ASCD.

Massell, D. 1994b. "Three Challenges for National Content Standards." *Education and Urban Society 26(2):*185-195.

Massell, D. 1995. "What We Know about Assessing what Students Know: A Literature Review on Alternative Assessment." Unpublished paper. Philadelphia, PA: Consortium for Policy Research in Education, University of Pennsylvania.

Massell, D. Forthcoming. "Opportunities For and Constraints on Performance Assessments: The New Standards Experience." (working title). Philadelphia, PA: Consortium for Policy Research in Education, University of Pennsylvania.

Massell, D., and S. H. Fuhrman. 1994. *Ten Years of State Education Reform: 1983-1993.* New Brunswick, NJ: Consortium for Policy Research in Education, Rutgers University.

Massell, D., and M. E. Goertz. 1994. *2061 Policy Blueprint.* Paper prepared for the American Association for the Advancement of Science. Washington, DC: AAAS.

McDonnell, L., and S. H. Fuhrman. 1985. "The Political Context of Education Reform." In V. D. Mueller and M. P. McKeown (eds.), The Fiscal, Legal and Political Aspects of State Reform of Elementary and Secondary Education, 43-64.

McLaughlin, M.W. 1991. "The Rand Change Agent Study: Ten Years Later." In A. R. Odden (ed.) *Education Policy Implementation*, 143-155. Albany, NY: State University of new York Press.

Mirel, J, and D. Angus. 1994. "High Standards for All? The Struggle for Equality in the American High School Curriculum, 1890-1990." *American Educator*, 4-42.

Nathan, J., and J. Ysseldyke. 1994. "What Minnesota has Learned about School Choice." *Phi Delta Kappan, Vol. 75*, May, p. 685.

National Association of State Boards of Education. 1995. Trends and Challenges in Education Governance. Alexandria, VA: Author.

National Center for Education Statistics. 1992. *The Condition of Education, 1992.* Washington, DC: U.S. Government Printing Office.

National Center for Education Statistics. 1995. "Use of School Choice." *Education Policy Issues: Statistical Perspectives.* Washington, DC: U.S. Department of Education, Office of Educational Research and Improvement.

National Commission on Excellence in Education. 1993. *A Nation at Risk.* Washington, DC: Author.

National Conference of State Legislatures. 1995. "Preliminary Partisan Composition of the State Legislatures: 1994 Election." Washington, DC: Author.

National Governors' Association and National Association of State Budget Officers. 1995. *The Fiscal Survey of the States.* Washington, DC: Author.

Noble, A. J., and M. L. Smith. 1994. "Old and New Beliefs about Measurement-driven Reform: 'Build It and They Will Come.'" *Educational Policy*, 9(2), 111-136.

Nolen, S.B., T.M. Haladyna, and N.S. Haas. 1989. Technical Report 89-2: A Survey of Arizona Teachers and School Administrators on the Uses and Effects of Standardized Achievement Testing. Phoenix, AZ: Arizona State University, West Campus.

O'Day, J., and M. S. Smith. 1993. "Systemic School Reform and Educational Opportunity." In S. H. Fuhrman (ed.) *Designing Coherent Education Policy: Improving the System.* 313322. San Francisco: Jossey-Bass.

Odden, A., and W. Clune. 1995. *"Improving Educational Productivity and School Finance."* Unpublished manuscript. Madison, WI: Consortium for Policy Research in Education, University of Wisconsin-Madison.

Odden, A., D. Monk, Y. Nakib, and L. Picus. 1995. "Story of the Education Dollar No Academy Awards and No Fiscal Smoking Guns." *Phi Delta Kappan, 77*(2): 161-168.

Organization for Economic Cooperation and Development. 1992. *Education at a Glance.* Paris: Author.

Pechman, E. M., and P. A. Hammond. 1991. *"A Background Report on Educational Assessment."* Report prepared for the National Research Council of the National Academy of Science.

Porter, A. 1993. "State and District Leadership for the Implementation of Project 2061." Background paper prepared for the American Association for the Advancement of Science Policy Blueprint. Washington, DC: AAAS.

Porter, A., M. W. Kirst, E. J. Osthoff, J. L. Smithson, and S.A. Schneider. 1993. *Reform Up Close: A Classroom Analysis.* Madison, WI: Wisconsin Center for Research in Education.

Purkey, S. C., and M. W. Smith. 1983. "Effective Schools: A Review." *Elementary School Journal 83:* 427-452

Resnick, D. P., and Resnick, L. B. 1992. "Assessing the Thinking Curriculum: New Tools for Educational Reform." In B. R. Gifford and M.C. O'Connor, eds, *Changing Assessments: Alternative Views of Aptitude, Achievement and Instruction.* Boston: Kluwer Academic Publishers.

Rowan, B. 1983. "instructional Management in Historical Perspective" *Educational Administration Quarterly,* 18, 43-59.

Schmidt, P. 1995. "Districts View Desegregation in a New Light." *Education Week, 15(15),* December 13, p. 1.

Shavelson, R. J., G. P. Baxter, and J. Pine. 1992. "Performance Assessments: Political Rhetoric and Measurement Reality." *Educational Researcher, May 22-27.*

Shavelson, R. J., G. P. Baxter, and X. Gao. 1993. "Sampling Variability of Performance Assessments." *Journal of Educational Measurement, 30(3),* 215-232.

Shields, P. M, M. S. Knapp, and B. Turnbull. 1995. "Academic challenge in high poverty classrooms" *Phi Delta Kappan, 76(10):* 770-776.

Smith, M. S., and J. O'Day. 1991. "Systemic School Reform." In S. H. Fuhrman and B. Malen (eds.) *The Politics of Curriculum and Testing,* pp. 233-267. Bristol, PA: Falmer Press.

Snell, R. K., K. Carter, A. Perez, and M. Rafool. 1995. *State Budget Actions,* 1995. Draft final report. Washington, DC: National Conference of State Legislatures.

Spillane, J., C. L. Thompson, C. Lubienski, L. Jita, and C. B. Reimann. 1995. "The Local Government Policy System Affecting Mathematics and Science Education in Michigan: Lessons from Nine School Districts." Draft report. East Lansing, MI: Consortium for Policy Research in Education.

U.S. Department of Education, Office of Educational Research and Improvement. 1994. *Digest of Education Statistics, 1994.* (National Center for Education Statistics). Washington, DC: Author.

U.S. Department of Education, Office of Educational Research and Improvement. 1995. *Digest of Education Statistics, 1995.* (National Center for Education Statistics NCES 95-029). Washington, DC: Author.

Walker, D. 1990. *Fundamentals of Curriculum.* Saddlebrook, NJ: Harcourt, Brace, Jovanovich, Inc.

Wiggins, G. 1993. "Assessment: Authenticity, Context, and Validity." *Phi Delta Kappan, 75(3),* 200-214.

APPENDIX 1

CPRE STATE RESPONDENTS

Location	Respondent(s)
State Department of Education	Superintendent and/or Deputy Superintendent
	Curriculum Specialist
	Assessment Specialists
	Teacher Policy Specialist(s) in Certification, Professional Development
	Special Education Director
	Budget Director
	Legislative Liaison
	Other as Appropriate
STATE BOARD OF EDUCATION	President or Executive Director
GOVERNOR'S OFFICE	Governor's Education Aide
LEGISLATURE	Education and Appropriation Committee
ASSOCIATIONS	Teachers' Union
	Major Interest Group Representatives
Community Members	Business Representative
	Education Journalist

CPRE LOCAL RESPONDENTS

Location	
CENTRAL DISTRICT OFFICE	Superintendent
	Curriculum Specialist
	Assessment Specialist
	Teacher Policy Specialist(s) in Certification and Professional
	Chief Business Officer
	Other
SCHOOL SITE PERSONNEL	Principal
	Teacher
ASSOCIATIONS	Teacher Union Representative
COMMUNITY MEMBERS	Business Representatives
	Parent Representatives
	Education Journalist

SPECIAL ISSUES RELATING TO TEACHERS AND TEXTBOOKS

TEACHING FOR HIGH STANDARDS: WHAT POLICYMAKERS NEED TO KNOW AND BE ABLE TO DO

By:

Linda Darling Hammond
and
Deborah Loewenberg Ball

Prepared for the National Education Goals Panel
June, 1997

What Matters Most: Teaching for America's Future, the report of the National Commission on Teaching and America's Future, is available on-line at http://www.tc.columbia.edu/~teachcomm.

This paper was commissioned by the National Education Goals Panel for release at its meeting on July 30, 1997. The opinions and recommendations expressed in this paper are those of the author and do not necessarily reflect those of the Goals Panel or its members.

Teaching for High Standards: What Policymakers Need to Know and Be Able to Do

The recent emphasis on raising standards has drawn Americans' attention to what makes a difference for student learning. The September, 1996 report of the National Commission on Teaching and America's Future (the Commission), What Matters Most: Teaching for America's Future, followed shortly by Pursuing Excellence, the report of the Third International Mathematics and Science Study (TIMSS), sharpened this discussion by pointing to the close relationship between students' achievement and the knowledge, skills, and practices of their teachers. According to these reports, *what teachers know and can do is crucial to what students learn.* Three policy implications follow:

1. The recruitment and retention of good teachers is key to the improvement of our schools.

2. A strong teaching force depends on serious attention to the preparation and ongoing learning of teachers.

3. School reform cannot succeed unless it focuses on creating the conditions – including the curriculum contexts – in which teachers can teach well.

In this paper, we discuss the relationship between teachers' knowledge and students' performace; summarize what research suggests about the kinds of teacher education and professional development needed to help teachers learn to teach to high standards; and describe what states are doing to provide these opportunities for teacher learning, and with what effects.

The Relationship between Teacher Knowledge and Student Achievement

For many decades the United States education system has tried to improve student achievement by tinkering with various levers in the great machinery of schooling: New management schemes, curriculum packages, testing policies, centralization initiatives, decentralization initiatives, and a wide array of regulations and special programs have been tried, all with the same effect. Reforms, we have learned over and over again, are rendered effective or ineffective by the knowledge, skills, and commitments of those in schools. Without know-how and buy-in, innovations do not succeed. Neither can they succeed without appropriate supports, including such resources as materials, time, and opportunities to learn.

Furthermore, studies discover again and again that teacher expertise is the most important factor in determining student achievement, followed by the smaller but consistently positive influences of small schools and small class sizes. That is, teachers

who know alot about teaching and learning and who work in environments that allow them to know students well are the critical elements of successful learning.

How does teachers' expertise affect student learning? Teacher expertise – or what teachers know and can do – affects all the core tasks of teaching. For example, what teachers understand, both about content and students, shapes how judiciously they select from texts and other materials and how effectively they present material in class. Their skill in assessing their students' progress depends also on how deeply they themselves know the content, and how well they can understand and interpret students' talk and written work. Nothing can fully compensate for the weakness of a teacher who lacks the knowledge and skill needed to help students master the curriculum.

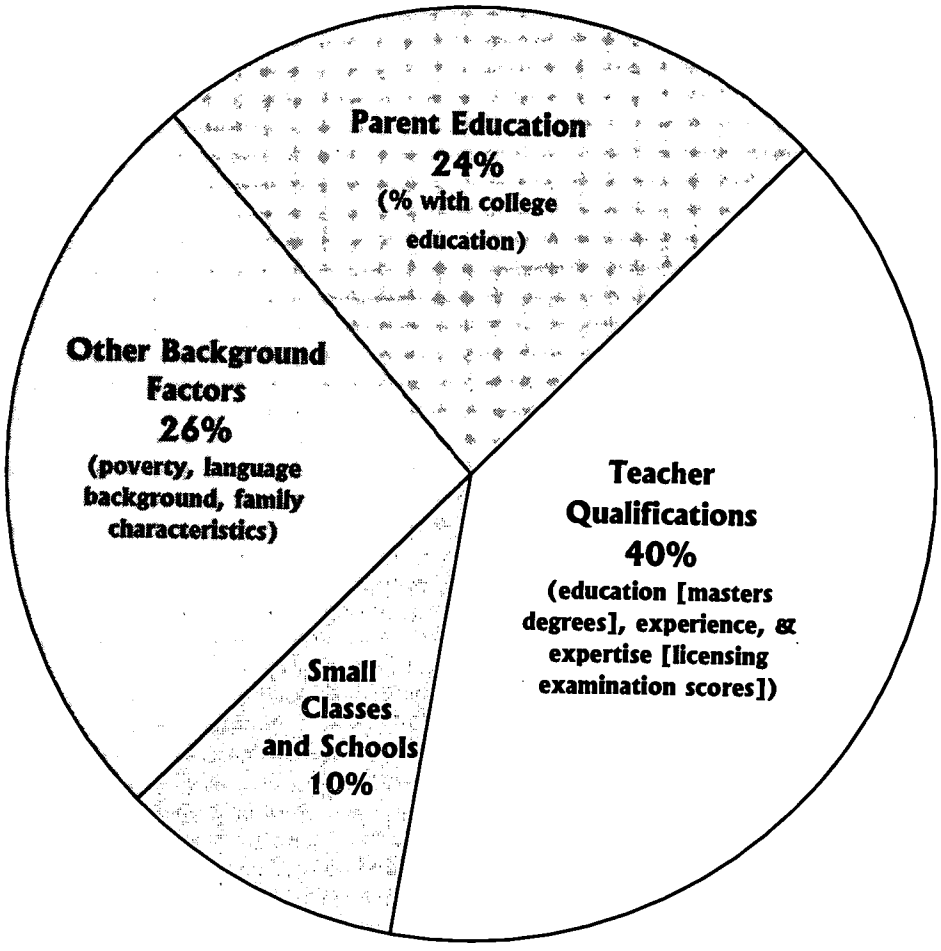
Measures of teachers' education, certification, knowledge, and experience have most often been the primary sources of large scale data on teacher expertise.[1] In an analysis of the most extensive data base since the Coleman study, Ronald Ferguson found that teachers' expertise (as measured by teacher education, scores on a licensing examination, and experience) accounted for far more variation in students' achievement than any other factor (about 40% of the total), and that every additional dollar spent on more highly qualified teachers netted greater increases in student achievement than did any other use of school resources.[2] The effects were so strong, and the variations in teacher expertise were so great, that the large disparities in achievement between black and white students were almost entirely accounted for by differences in the qualifications of their teachers. An additional contribution to student achievement was made by small schools and lower pupil-teacher ratios. In combination, well-prepared teachers working in personalized environments contributed as much to student outcomes as socioeconomic factors. (See figure 1.)

Ferguson's findings closely mirror those of a recent review of 60 studies by Greenwald, Hedges, and Laine,[3] which found that teacher education, ability, and experience, along with small schools and lower teacher-pupil ratios, are associated with significant increases in student achievement. In their estimate of the achievement gains associated with various uses of funds, additional spending on teacher education outweighed other variables as the most productive investment for schools. (See figure 2.)

Many other studies have come to similar conclusions. For example, a study of high- and low-achieving schools in New York City with similar student populations found that differences in teacher qualifications accounted for more than 90% of the variation in student achievement in reading and mathematics at all grade levels tested.[4] A Tennessee study of the effects of teachers on student learning found that elementary school students who are assigned to ineffective teachers for three years in a row score fifty percentile points lower on achievement tests than those assigned to the most effective teachers over the same period of time.[5] (See figure 3.)

Figure 1

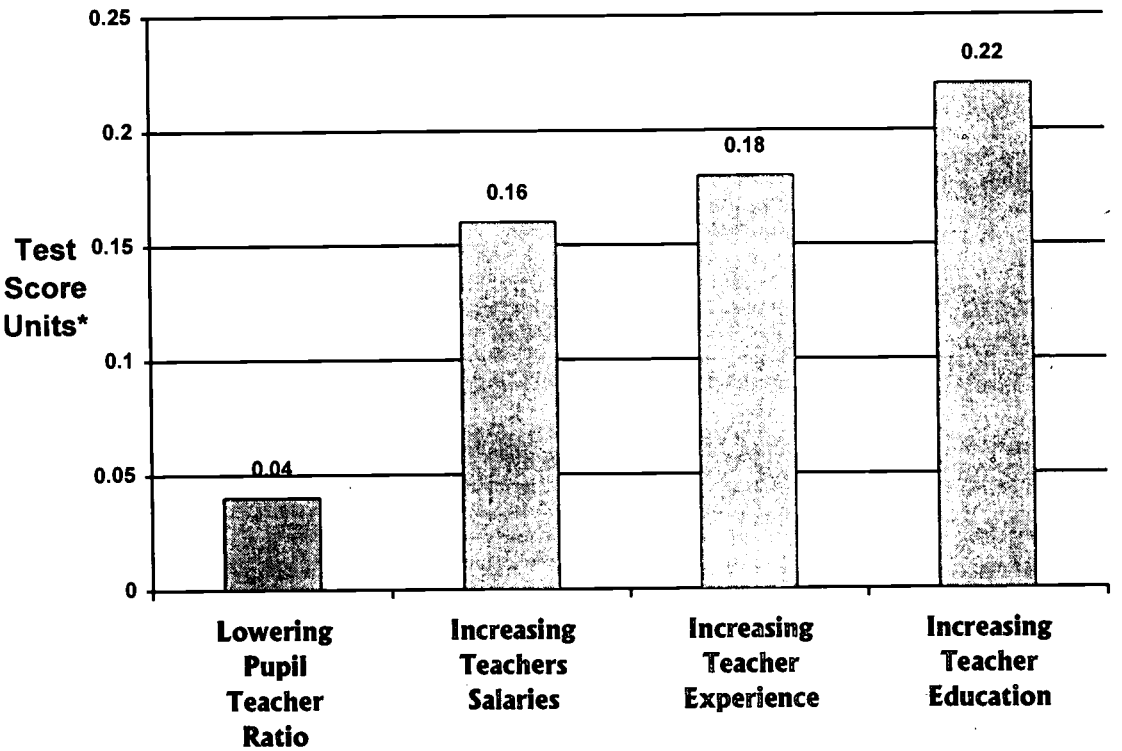
Average Proportion of Variance in Student Test Scores (Grades 1-7) Explained By:



Developed from data presented by Ronald F. Ferguson, "Paying for Public Education: New Evidence of How and Why Money Matters," *Harvard Journal on Legislation* 28 (Summer 1991): 465-98

Figure 2

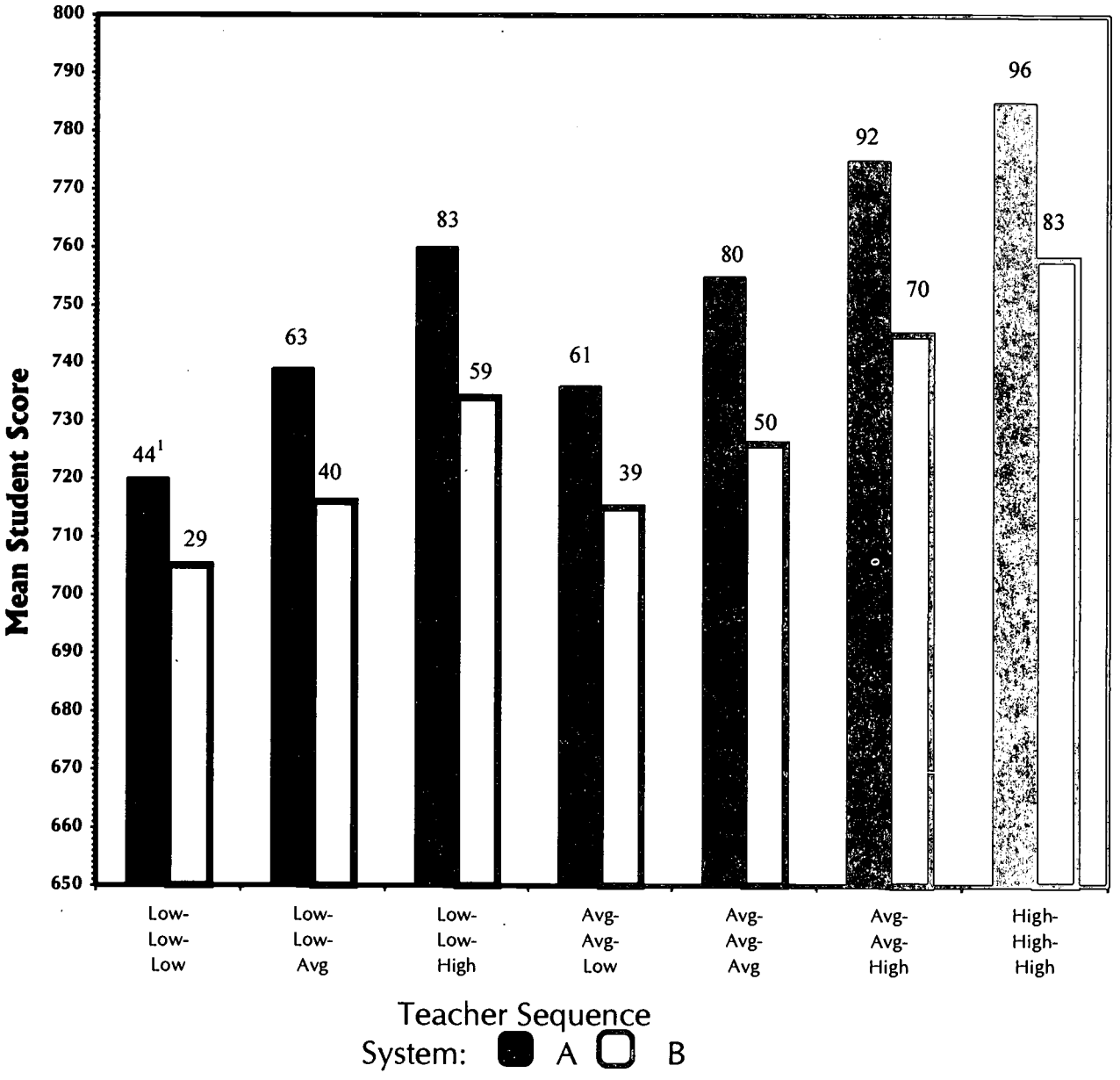
Size of Increase in Student Achievement for Every $500 Spent on:



*Achievement gains were calculated as standrd deviation units on a range of achievement tests used in the 60 studies reviewed.

Greenwald, R., L.V. Hedges, & R.D. Laine (1996). The Effect of School Resources on Student Achievement. *Review of Educational Research* 66(3), pp. 361-396.

Figure 3
Cumulative Effects of Teacher Sequence on Fifth Grade Math Scores For Two Metropolitan Systems



[1] Denotes the corresponding percentile (CTB/McGraw-Hill, 1990, pp. 104-115).

What matters for teacher effectiveness? Another body of research confirms that teacher knowledge of subject matter, student learning and development, and teaching methods are all important elements of teacher effectiveness. Reviews of several hundred studies contradict the longstanding myths that "anyone can teach" and that "teachers are born and not made." Teacher education, as it turns out, matters a great deal. In fields ranging from mathematics and science to early childhood, elementary, vocational, and gifted education, teachers who are fully prepared and certified in both their discipline and in education are more highly rated and are more successful with students than are teachers without preparation, and those with greater training are found to be more effective than those with less.[6]

In science, a review of 65 studies found that teachers' effectiveness depends on the amount and kind of teacher education and disciplinary training they have had and on the professional development opportunities they experience later in the career.[7] And in mathematics, another review found that the extent of teachers' preparation in mathematics methods, curriculum, and teaching is as important in predicting effectiveness as is preparation in mathematics itself.[8] Finally, students who study with fully certified mathematics teachers experience significantly greater gains in achievement than those who are taught by unlicensed or out-of-field teachers.[9]

The National Assessment of Educational Progress has documented that the qualifications of students' teachers are also among the correlates of reading achievement: Students of fully certified teachers and of teachers with higher levels of education do better. Furthermore, these teachers are more likely to have had professional coursework that allows them to use the literature-based and writing-based approaches to teaching reading and writing that stimulate the higher level performance skills associated with stronger achievement (figure 4.)

Teachers who have spent more time studying teaching are more effective overall, and strikingly so for developing higher-order thinking skills and for meeting the needs of diverse students.[10] Not only does teacher education matter, but more teacher education appears to be better than less. As we describe below, recent studies of redesigned teacher education programs – those that offer a five- or six-year program including an extended internship – find their graduates to be more successful and more likely to enter and remain in teaching than graduates of traditional undergraduate programs.[11]

Figure 4

Correlates of Reading Achievement, Grade 4
National Assessment of Education Progress, 1992
Average Proficiency Scores (Percent of Students)

CORRELATES OF READING ACHIEVEMENT	LOWER SCORES		HIGHER SCORES
TEACHER QUALIFICATIONS			
Level of Certification	None, provisional or emergency (7%) 214	Regular, not highest level (37%) 216	Highest level (57%) 219
Level of Education	Bachelor's (54%) 215		Master's (45%) 220
Coursework in literature-based instruction	No coursework (16%) 214		Yes coursework (84%) 218
Coursework in whole language approaches	No coursework (20%) 214		Yes coursework (80%) 218
Coursework in phonics	Yes coursework (44%) 214		Yes coursework (56%) 220
Coursework in study strategies	No coursework (33%) 216		Yes coursework (67%) 218
Coursework in motivational strategies	No coursework (14%) 215		yes coursework (86%) 218
TEACHING PRACTICES			
Ability Grouping	Students grouped by ability (34%) 212		Students not grouped by ability (66%) 220
Types of Materials	Primarily basal readers (33%) 214	Basal and trade books (51%) 218	Primarily trade books (13%) 224
Instructional Approaches	Structured Subskills (5%) 200	Literature-based (31%) 219	Integrative language (43%) 220
Instructional Emphasis on Integrating Reading and Writing	Little/ no emphasis (11%) 211	Moderate emphasis (42%) 215	Heavy emphasis (55%) 220
Emphasis on Literature-based reading	Little/no emphasis (11%) 208	Moderate emphasis (38%) 217	Heavy emphasis (50%) 220
Amount of time devoted to decoding skills	Almost all the time (15%) 207	Some of the time (69%) 218	Rarely (15%) 221
Frequency with which students read aloud	Almost every day (47%) 213	At least weekly (45%) 221	Less than wekly (8%) 224
Amount of time devoted to oral reading	Almost all the time (24%) 211	Some of the time (70%) 219	Rarely/never (7%) 226
Frequency with which students read silently	Less than weekly (2%) 208	At least wekly (23%) 213	Almost every day (75%) 219
Amount of time devoted to comprehension and interpretation	Rarely/never (0%)	Some of the time (30%) 216	Almost all of the time (70%) 218
Frequency of group activities or projects about what students read	Less than weekly (76%) 217	At least once a week (21%) 219	Almost every day (3%) 221

Figure 4 (Continued)
Correlates of Reading Achievement, Grade 4
National Assessment of Education Progress, 1992
Average Proficiency Scores (Percent of Students)

CORRELATES OF READING ACHIEVEMENT	LOWER SCORES		HIGHER SCORES
Frequency with which students write about what they have read	Less than weekly (26%) 214	At least once a week (49%) 217	Almost every day (25%) 221
Frequency with which teachers use reading kits to teach reading	At least once a week (22%) 211	At least once a month (20%) 219	Never or rarely (58%) 219
Frequency with which computer software is used to teach reading	At least once a week (25%) 213	At least once a month (23%) 217	Never or rarely (52%) 219
Frequency with which a variety of books are used to teach reading	Less than weekly (35%) 215	At least once a week (22%) 214	Almost every day (43%) 220
Frequency with which teahcers send or take clas to library	Never or rarely (5%) 209	At least once a month (9%) 208	At least once a week (85%) 219
Use of multiple choice tests to assess students in reading	At least once a week (14%) 209	At least once a month (49%) 218	Less than monthly (36%) 222
Use of short-answer tests to assess students in reading	At least once a week (34%) 214	At least once a month (44%) 217	Less than monthly (22%) 222
Students write paragraphs about what they have read to assess their reading	Less than monthly (14%) 210	At least once a month (39%) 218	At least once a week (46%) 220
Use of individual or group projects or presentations are used to assess reading	Less than monthly (34%) 212	At least once a month (54%) 220	At least once a week (12%) 220

Source: 1992 NAEP Trial State Assessment
L. Darling-Hammond, National Commission on Teaching and America's Future

Problems in the Preparation of U.S. Teachers

Despite the critical importance of teacher knowledge, the United States offers far fewer supports for teacher learning than do industrialized countries that rank higher on educational outcome measures. In addition, large numbers of U.S. teachers are not adequately prepared for their work. For example, the National Commission on Teaching found that:

- In recent years, more than 50,000 people have entered teaching annually on emergency or substandard licenses. This represented about 1/4 of newly hired teachers in 1991.[12]

- Nearly one-fourth (23%) of all secondary teachers do not have even a minor in their main teaching field. This is true for more than 30% of mathematics teachers and 17% of science teachers.[13]

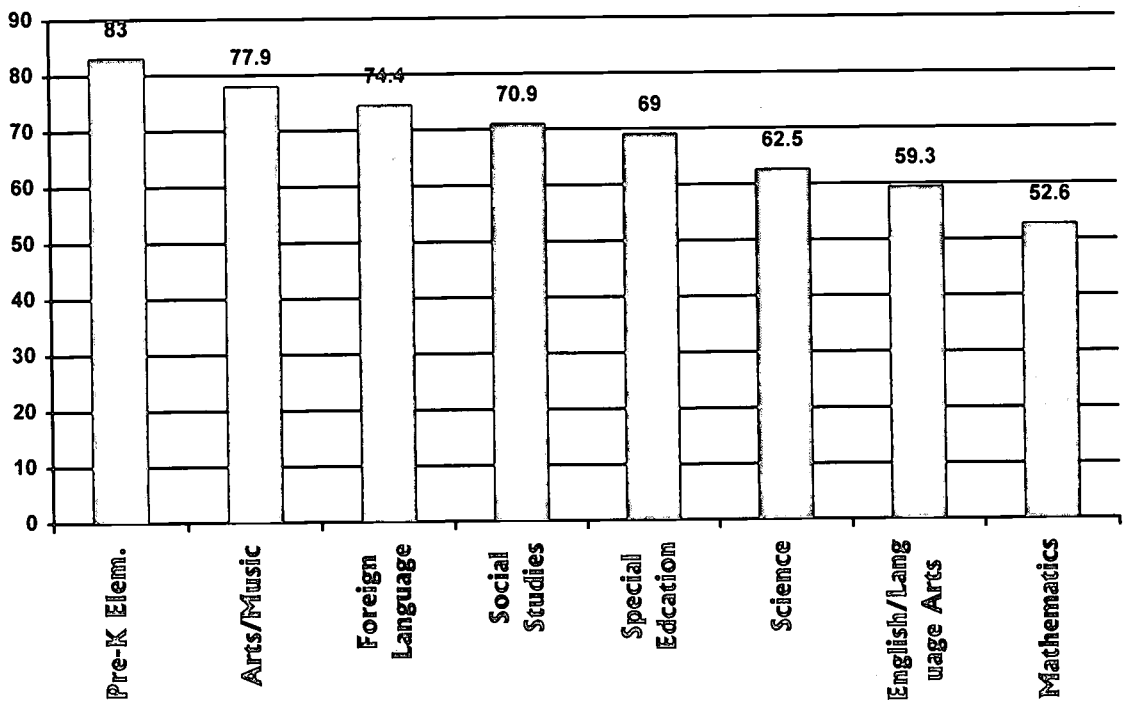
- Fifty-six percent of high school students taking physical science are taught by out-of-field teachers, as are 39% of those taking life science and 27% of those taking mathematics.[14] The proportions of students taught by out-of-field teachers are much higher in lower track classes, in high-poverty schools, and high-minority schools.

- In schools with the highest minority enrollments, students have less than a 50% chance of getting a science or mathematics teacher who holds a license and a degree in the field they teach.[15]

These problems in the preparation and licensing of teachers are reflected in the performance of U.S. students on international assessments. For example, the U.S. has experienced chronic shortages of mathematics and physical science teachers for more than 40 years, and has typically met these problems by lowering standards rather than by increasing the incentives to teach. As noted above, more than 30% of U.S. mathematics teachers were teaching out-of-field in 1991, and only 52% of U.S. math teachers had both a license and a major in their field (See figure 5.) If U.S. students are much more likely to have teachers who are unprepared in mathematics, it should be no surprise that U.S. students continue to compare least favorably with their international peers in mathematics, with 8th graders ranking 18th out of 25 countries that met the TIMSS study guidelines (see figure 6).

Figure 5

Percentage of Public School Teachers with a State License and a Major in the Main Teaching Assignment field: 1990-91



Source: U.S. Department of Education, Schools and Staffing Survey, 1990-91, Published in Marilyn M. McMillen, Sharon A. Bobbit, and Hilda F. Lynch, *Teacher Training, Certification, and Asignment in Public Schools: 1990-91*, (Paper presented at annual meeting of the American educational Research Association, New Orleans, LA, April 1994)

Figure 6
Results from the Third International Mathematics and Science Study
(International Rankings)

Nation	Math Average	Nation	Science Average	Nation	Physics Percent Correct
Singapore	643	Singapore	607	Singapore	69
Korea	607	Czech Republic	574	Japan	67
Japan	605	Japan	571	Korea	65
Hong Kong	588	Korea	565	Czech Republic	60
Belgium-Flemish	565	Hungary	554	Hungary	60
Czech-Republic	564	England	552	England	62
Slovak Republic	547	Belgium-Flemish	550	Slovak Republic	61
Switzerland	545	Slovak Republic	544	Hungary	60
France	538	Ireland	538	Canada	59
Hungary	537	Russian Federation	538	Hong Kong	58
Russian Federation	535	Sweden	535	New Zealand	58
Canada	527	**United States**	**534**	Switzerland	58
Ireland	527	Canada	531	Russian Federation	57
Iran, Islamic Republic	428	Norway	527	Sweden	57
Sweden	519	New Zealand	525	Norway	57
New Zealand	508	Hong Kong	522	Ireland	56
England	506	Switzerland	522	**United States**	**56**
Norway	503	Spain	517	Spain	55
United States	**500**	France	498	France	54
Latvia (LSS)	493	Iceland	494	Iceland	53
Spain	487	Latvia (LSS	485	Latvia (LSS)	51
Iceland	487	Portugal	480	Lithuania	51
Lithuania	477	Lithuania	476	Portugal	48
Cyprus	474	Iran, Islamic Republic	470	Iran, Islamic Republic	48
Portugal	454	Cyprus	463	Cyprus	46
International Average	**527**	**International Average**	**527**		

U.S. students tend to do better in the sciences than in mathematics, ranking 12th overall out of 25 countries that met the TIMSS guidelines. In general science courses, only 17% of all teachers are out-of-field. But 56% of U.S. high school students who take a physical science course are taught by out-of-field teachers because shortages of physical science teachers are much more severe than they are in other science fields. Thus, it should not be surprising that U.S. students scored well below average in physics (ranking 17th out of 25 countries) as compared to their international peers.

By contrast, U.S. students have compared favorably with students in other countries in reading, ranking at or above the median in 4th and 8th grades. This is partly due to the fact that there have been large investments in teachers' preparation to teach reading at the elementary level – for both reading specialists and "regular" classroom teachers – and there is very little hiring of unqualified teachers in these fields. Most districts and schools provide substantial expert support in reading for both teachers and students. In contrast, despite the fact that so many teachers lack the requisite expertise in mathematics, most districts allocate dramatically fewer resources to similar support in mathematics.[16]

As we describe later, variations in the qualifications of teachers across states – and state investments in teacher quality – are also related to how well students perform on national assessments in these fields.

International Comparisons of Teacher Development

Despite the importance of teacher expertise, when compared to many other countries that might be thought of as peers or competitors, the U.S. invests far less in the preservice and inservice preparation of teachers and allows much greater variability in teachers' access to knowledge. Many European and Asian countries support high-quality teaching by:

- pegging teacher salaries to those of professions like engineers or civil servants so that teaching does not experience shortages of qualified personnel,
- subsidizing a rigorous program of teacher preparation so that the most talented candidates can be recruited,
- encouraging or requiring graduate preparation in education on top of a bachelor's degree, including at least a year-long internship in a school working in partnership with the university,
- requiring rigorous examinations of knowledge about subject matter and teaching before entry into the profession,
- providing beginning teachers with intensive mentoring, support systems, and reduced teaching loads, so that they can gradually learn to teach proficiently,
- building extensive time for learning and collective planning into teachers' schedules so that they can work on teaching together.[17]

Teaching and teacher education abroad. The combination of these strategies

creates systematic supports for teaching throughout the career, beginning with its foundations in preservice education. In Germany, for example, prospective teachers earn the equivalent of academic majors in two disciplines and then pursue two to three more years of rigorous teacher preparation which combines pedagogical seminars with classroom observations and intensively supervised practice teaching. Preparation in Luxembourg is a seven-year process including graduate level professional training. In France, candidates pursue a five-year program of undergraduate studies and teacher education leading up to an intensively supervised year-long internship in schools much like the newly-launched (but not yet widespread) professional development schools in the U.S. In these countries, teachers are almost never hired without full preparation, a practice enabled by subsidies that underwrite teacher preparation and salaries comparable to those in other professions. Once they reach the classroom, special supports are typically available for beginning teachers and substantial time exists for ongoing professional learning.

Japan and Chinese Taipei are also moving toward extended programs of teacher preparation, including greater study of teaching and learning and an intensive internship. In Japan, for example, after graduating from a teacher education program and passing a highly competitive teacher appointment examination, beginning teachers work with a master teacher who observes them weekly. Their reduced load allows them to observe the classes of other teachers, participate in seminars and training sessions, and undertake 60 days of in-school professional development on topics such as classroom management, computer use, teaching strategies, and counseling methods.

Inservice professional development opportunities are also extensive. In many of these countries, teachers spend between 15 and 20 hours per week with students and the remaining time working with colleagues on joint planning and curriculum development, visiting parents, counseling students, and pursuing research, study groups, and other learning activities. Teachers regularly visit other schools, attend seminars provided by teachers, conduct group research projects, participate in ongoing teacher-led study groups in various subject areas, and offer demonstration lessons to one another.

These activities are often organized around the state or national curriculum framework, which is typically a lean instrument that outlines a relatively small number of major concepts and ideas to be treated, leaving to teachers the job of figuring out a range of strategies for doing so in the context of their own school and student body. In China, for example, the common structure provided by the curriculum guide directly supports a kind of professional discourse rarely seen in the U.S. Teachers compare notes about particular lessons and problems, discuss how their students respond to specific tasks, conduct demonstration lessons for one another, and discuss plans together.[18]

It is also worth noting here that one of the findings of the TIMSS studies was that U.S. texts and curriculum guidelines require mathematics and science teachers to cover far more topics superficially, and therefore less successfully, than do curriculum guides in

other countries, which emphasize in-depth learning about a smaller range of topics each year. Thus, teaching is both more thoughtfully guided and more consciously adapted to students' learning needs in many other countries whose students achieve at high levels.[19]

Teacher development in the U.S. By contrast, the United States lacks a professional development system for teachers. To begin with, teachers generally must pay for their own preparation and professional development, despite the fact that they earn 25 to 20% less than other professionals with similar levels of education. These fiscal barriers to preparation and entry produce both chronic shortages of qualified teachers in some fields and dramatically uneven levels of preparation across the teaching force.

Once in the classroom, U.S. teachers have only 3 to 5 hours a week in which to prepare their lessons, usually in isolation from their colleagues. Most have no time to work with or observe other teachers; they experience occasional hit-and-run workshops that are usually unconnected to their work and immediate problems of practice. This occurs despite the fact that there is in this country an enormous staff development industry. Districts, counties, and private entrepreneurs sponsor workshops, institutes, and after-school dinner meetings to develop, train, refresh, update, and inservice teachers.[20] Administrators form committees, bring in experts, adopt new textbook series. Teachers read *Teaching Mathematics*, *Instructor*, *Learning*, and *American Educator*. They purchase commercial black-line masters for activities and they collect books. They enroll in master's program courses. **However, much of such professional education is superficial, unconnected to a coherent vision of teaching or a set of curricular goals, and disjointed across localities and the courses of teachers' careers. Further, access to learning opportunities varies widely across schools and districts, depending on the vastly uneven level of resources available for education and the quite different views of school boards about whether and how to spend it on learning for teachers.**

In addition, most teachers in the U.S. have had a relatively thin program of preservice education. Most undertake an undergraduate program of teacher education that necessarily makes trade-offs between disciplinary preparation and pedagogical preparation (generally taught in unconnected courses) and that leaves only a short time for student teaching at the end of a brief training sequence. While some entering teachers are now graduating from redesigned programs that provide more integrated and extended study of content and teaching, other entrants – generally assigned to teach in poor urban and rural schools – receive no preparation for teaching at all. Furthermore, many new teachers are hired into the most disadvantaged schools where they are given the most challenging students and most difficult teaching assignments without mentoring or support. For all these reasons, about 30% of entrants to teaching leave within the first several years. In short, many U.S. teachers enter the profession with inadequate preparation, and few have many opportunities to enhance their knowledge and skills over the course of their careers.

It would be an oxymoron to call the U.S. teacher education enterprise a "system." Its fragmentation and variability account for many of the problems we described above.

There are at least three major sources of variability:

1. Variability in standards for candidates. There is extremely wide variation in the standards to which entering teachers are held. Licensing standards are radically different from state to state. Some high-standards states require a bachelor's degree in the subject to be taught plus intensive preparation for teaching including at least 15 weeks of student teaching and preparation for working with special needs students. Some low-standards states require only a handful of education courses and a few weeks of student teaching, little or no preparation in child development or learning theory, and less than a minor in the field to be taught. Forty states allow teachers to be hired on temporary or emergency licenses without having had any preparation or having met any standards at all. Similarly, some states require serious performance examinations of teaching knowledge and skill, whereas others require only basic skills tests. Some enforce their standards stringently and refuse to hire unqualified teachers, whereas others allow districts to hire large numbers of unqualified and underprepared candidates, even when qualified candidates are available.

2. Variability in standards for programs. The regulation of teacher education institutions is equally variable. Unlike other professions, most states do not require education schools to be professionally accredited, and many state procedures for approving programs are inadequate to ensure quality. With fewer than half of colleges having met national professional standards, the quality of programs in the more than 1300 institutions that now prepare teachers ranges from excellent to very poor. While a growing number of teachers are prepared in rigorous five or six-year programs including intensive internships, many are still prepared in underfunded four-year programs that are treated as "cash cows" by their universities, producing greater revenues for the education of future businessmen, lawyers, and accountants than they spend on the education of the future teachers they serve. Because states have set up their own approval systems in lieu of professional accreditation, and because most states approve all programs regardless of their quality, there is little leverage on for the improvement of teacher education programs.

3. Variability in teacher education curriculum and faculty. Prospective teachers take courses in the arts and sciences, in schools of education, and spend time in schools. What they study and who teaches it varies widely. Unlike other professions where the professional curriculum has a coherence in substance and pedagogy, the curriculum of teacher education is distributed widely, rarely with any effort at coordination. Many of those who teach teachers do not think of themselves as "teacher educators" – faculty in English or mathematics, for example, and most have little preparation for the task of educating teachers. They teach their courses as they would to any college student, leaving it to the prospective teachers to integrate subject matter and pedagogical studies. Many faculty in schools of education do not think of themselves as teacher educators, either. Instead, they are specialists in subjects like sociology, psychology, or reading.[21]

The quality of recently developed alternative certification programs is equally variable: Some are year-long postbaccalaureate models that have integrated theory and

skills development more productively than some traditional programs. By linking key coursework to intensively supervised internships, they provide a high-quality preparation to mid-career recruits who want to enter teaching. Others, however, offer only a few weeks of training that ignores such fundamentals as learning theory, child development, and content pedagogy, and places recruits in classrooms without supervised practice. Finally, few states require or fund the kinds of internships provided for new entrants in other professions such as architecture, psychology, nursing, medicine, or engineering. Structured induction programs are still rare in teaching, even though they have proven to be quite effective where they exist.

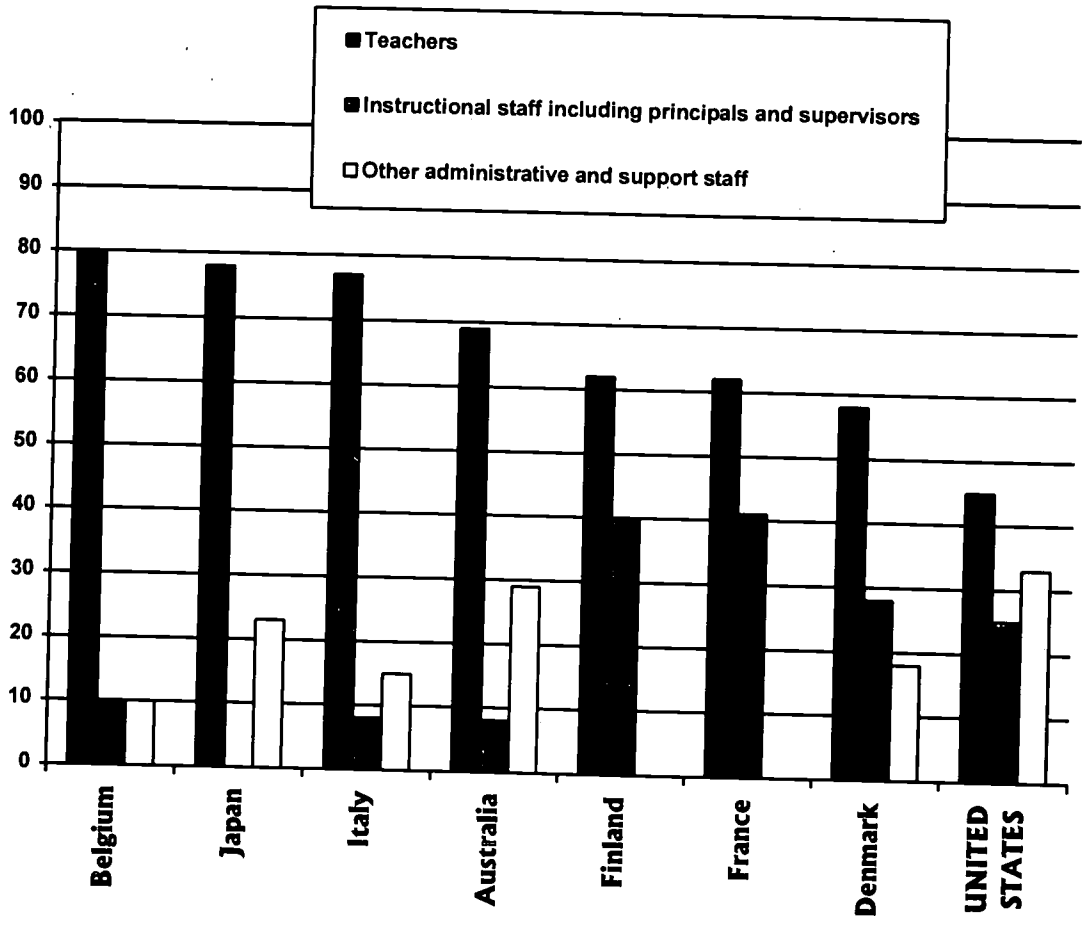
How are other countries able to support teaching more effectively? The more professional conception of teaching that exists in the European and Asian countries we mentioned earlier is made possible partly by the setting of standards for teaching by ministries of education or professional bodies established for this purpose. Examinations are set by these bodies as well. Schools of education are heavily subsidized by governments as is the training of candidates, so that the knowledge of teachers is not a function of individual ability-to-pay or candidates' preferences about how much they would like to study. Schools of education must meet standards regarding what is to be taught and learned.

Substantial ongoing professional development is made possible by the fact that teachers are the central investment of schools. Rather than create a large bureaucracy to design, monitor, inspect, and augment the work of teachers, funds are spent to hire a greater number of well-paid, well-educated teachers who make most school decisions and support each other in collegial learning. Consequently, classroom teachers comprise 60% to 80% of education employees in these other countries, as compared to only 43% in the U.S., where the number of administrative and nonteaching staff has more than doubled over the last 30 years. (See figures 7 and 8.) The logic of these other systems is that the greater preparation and inservice support teachers receive helps assure that they can make good decisions about curriculum, teaching, and assessment without legions of supervisors and inspectors to prescribe their work.

Teaching in these other countries is also less bureaucratically organized than it is in the U.S. It is not uncommon, for teachers in Germany, Japan, Switzerland, Sweden, and Denmark to serve as counselors, teach multiple subjects, and teach the same students for multiple years, so that they come to know their students well both academically and personally. Where similar arrangements for personalizing teacher-student relationships have been tried in the U.S., research shows that student achievement is significantly higher, as a consequence of teachers' greater knowledge of students' learning needs.[22] By hiring more teachers who are better-prepared and better-supported, and by organizing schools around their work with students, the U.S. could also reduce the bureaucratic superstructures that currently drain resources from classrooms where they could make a difference.

Figure 7

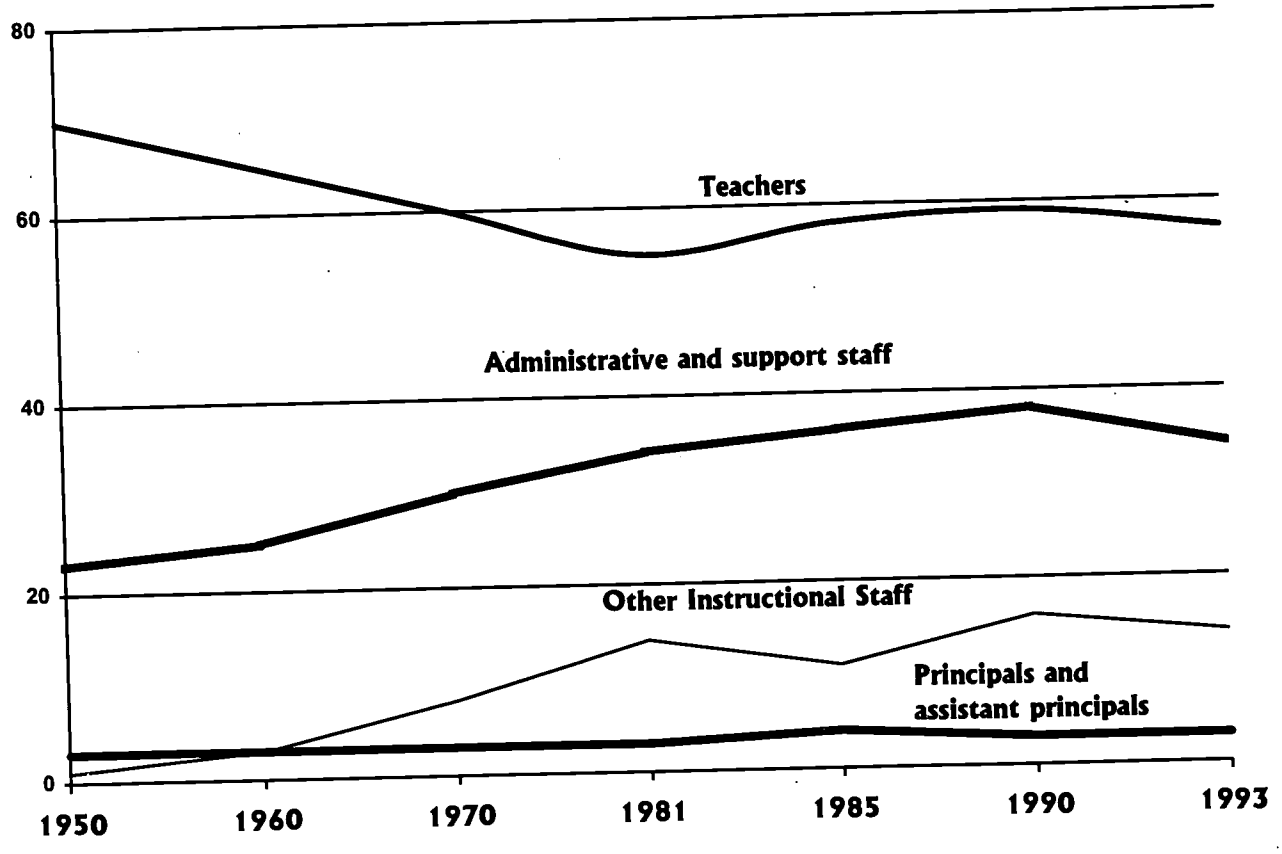
Comparisons of Educational Staff By Function



Source: Organization for Economic Cooperation and Development (OECD), *Education at a Glance: OECD Indicators* (Paris: OECD, 1995), table p31, pp. 176-177.

Figure 8

Type of Staff Employed by Public Schools



NOTE: Plotted points in each chart includes school years ending: 1950, 1960, 1970, 1981, 1985-1991, 1993.

Source: U.S> Department of Education, National Center for Education Statistics, Statistics of State School Systems, Commom Core of Data, 1992, and other unpublished estimates. Published in *The Condition of Education* 1993 (Washington, D.C.: National Center for Education Statistics, 1993), pp. 148,149.

Recommendations of the National Commission on Teaching and America's Future

The National Commission on Teaching emphasized the critical importance that well-prepared teachers and well-designed schools make for the achievement of higher standards. The Commission urged that standard-setting continue "so that high-quality, professionally informed curriculum guidance is widely available to help teachers organize their teaching and build on the work of their predecessors." "The essential companion to this effort," the Commission noted, "is investment in teacher and school capacities," and it offered a set of interlocking recommendations to ensure a systemic approach to developing high-quality teaching. They include:

I. Standards for teachers linked to standards for students. Clearly, if students are to achieve high standards, we can expect no less from their teachers and other educators. The first priority is reaching agreement on what teachers should know and be able to do in order to help students succeed at meeting the new standards. This task has recently been undertaken by three professional bodies that set standards for teacher education (the National Council for Accreditation of Teacher Education), beginning teacher licensing (the Interstate New Teacher Assessment and Support Consortium), and the advanced certification of accomplished veteran teachers (the National Board for Professional Teaching Standards). Their combined efforts to set standards for teaching linked to new student standards outline a coherent continuum of teacher development throughout the career. To advance these standards, the Commission recommends that states:

- Establish professional standards boards.
- Insist on professional accreditation for all schools of education.
- License teachers based on demonstrated performance of ability to teach to the new standards, including tests of subject matter knowledge, teaching knowledge and teaching skill.
- Use National Board standards as the benchmark for accomplished teaching.

II. Reinvent teacher preparation and professional development. For teachers to have continuous access to the latest knowledge about teaching and learning, the Commission recommends that states, schools, and colleges:

- Organize teacher education and professional development around standards for students and teachers.
- Institute extended, graduate-level teacher-preparation programs that provide year-long internships in a professional development school.
- Create and fund mentoring programs for beginning teachers that provide support and assess teaching skills.
- Create stable, high-quality sources of professional development — then allocate one percent of state and local spending to support them, along with additional matching funds to school districts.

- Embed professional development in teachers' daily work through joint planning, study groups, peer coaching, and research.

III. Overhaul teacher recruitment, and put qualified teachers in every classroom.

The Commission urged states and districts to address teacher recruitment problems by:

- Increasing the ability of financially disadvantaged districts to pay for qualified teachers and insisting that school districts hire only qualified teachers.
- Redesigning and streamlining district hiring.
- Eliminating barriers to teacher mobility, by promoting reciprocal interstate licensing and working with states to develop portable pensions.
- Providing scholarships and forgivable loans to recruit teachers for high-need subjects and locations.
- Developing high-quality pathways to teaching for recent graduates, mid-career changers, and paraprofessionals already in the classroom.

IV. Encourage and reward knowledge and skill. Schools have few ways of encouraging outstanding teaching or rewarding increases in knowledge and skill. Uncertified entrants are paid at the same levels as those who enter with highly developed skills. Novices take on exactly the same kind of work as 30-year veterans. Mediocre teachers receive the same rewards as outstanding ones. Teachers must leave the classroom to get promoted. To address these issues, the Commission recommends that states and districts:

- Develop a career continuum and compensation systems that reward knowledge and skill.
- Enact incentives for National Board Certification.
- Remove incompetent teachers through peer assistance and review programs that provide necessary supports and due process.

V. Create schools that are organized for student and teacher success. In order to be able to direct their energies around a common purpose, schools need to adopt shared standards for student learning that become the basis for common efforts of teachers, parents, and the community. Then, schools must be freed of the tyrannies of time and tradition to permit more powerful student and teacher learning. This includes restructuring time and staffing so that teachers have regular time to work with one another and with groups of students; rethinking schedules so that students and teachers have more extended time together over the course of the day, week, and years; and reducing barriers to the involvement of parents so that families and schools can work together. To accomplish this the Commission recommends that state and local boards work to:

- Reallocate resources to invest more in teachers and technology and less in non-teaching personnel.
- Select, prepare, and retain principals who understand teaching and learning and who can lead high-performing schools.

- Restructure time so students have more time for in-depth learning and teachers have time to work with and learn from one another.

Professional Development that Makes a Difference

What do we know about teacher learning that might help inform the improvement of professional development?[23] Recent years have seen new attention to problems of teacher education and teacher learning, yielding an increasing knowledge base useful for the design of better opportunities for teachers' ongoing learning. Five premises are especially pertinent to the improvement of teachers' opportunities to learn:

1. What teachers bring to learning to teach – their prior beliefs and experiences – affects what they learn. Increasingly, teachers' own histories – personal and professional – are thought to play an important role in what they learn from professional development experiences.

2. Learning to teach to the new standards takes time and is not easy. Changes do not happen overnight, nor simply by deciding to teach differently. There is as much to unlearn as there is to learn, and what there is to learn is complex. Teachers face making changes in deeply-held notions about learning and knowledge, reconsidering their assumptions about students, and developing new ways of teaching, as well as of assessing their work.

3. Content knowledge is key to learning to teach content so that students understand it. All the techniques in the world will not help a teacher choose the most productive examples for a presentation. Similarly, listening skills are insufficient to help a teacher interpret children's work. In both cases, teachers' effectiveness depends on what teachers understand about the material at hand and about the discipline more broadly.

4. Knowledge of children and their ideas and ways of thinking is crucial to teaching for understanding. Learning more about students, and about how to listen to them is crucial. How to *hear* what students say is more than a matter of acuity, for it requires seeing the world through another's eyes and perspective, not at all an easy task (especially when those worlds are diverse, sometimes disparate). Knowing how to link students and the curricular goals to which schools are responsible depends on insight into learners – what interests them, what they bring to learning a particular idea or skill, how they learn.

5. Opportunities for analysis and reflection are central to learning to teach. Teachers need time, space, and encouragement to reflect in ways that facilitate their learning – by talking with others, by keeping a journal, by engaging in action research.[24]

Despite the commonplace nature of these five premises, they are not at the foundation of most professional development. A great deal of what teachers encounter does not consider them as learners, is not designed to help them develop over time, does not focus on the content or students whom they teach, and does not offer opportunity for focused analysis and reflection. Moreover, it is most often conducted at a distance from the materials and problems of the work. In order to develop their practice, teachers need experience with the tasks and ways of thinking that are fundamental to the practice. Those experiences must be immediate enough to be compelling and vivid. To learn more than mere imitation or survival, such experiences also must be sufficiently distanced to be open to careful scrutiny, unpacking, reconstruction, and analysis.

It has become popular to talk about teachers as "lifelong learners," and about teaching as something that one learns over time. All teachers accumulate experience. But neither experience nor time alone can improve teaching. To highlight the complexity of "learning from experience," Sarason[25] pointed to the difference between two 20-year teaching veterans, commenting that one had twenty years of experience while the other had one year of experience twenty times. What is it that distinguishes learning from and improving one's practice from simply having experience?[26] Teachers need to learn how to operate experimentally in response to unique students and uncertain situations; then they need to be able to use what they learn in those particular cases to inform and improve future teaching. In order to develop their teaching, teachers must see their learning as essential to practice, and must learn how to inquire systematically into practice. Thus, the best way to improve both teaching and teacher learning is to create the capacity for much better learning about teaching as a *part of teaching*. Professional development would be substantially improved if we were to develop ways to learn and teach about practice *in* practice.

How can teachers learn methods of inquiry about their work, so as to improve their understanding of learning and teaching? One element of such professional learning is that it is centered in the critical activities of the profession. As in medicine and law, to be "in" practice is not necessarily to be in an operating room or a courtroom. One is "in" a realm of legal practice when one drafts or comments on appellate briefs in a legal library, by considering a variety of briefs and other sources that bear on the matters in question. Centering professional education "in practice" means, first, identifying the central activities of teaching practice, and second, selecting or creating materials that usefully depict that work and could be selected, represented, or modified to create opportunities for novice and experienced practitioners to learn.

The investigation of practice is another key element in a more professional approach to learning. In order to prepare people who are truly able to be learners in and from their practice, professional education must emphasize questions, investigations, and critiques of teaching and learning. The pedagogy of professional education would in considerable part be a pedagogy of investigation[27] using tools that permit analysis.

Finally, the elements sketched above could not be adequately cultivated without the development of more substantial professional discourse and engagement in communities of practice. Continuing thoughtful discussion among learners and teachers is an essential element of any serious education, because it is the chief vehicle for analysis, criticism, and communication of ideas, practices, and values. Moreover, the discourse of professional education should help to build collegiality among teachers, and create a set of relations rooted in shared intentions and challenges of the work. Such discourse should focus on deliberation about and development of standards for practice and on the improvement of teaching and learning.

Are there examples of current approaches to professional development that reflect these ideas? Below we discuss four current lines of work that hold promise for professional development that can make a difference.

Integrating theory and practice. Traditional beginning teacher education courses and "inservice" workshops for practicing teachers have been organized to help educators acquire the knowledge and skill thought to be crucial to teaching. In courses and workshops, educators learn theories and methods of teaching, and in classroom settings, they practice using what they have been taught. The assumption, held by instructors and learners at the university as well as by teachers, field supervisors, and learners in classrooms, is that knowledge is acquired in coursework and applied in practice.[28]

This divide between theory and practice, however, has left a critical gap unattended. Student teachers are often in the end most influenced by what they see their cooperating teachers do, or by their own memories from school. The effect of teacher education is often small. Although they collect ideas, learn theories, and develop some strategies, beginning teachers have often reported that their professional preparation was of little use or practicality.[29]

Over the past decade, however, many schools of education and school districts have begun to change these practices. Stimulated by the efforts of the Holmes Group and the National Network for Educational Renewal, more than 300 schools of education have created programs that extend beyond the confines of the traditional 4-year bachelors degree program, thus allowing more extensive study of the disciplines to be taught along with education coursework that is integrated with more extensive clinical training in schools. Some are one- or two-year graduate programs that serve recent graduates or mid-career recruits. Others are 5-year models that allow an extended program of preparation for prospective teachers who enter teacher education during their undergraduate years. In either case, because the 5th year allows students to devote their energies exclusively to the task of preparing to teach, such programs allow for year-long school-based internships that are woven together with coursework on learning and teaching.

A number of recent studies have found that graduates of extended (typically 5 year)

programs are not only more satisfied with their preparation, they are viewed by their colleagues, principals, and cooperating teachers as better prepared, are as effective with students as much more experienced teachers, and are much more likely to enter and stay in teaching than their peers prepared in traditional 4-year programs.[30]

Many of these programs have joined with local school districts to create professional development schools where novices' clinical preparation can be more purposefully structured. Like teaching hospitals in medicine, these schools aim to provide sites for state-of-the-art practice which are also organized to support the training of new professionals, extend the professional development of veteran teachers, and sponsor collaborative research and inquiry. Programs are jointly planned and taught by university-based and school-based faculty. Cohorts of beginning teachers get a richer, more coherent learning experience when they are organized in teams to study and practice with these faculty and with one another. Senior teachers report that they deepen their knowledge by serving as mentors, adjunct faculty, co-researchers, and teacher leaders. Thus, these schools can help create the rub between theory and practice that teachers need in order to learn, while creating more professional roles for teachers and building knowledge in ways that are more useful for both practice and ongoing theory-building.[31]

These new programs typically engage prospective teachers in studying research and conducting their own inquiries through cases, action research, and the development of structured portfolios about practice. They envision the professional teacher as one who learns from teaching rather than one who has finished learning how to teach, and the job of teacher education as developing the capacity to inquire sensitively and systematically into the nature of learning and the effects of teaching.

Developing professional discourse around problems of practice. A related avenue worth pursuing in seeking to improve the quality and impact of professional development centers on this inquiry orientation to knowledge. Traditionally, professional development (such as inservice workshops) and professional forums (such as journals and state meetings) assume an orientation that concentrates on answers: conveying information, providing ideas, training in skills.[32] With enthusiasm and clever quips, leaders distribute ideas, tips, and guidance. Handouts and reproducible worksheets are eagerly collected and filed. In some sessions, participants share ideas -- but this is still very much a discourse of answers, a confident stance of certainty. On one hand, this offers participants an enormous assortment of potential resources. However, their potential is restricted by the lack of critical discussion. The common view that "each teacher has to find his or her own style" maintains the individualism and isolation of teaching and impedes teachers' growth. What is needed instead are forums in which teaching and learning can be discussed and analyzed, where serious examination of practice, its outcomes, and its alternatives is possible.

One way is which this sort of forum has developed is in groups or sessions in which teachers look closely at artifacts of practice. The Bay Area Writing Project, now the National Writing Project, is one example of a highly successful and longstanding initiative focused on writing and the teaching of writing. Teachers meet regularly to write, read and discuss one

another's writing, look at and talk about children's writing, and develop curriculum and teaching strategies for writing. At the Education Development Center, Schifter and her colleagues have designed a series of projects over the last decade in which elementary teachers examined students' written work in mathematics. Not unlike the effective curriculum-based workshops reported by Cohen and Hill, these projects involved teachers in learning mathematics as well as learning about students' thinking about the same mathematics. Teachers also wrote cases about their students and their efforts to help them learn that same mathematics, thus both developing and discussing their own thinking and also creating concrete artifacts for others' discussion and learning.[33]

Some such opportunities for teachers to work directly with artifacts of practice and to to develop new forms of professional discourse emerge as a product of state and local policy initiatives. In Vermont, for example, a new state assessment system which used portfolios of student work became an occasion for teachers to work together. They examined student portfolios and developed guidelines for the construction of such portfolios, as well as standards for what would count as excellent, acceptable, and weak work. North Carolina is another state in which a high level of professional activity has grown in and around powerful state networks of teachers and teacher educators in mathematics and science. Statewide conferences for teachers, along with strong professional connections and communications, serve to support a context in which individual teachers learn and in which leaders develop who, in turn, strengthen the network. As we describe below, these kinds of strategies for professional development have been prominent in some of the states that have experienced substantial increases in student achievement in recent years.

Content-based professional development. In a recent study of California elementary teachers, Cohen and Hill report on a particular kind of professional development that appears to be strongly related to both changes in teachers' practices and their students' learning.[34] Based on analyses of a survey that they administered to a random sample of California elementary teachers and on achievement scores for the students of these teachers, the researchers report that when teachers had extensive opportunities to learn in what they called "student curriculum workshops" in elementary mathematics, their practices more closely resembled those envisioned by the new curriculum framework and their students' achievement on mathematics assessments was significantly higher.

These "student curriculum workshops" refer to teachers' opportunities to use new student curriculum units related to specific concepts in the mathematics framework to investigate mathematics content, instruction, and learning. Within these workshops, leaders in the state department of education devised a strategy called "replacement units," which offered teachers a chance to change one unit within their mathematics teaching by using some specially designed materials for specific curricular areas. These "replacement units" could be taught by teachers in place of their textbook's more conventional approach to particular mathematical topics. In some cases, the content was new (e.g., discrete mathematics) and in others the units used new approaches to familiar topics (e.g., multiplication). As teachers studied and used these units, they discussed them with their colleagues. These discussions focused on content as well as on

pedagogy and curriculum, and created an unusual opportunity to learn, both in their own classrooms and from one another.

These sorts of workshops were strikingly distinguishable from other workshops in which there was not any deep connection to a central topic in a school subject. According to the researchers, these sorts of professional development seemed to offer teachers the opportunity to learn new content and new strategies for teaching it, both grounded in issues and problems of their work. Although much professional development continues to be generic (focusing for example on "learning styles" or classroom management), these findings suggest that professional development could be still more effective if it were grounded in particular content material and in the teaching and learning of those topics as represented in concrete problems of practice.

These findings also hold a message for the use of the barrage of newly-developed curriculum material that teachers and schools are adopting. These results suggest that curriculum materials designed for students could offer teachers a concrete context to explore in a way that is connected to content, pedagogy, and learning. In mathematics, for example, the National Science Foundation funded several major curriculum projects in the last five years, and new textbook series are hitting the market now. These materials, published commercially, and aligned with standards for mathematics teaching and systematically piloted in real classrooms, will offer schools new options for instructional material. Wise planning would include serious consideration of how to use the adoption of new innovative material as an occasion to design and launch a teacher study group or other opportunity for teachers to learn.

Learning from the analysis of practice. The examples in the previous section share the feature that they offer access to a common set of material drawn from practice to ground professional discourse. Samples of student work and of teacher work are central to the professional development emerging from the emergence of both student and teaching standards, including those of the National Board for Professional Teaching Standards and its analog for beginning teacher licensing – the Interstate New Teacher Assessment and Support Consortium (INTASC). Teachers report that they learn a great deal from analyzing their own and each other's practice against a set of common standards that reflect accomplished teaching and from developing a portfolio that is based on artifacts and reflections on their work.

The INTASC portfolio process, which is designed to support a performance-based licensing system for beginning teachers, can serve as a curriculum for the professional development of beginning and experienced teachers as well as teacher educators. INTASC offers a model to guide beginning teachers in assembling evidence of their professional work that can be evaluated by other educators. In states like Connecticut that have launched these assessments, beginning teachers have an experienced mentor who talks with them about their work and about the process of collecting and assembling their portfolio. This creates an opportunity to structure a focused and ongoing discussion of practice. In addition,

experienced teachers are among those who read and examine these portfolios. As they talk with one another about particular candidates' portfolios, they discover many places where they do not agree, have different interpretations, or mean different things by the same term. They also begin to develop some shared standards and language with which to look at teaching and learning. Similarly, teacher educators who become involved, either in assisting beginning teachers in developing their portfolios or in evaluating finished portfolios, have unprecedented opportunities to look closely at practice and to discuss it with other educators. These opportunities can be avenues for them to consider what they are preparing teachers for, and what they might need to learn to do that.

Videotaped lessons that are analyzed and placed in the context of students and curriculum are cornerstones of the National Board and INTASC portfolios. In other contexts, too, such as preservice teacher education and ongoing professional development, videotape offers a concrete context for close study of students, learning, content, and pedagogy. One reason is that "images of reform" are more powerful than abstract discussions of new ideas. Teachers who have never seen children engaged in a mathematics problem, or discussing text, need to have opportunities to see what this can look like. These serve, in part, as existence proofs that such practice can happen in schools and they establish initial stepping stones to the development of such practice.[35]

Videotape can be used to frame tasks that allow teachers to engage in focused analyses of teaching. Unlike observations of real-time teaching, videotape can be stopped in the middle of an activity to think, write, or talk about it; replay the activity over; and chunk activities together in different ways for different analytic purposes. Teachers can scrutinize particular moves or statements at various points in the lesson and and compare their interpretations or analyses with others'. They can trace a particular idea in the class, examining the roles of teacher and students in the development of that idea. They can focus on particular children and to examine how particular children are thinking. Such work can help teachers develop multiple perspectives and frames of reference with which to interpret information and make conjectures in practice. It may also support the development of teachers' communication skills and capacities by providing a shared common context for the analysis of teaching. In talking with others, teachers can develop language and shared referents for communicating about teaching.[36]

Some examples can be found in university-based teacher education. Michigan State and University of Michigan faculty have been devising ways to use multimedia records of practice mounted in a hypertext computer system – videotapes of lessons, children's work, teacher lesson plans, assignments, and reflections – taken from a third and fifth grade mathematics class across an entire school year as the basis for study of teaching. These artifacts provide opportunities for beginning teachers to investigate teaching and learning, to interpret what they see in multiple ways, and to come to appreciate the context-specific nature of both teaching and knowing in teaching. Teacher education students may study particular children's progress across a year using the records of practice. They may explore the culture of the classroom and how it evolved. They may scrutinize the curriculum to

uncover what is being taught, to whom, and who is learning what, and how. Using tools of technology, they can bridge the gap between theory and practice by bringing the classroom to the university.

Promising State Strategies for Improving Teaching

Some states have already begun to take advantage of these more powerful approaches to teacher learning, and many more are preparing to do so, as they add teacher policy to the array of tools they are using in pursuit of higher student standards. In this section we summarize evidence about what has already made a difference in some states and describe practices that seem likely to do so.

Lessons from Last Decade's Reforms

The critical importance of investments in teaching is demonstrated by states' experiences over the past decade. Over that decade of reform, a few states undertook major initiatives aimed at improving the quality of teaching. Notable among them for the size and scope of investments were North Carolina and Connecticut. Both of these states coupled major statewide increases in teacher salaries with intensive recruitment efforts and initiatives to improve preservice teacher education, licensing, beginning teacher mentoring, and ongoing professional development. Since then, North Carolina has posted among the largest student achievement gains in mathematics and reading of any state in the nation, now scoring well above the national average in 4th grade reading and mathematics, although it entered the 1990s near the bottom of the state rankings. (See figures 9-11). Connecticut has also posted significant gains, becoming one of the top scoring states in the nation in mathematics and reading, despite an increase in poverty in the state during that time.

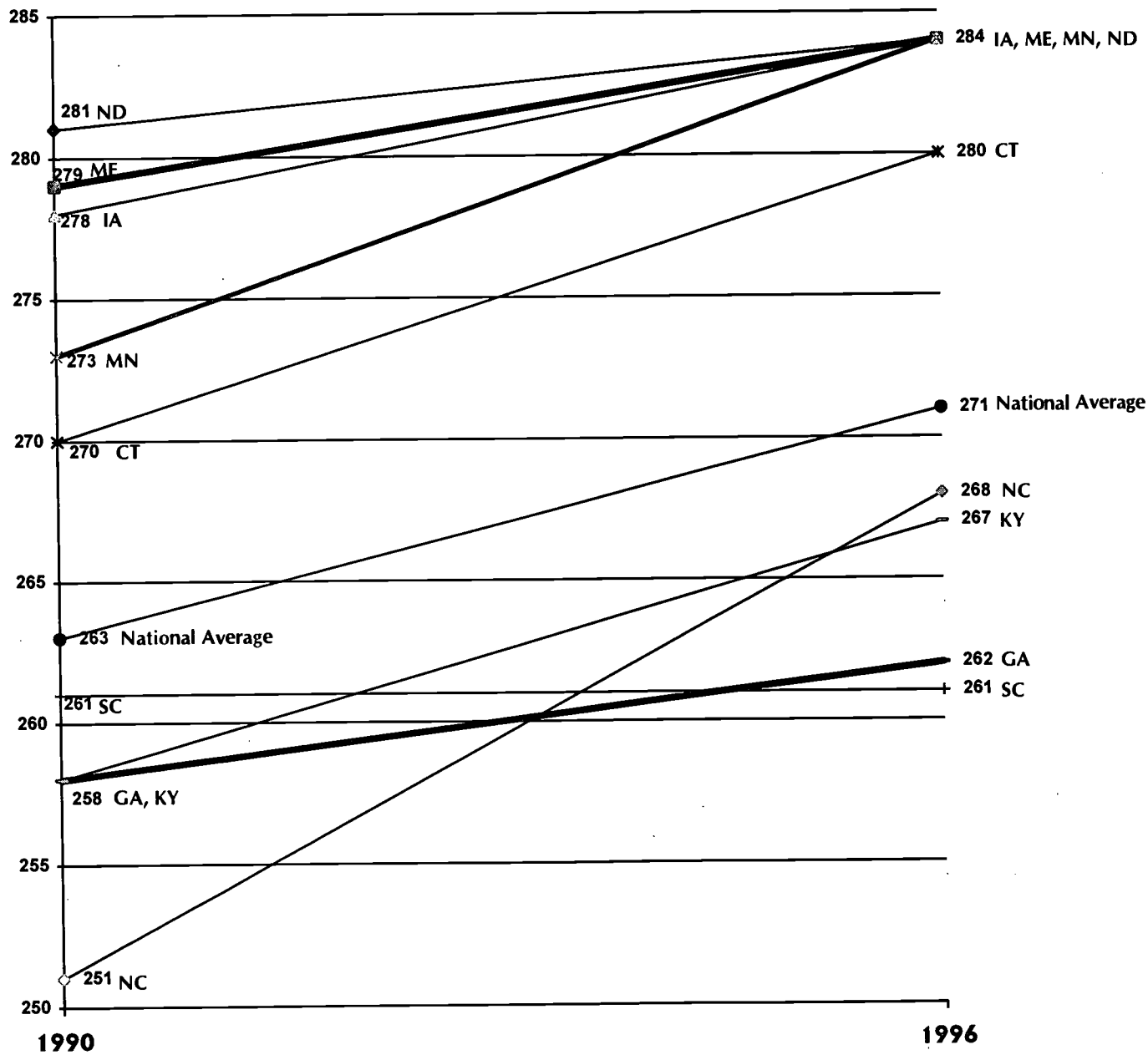
North Carolina's reforms boosted minimum salaries, launched an aggressive campaign to recruit able students into teacher preparation by subsidizing their college education, required schools of education to become professionally accredited, invested in teacher education improvements, created professional development academies and a North Carolina Center for the Advancement of Teaching, developed local sites to support networks like the National Writing Project, launched a beginning teacher mentoring program, and introduced the most wide-ranging set of incentives in the nation for teachers to pursue National Board certification. North Carolina now boasts more Board-certified teachers than any other state. Recently, the state has created a state professional standards board for teaching and has passed legislation that will create professional development school partnerships for all schools of education, will develop a more intensive beginning teacher mentoring program, will further upgrade licensing standards, will create incentives for teacher knowledge and skill, and will raise teacher salaries once again.

Connecticut spent over $300 million in 1986 to boost minimum beginning teacher salaries in an equalizing fashion that made it possible for low-wealth districts to compete in

the market for qualified teachers. This initiative completely eliminated teacher shortages in the state and created surpluses of teachers. At the same time, the state raised licensing standards, instituted performance- based examinations for licensing and a state-funded beginning teacher mentoring program, required teachers to earn a master's degree in education for a continuing license, invested in training for mentors, and supported new professional development strategies in universities and school districts. Recently, the state has further extended its performance-based licensing system to incorporate the new INTASC standards and portfolio assessments modeled on those of the National Board for Professional Teaching Standards and is supporting the creation of professional development schools linked to local universities. Both North Carolina and Connecticut have recently launched performance assessment systems for students to create better measures of students' higher order thinking and performance skills.

Figure 9

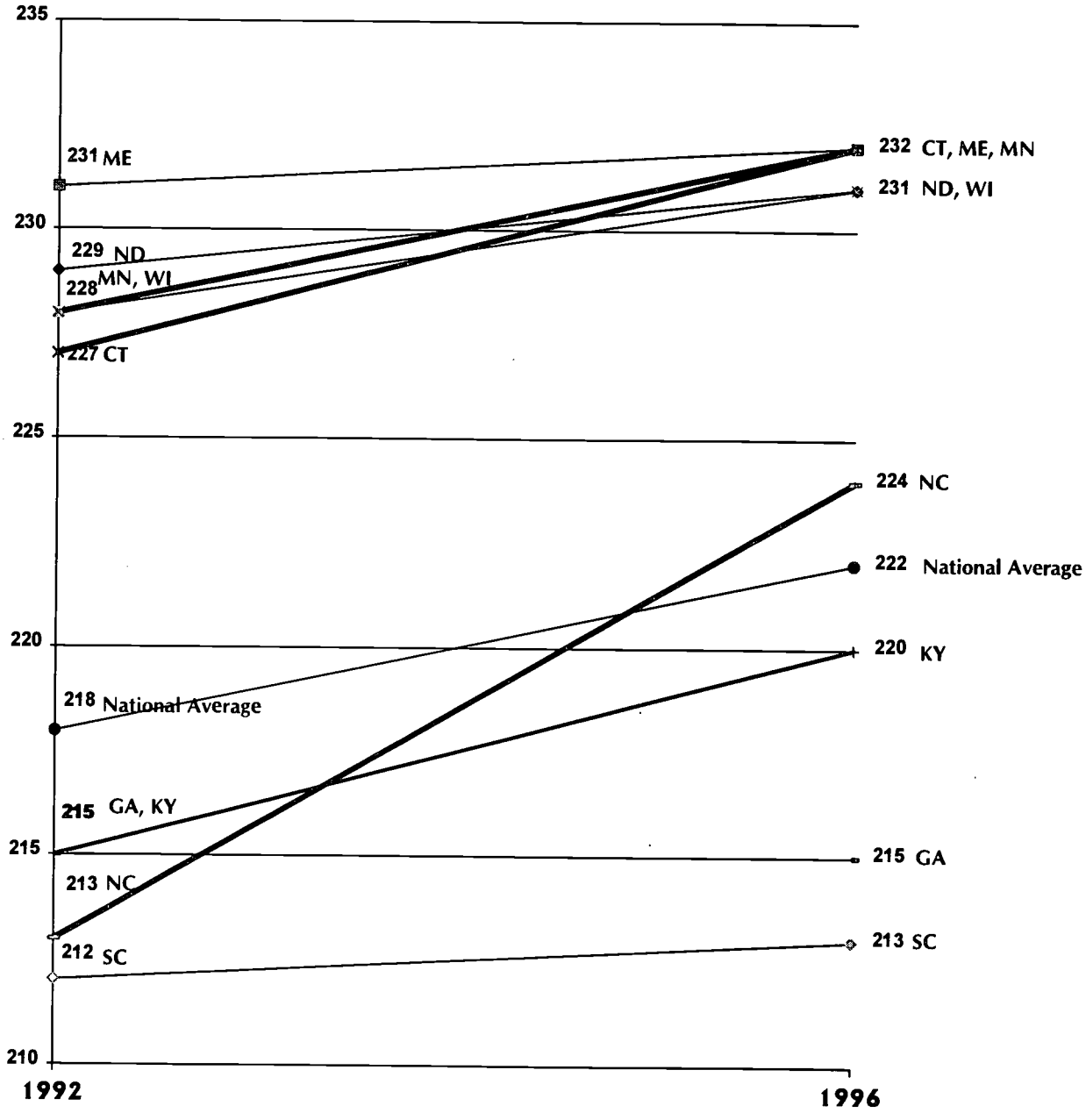
Changes in NAEP Scores
Grade 8 Math (1990-1996)



*Note: Maine did not participate in 1990. Score is from 1992 assessment.
Source: U.S. Department, National Center for Education Statistics, *NAEP 1996 Mathematics Report Card for the Nation and the States*, Table 2.3, p.30.

Figure 10

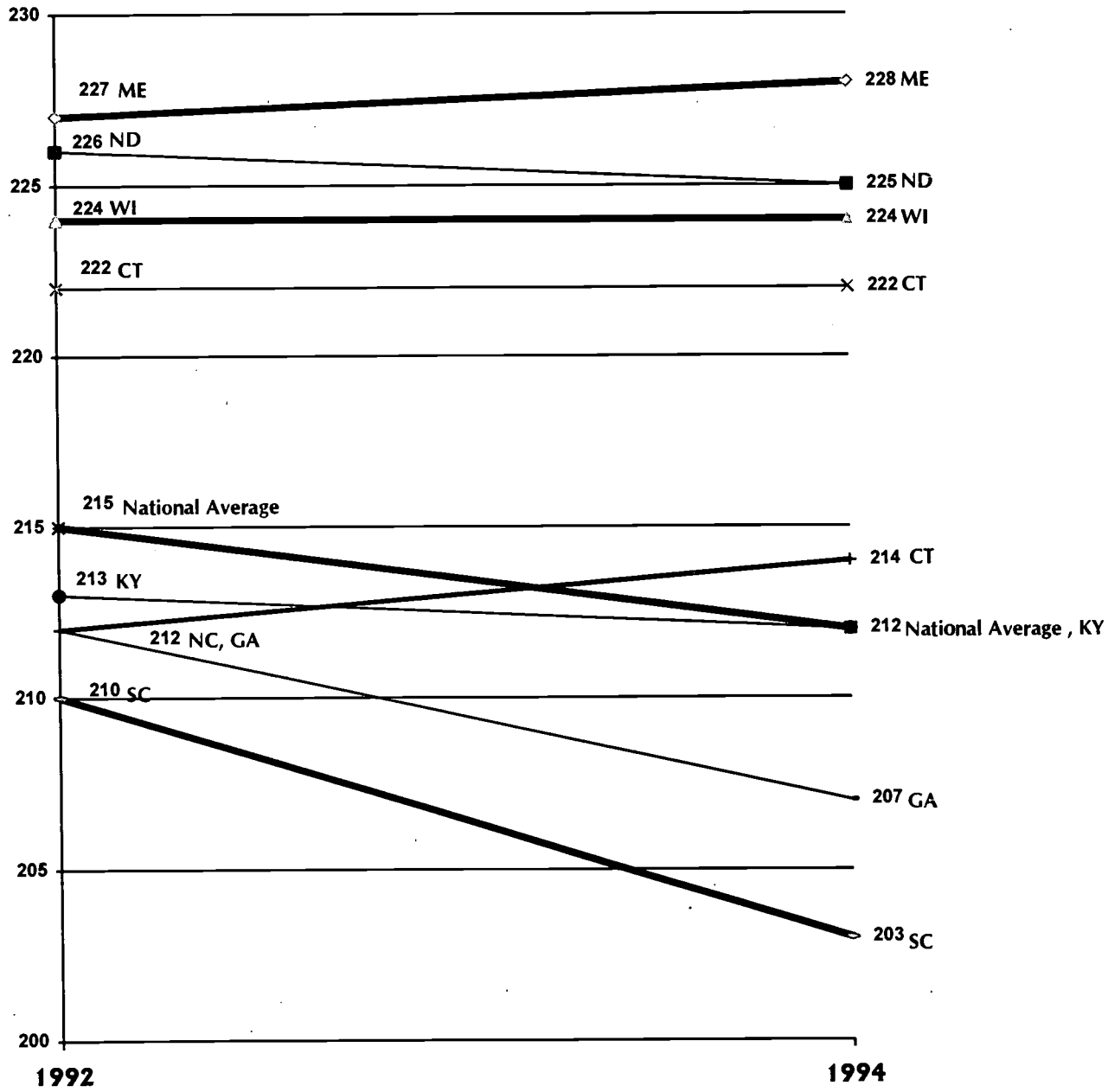
Changes in NAEP Scores
Grade 4 Math (1990-1996)



Source: U.S. Department, National Center for Education Statistics, *NAEP 1996 Mathematics Report Card for the Nation and the States*, Table 2.2, p. 28.

Figure 11

Changes in NAEP Scores
Grade 4 Reading (1992-1994)



Source: **U.S. Department, National Center for Education Statistics,** *NAEP 1996 Reading Report Card for the Nation and the States,* Table 2.3, p. 25.

Meanwhile, the nation's top-scoring states have long supported high-quality teaching and teacher learning in a variety of ways. Figures 9-11 show that Minnesota, North Dakota, Iowa, Wisconsin, and Maine repeatedly rank at the top of the state distribution in student achievement, despite the fact that none of them has had a statewide curriculum or high-stakes testing system.[37] These states, however, have a long history of professional policy. Minnesota, North Dakota, and Iowa are among the 12 states that have state professional standards boards. All three have enacted high standards for entering teaching and are among the few states that refuse to hire unqualified teachers on substandard licenses. School districts in Minnesota, North Dakota, and Wisconsin are among the nation's most likely to require a college major or minor in the field taught along with full state certification as a condition of hiring.[38] Minnesota, North Dakota, and Iowa have some of the lowest rates of out-of-field mathematics teaching of any states in the country.[39]

These states have also been leaders in redefining teacher education and licensing. Minnesota was the first state to develop performance-based standards for licensing teachers and for approving schools of education during the mid-1980s, and has developed a beginning teacher residency program in the years since.[40] During the 1980s, Wisconsin was one of the first states to require teachers to earn a major in their subject area in addition to extensive preparation for teaching. Thus, teacher education in Wisconsin is typically a 4 1/2 to 5 year process. (The Wisconsin approach stands in contrast to that of some other states that reduced preparation for teaching when they required students to gain a major in their subject area.) Maine, Wisconsin, Iowa, and Minnesota have all incorporated the INTASC standards into their licensing standards and have piloted performance-based assessments of teaching within universities.

The Commission highlighted as exemplars of leading edge preservice and inservice teacher education Maine's innovative postbaccalaureate teacher education program at the University of Southern Maine and its Southern Maine Partnership – one of two school-university partnerships supported by the state. Maine also supports regional coalitions of school improvement teams, and both Maine and Iowa have launched state grants programs that allow schools to undertake research-based inquiry and professional development tied to their schoolwide efforts to redesign education.

On the other hand, reform strategies that did not substantial efforts to improve teaching have been much less successful. States that instituted new standards and tests in the 1980s without investing in teaching did not experience improved achievement. For example, the first two states to organize their reforms around a standards and testing strategy were Georgia, with its Quality Basic Education Act (QBE) and South Carolina, with its Education Improvement Act of 1984. These states developed extensive testing systems attached to high stakes consequences for students, teachers, and schools. Although both states also mandated tests for teachers, they did not link these assessments to emerging

knowledge about teaching or to new learning standards, nor did they invest in improving schools of education or ongoing professional development. As figures 9-11 show, student achievement in mathematics has been flat in these states while achievement in reading declined.

Neither student standards and assessments nor increased salaries for teachers were enough to overcome the effects of large numbers of uncertified teachers and low standards for teacher education, licensing, and hiring. It is also possible that the states' multiple-choice basic skills testing systems worked in opposition to the kinds of student achievement sought by the more performance-based National Assessment of Educational Progress (NAEP), which demands a more sophisticated set of learning and teaching strategies. In fact, as figure 4 shows, frequent use of multiple-choice and short-answer tests in reading is associated with lower scores on the NAEP, rather than higher ones.

The high stakes aspects of these reforms may have created other problems as well, such as the states' declining graduation rates. In many states and school districts, test-based sanctions have created incentives for schools to keep out or push out the most educationally needy students: Large numbers of students have been retained in grade so that their scores look better, placed in special education so that their scores don't count, denied admission to schools of choice, or pushed out of schools in order to keep average scores up.[41] These strategies have been found to lead to lower student achievement and higher dropout rates in the long run, even though test scores appear to improve in the short run.[42]

A slightly different story chacterizes the reforms in Kentucky, which have included new standards and assessments without high stakes for students. Kentucky's assessments are much more performance-oriented than traditional standardized tests, and they were accompanied by school redesign initiatives and massive investments in school spending to equalize funds for poor districts. Although Kentucky did not initially invest much of its resources in teacher development, it quickly became apparent that such investments would be needed for any of the state's ambitious reforms to succeed. Since 1990, Kentucky has created a professional standards board, upgraded teacher education and licensing requirements, and created a variety of new approaches to professional development.

Although student achievement in reading declined slightly in Kentucky between 1992 and 1994, mathematics achievement increased, although not as steeply as in North Carolina or Connecticut.

The lessons of reforms to date suggest that states should be encouraged to develop standards and assessments for students that emphasize authentic forms of learning and that evaluate longitudinal gains in useful ways. They should also seek to develop systems that help teachers and principals gain the knowledge they need to teach more effectively and to redesign schools so that they can succeed in helping very diverse students learn to meet these new standards.

Promising Strategies for the Future

The strategies used by states that have made great strides in student learning over the last decade are instructive. They include a number that are the basis for systemwide efforts to improve teaching in twelve states that have become partners with the National Commission on Teaching and America's Future: Georgia, Illinois, Indiana, Kansas, Kentucky, Maine, Maryland, Missouri, Montana, North Carolina, Ohio, and Oklahoma. These states, and several others that are working with the Commission as associates, have launched a policy inventory that takes stock of the current status of teaching in the state; they have also convened a policy group of stakeholders to use these data in creating strategic plans for legislative and programmatic change aimed at recruitment, preparation, ongoing professional development, and support of teaching.

These states are striving to build policy systems that can support teaching to new standards. Among several promising strategies are the following:

Standards-Based Reforms of Teaching. Virtually all of the Commission's partner states are developing systems of standards for teaching to ensure that teachers have the knowledge and skills to teach students to meet the new curriculum standards. These systems create a continuum of standards for teacher development that are aligned with one another and with the emerging student standards – professional accreditation of education schools through NCATE (the National Council for Accreditation of Teacher Education), beginning teacher licensing assessments using INTASC standards, and advanced certification of accomplished practice through the National Board for Professional Teaching Standards (NBPTS). States that build this continuum into their policies for approving programs, licensing teachers, and rewarding expert veteran teachers will have developed the foundation for a professional development *system* that ensures teachers have the knowledge and skills they need to teach diverse learners to high levels.

These standards and the performance-based assessments that accompany them provide a means for rethinking preparation and professional development and for creating incentives for the acquisition of knowledge and skill. Where they are accompanied by policies that equalize the ability of districts to hire qualified teachers and by subsidies for the preparation of future teachers for high need fields and locations (as is true, for example, in North Carolina and Kentucky), they provide the means for creating greater equity in the quality of education children will receive.

Redesign of Teacher Education and Induction. Some partner states, like Illinois, North Carolina, and Ohio, have been creating strategies for redesigning schools of education to include professional development schools, sites like teaching hospitals where teachers in training can learn under the guidance of master teachers and teacher educators in settings that are striving to develop state-of-the-art practice for both students and teachers. Some of states are encouraging schools of education to move toward five-year models that provide a

year-long internship in professional development school sites. New induction models that provide beginners with much more intensive supervision and with assessment for a continuing license tied to the new teaching standards are under construction in North Carolina, Indiana, and Illinois.

Restructured Professional Development. A number of states are working to redesign professional development using the principles we described above. Missouri enacted a two percent set-aside of state and local funds for professional development several years ago. These funds are being used, in part, to support regional professional development centers, while some local districts are using funds to support teacher networks and study groups of various kinds. Ohio has also created regional teacher academies to extend the work launched in the very successful Mayerson Academy in Cincinnati which provides sustained sources of professional development supported by new technologies and shaped and managed by district teachers in collaboration with nearby universities. Ohio also maintains a venture capital fund that has been extremely successful in getting school staffs to undertake research, inquiry, and professional development linked directly to their school needs and immediate problems of practice. Maine supports two school-university partnerships and regional school improvement centers focused on teacher inquiry and support for school-based research, study groups, and professional development schools. Content-based professional development networks in California and Vermont have received state support to work with teachers around new curriculum frameworks and assessments.

All of these efforts hold promise for moving beyond the generic, "hit-and-run" workshops of an earlier era to help teachers successfully meet the challenge of teaching much more ambitious content to students who learn in a wide variety of ways. Professional development that links theory and practice, that creates discourse around problems of practice, that is content-based, and that engages teachers in analysis of teaching can provide the supports needed for the serious teacher learning needed to engender powerful student achievement.

FOOTNOTES

[1] With the advent of new portfolio assessment strategies for assessing the knowledge and skills of beginning and experienced teachers as part of the INTASC (Interstate New Teacher Assessment and Support Commission) and NBPTS (National Board for Professional Teaching Standards), better means exist for probing teachers' expertise that may produce even greater ability to evaluate expertise and its effects on student learning.

[2] Ronald Ferguson, "Paying for Public Education: New Evidence on How and Why Money Matters," Harvard Journal of Legislation, Vol. 28 (Summer 1991), pp. 465-98.

[3] Rob Greenwald, Larry V. Hedges, Richard D. Laine, "The effect of school resources on student achievement," Review of Educational Research, Vol. 66 (Fall 1996): 361-396.

[4] Eleanor Armour-Thomas, Camille Clay, Raymond Domanico, K. Bruno, and Barbara Allen, An Outlier Study of Elementary and Middle Schools in New York City: Final Report. New York: New York City Board of Education, 1989.

[5] William L. Sanders and June C. Rivers, Cumulative and Residual Effects of Teachers on Future Student Academic Achievement. Knoxville: University of Tennessee Value-Added Research and Assessment Center, November 1996.

[6] For reviews, see Patricia Ashton and Linda Crocker, "Systemic Study of Planned Variation: The Essential Focus of Teacher Education Reform," Journal of Teacher Education, Vol. 38 (May/June 1987): 2-8; Carolyn Evertson, Willis Hawley, and M. Zlotnick, "Making a Difference in Educational Quality through Teacher Education," Journal of Teacher Education, Vol. 36 (May/June, 1985): 2-12; Linda Darling-Hammond, "Teaching and Knowledge: Policy Issues Posed by Alternative Certification of Teachers," Peabody Journal of Education, Vol. 67 (Spring 1992): 123-154; Martin Haberman, An Evaluation of the Rationale for Required Teacher Education: Beginning Teachers With or Without Preparation. Prepared for the National Commission on Excellence in Teacher Education, Milwaukee, WI: University of Wisconsin, September 1984; Cynthia A. Druva and Ronald D. Anderson, "Science Teacher Characteristics by Teacher Behavior and by Student Outcome: A Meta-analysis of Research," Journal of Research in Science Teaching 20 (May 1983): 467-479; E. G. Begle, Critical Variables in Mathematics Education: Findings from a Survey of the Empirical Literature (Washington, D.C.: Mathematical Association of America and National Council of Teachers of Mathematics, 1979); Thomas L. Erekson and Lowell Barr, "Alternative Credentialing: Lessons from Vocational Education," Journal of Teacher Education 36 (May/June 1985): 16-19; James D. Greenberg, "The Case for Teacher Education: Open and Shut," Journal of Teacher Education 34 (July/August 1983): 2-5; Edith Guyton and Elizabeth Farokhi, "Relationships among academic performance, basic skills, subject matter knowledge and teaching skills of teacher education graduates. Journal of Teacher Education (Sept-Oct. 1987): 37-42.

[7] Druva and Anderson, op. cit.

[8] Begle, op cit.

[9] Parmalee Hawk, Charles R. Coble, and Melvin Swanson (1985). Certification: It Does Matter, Journal of Teacher Education, 36 (3): 13-15.

[10] Jon J. Denton and Lorna J. Lacina, "Quantity of Professional Education Coursework Linked with Process Measures of Student Teaching," Teacher Education and Practice (1984): 39-64; Victor A. Perkes, "Junior High School Science Teacher Preparation, Teaching Behavior, and Student Achievement," Journal of Research in Science Teaching, Vol. 6 (1968): 121-126; J. B. Hansen, "The Relationship of Skills and Classroom Climate of Trained and Untrained Teachers of Gifted Students," (unpublished dissertation, Purdue University, Indiana, 1988).

[11] For a review, see What Matters Most.

[12] National Center for Education Statistics, Unpublished tabulations from the Schools and Staffing Surveys (Washington, D.C.: National Data Resource Center); Emily Feistritzer, Alternative Teacher Certification: A State-by-State Analysis. (Washington, D.C.: National Center for Education Information, 1990).

[13] Marilyn M. McMillen, Sharon A. Bobbitt, and Hilda F. Lynch, "Teacher Training, Certification, and Assignment in Public Schools: 1990-91." Paper presented at the annual meeting of the American Educational

Research Association, New Orleans, LA: April 1994.

[14] Richard M. Ingersoll, Schools and Staffing Survey: Teacher Supply, Teacher Qualifications, and Teacher Turnover, 1990-1991. Washington, DC: National Center for Education Statistics, U.S. Department of Education, 1995, p. 28.

[15] Jeannie Oakes, Multiplying Inequalities: The Effects of Race, Social Class, and Tracking on Opportunities to Learn Mathematics and Science. Santa Monica, CA: RAND Corporation, 1990.

[16] J. Price and D. Ball, "There's always another agenda": Marshalling resources for mathematics reform. Journal of Curriculum Studies (in press).

[17] For a review see What Matters Most: Teaching for America's Future.

[18] Lynne Paine and L. Ma, Teachers working together: A dialogue on organizational and cultural perspectives of Chinese teachers. International Journal of Educational Research, 19, 675–697, 1993.

[19] William Schmidt, Curtis McKnight, and Senta Raizen, A Splintered Vision, Kluwer Academic Publishers, 1996.

[20] Dennis Sparks & Loucks-Horsley, "Models of staff development," In W. R. Houston (Ed.), Handbook of research on teacher education (pp. 234–250). New York: Macmillan, 1990.

[21] Lanier, J. and Little, J. W., "Research on teacher education," In M. C. Wittrock (Ed.), Handbook of research on teaching (3rd ed.), (pp. 527-569). New York: Macmillan, 1986.

[22] Valerie Lee, Anthony Bryk, & Mary Lou Smith, "The Organization of Effective Secondary Schools." In L. Darling-Hammond (ed.), Review of Research in Education, Vol. 19. Washington, D.C. American Educational Research Association, 1993; Gottfredson, G.D. and Daiger, D.C. (1979). Disruption in 600 schools. Baltimore, MD: The Johns Hopkins University, Center for Social Organization of Schools; Jomills Braddock, and James McPartland, "Education of Early Adolescents." In L. Darling-Hammond (ed.), Review of Research in Education, Vol. 19. Washington, D.C. American Educational Research Association, 1993.

[23] This section of the paper and the one that follows draw from D. L. Ball, "Developing mathematics reform: What don't we know about teacher learning – but would make good working hypotheses?" In S. Friel & G. Bright (Eds.), Reflecting on our work: NSF Teacher Enhancement in K-6 Mathematics, pp. 77 - 111, Lanham, MD: University Press, 1995, and D. L. Ball, "Teacher learning and the mathematics reforms: What do we think we know and what do we need to learn?" Phi Delta Kappan, 77(7), 500- 508, 1996.

[24] This section borrows extensively from Deborah Ball & David Cohen, Developing practice, developing practitioners: Toward a practice-based theory of professional education. Paper prepared for the National Commission on Teaching and America's Future. Teachers College: New York, 1995.

[25] Sarason, 1962.

[26] M. Lampert and D. L. Ball, ibid. Also, M. Lampert and D. L. Ball. "Learning teaching: New pedagogies, new technologies," Teachers College Press (in press, 1998).

[27] Feiman-Nemser & M. "The First Year of Teacher Preparation: Transition to Pedagogical Thinking," Journal of Curriculum Studies, 1986, pp. 239-256

[28] See, for example, S. Feiman-Nemser, "Learning to Teach," In L. Shulman & G. Sykes (Eds.), Handbook of Teaching and Policy (Longman: 1983), pp. 150-170; D. Lortie, Schoolteacher: A Sociological Study. University of Chicago Press: 1975; Robert Tabachnik, Thomas Popkewitz, & Kenneth Zeichner. "Teacher Education and the Professional Perspectives of Student Teachers," Interchange, 10 (4), 1979-80, 12-29.

[29] For data on effectiveness and retention see Michael Andrew, "The Differences between Graduates of Four-Year and Five-Year Teacher Preparation Programs," Journal of Teacher Education, 41 (1990): 45-51; Thomas Baker, "A Survey of Four-Year and Five-Year Program Graduates and their Principals," Southeastern Regional Association of Teacher Educators (SRATE) Journal 2, no. 2 (Summer 1993): 28-33; Michael Andrew and Richard L. Schwab, "Has Reform in Teacher Education Influenced Teacher Performance?: An Outcome Assessment of Graduates of Eleven Teacher Education Programs," Action in Teacher Education 17 (Fall 1995): 43-53; Jon J. Denton and William H. Peters, "Program Assessment Report: Curriculum Evaluation of a Non-Traditional Program for Certifying Teachers," (Unpublished report, Texas A&M University, College Station, TX, 1988); and Hyun-Seok Shin, "Estimating Future Teacher Supply: An Application of Survival Analysis (Paper presented at the annual meeting of the American Educational Research Association, New Orleans, LA, April

1994).(Andrew, 1990; Andrew & Schwab, 1995; Arch, 1989; Denton & Peters, 1988; Dyal, 1993; Shin, 1994).

[30] For a review see Linda Darling-Hammond, Professional Development Schools: Schools for Developing a Profession. NY: Teachers College Press, 1995.

[31] Little, J. W. (1993). Teachers' professional development in a climate of educational reform. Educational Evaluation and Policy Analysis, 15 (2), 129–151.; Lord, B. (1994). In N. Cobb (Ed.), The future of education: Perspectives on national standards in America, (pp. 178-194). New York: College Entrance Examination Board; Sparks & Loucks-Horsley, 1990, ibid.

[32] Schifter, D. (1996). What's happening in math class? Volume 2: Reconstructing professional identities. New York: Teachers College Press. See also C. Barnett, (1997). Teacher learning from writing cases. Paper presented at the Research Presession of the National Council of Teachers of Mathematics, Minneapolis. (Wested, San Francisco, CA.)

[33] Cohen, D. K. & Hill, H. (1997, April). Instructional policy and classroom performance: The mathematics reform in California. Paper presented at the annual meeting of the American Educational Research Association, Chicago,IL

[34] This can also easily backfire. Teachers can simply dismiss what they see: "These kids are just very bright – my students would not be able to do this." "This cannot happen every day."

[35] M. Lampert & D.L. Ball, Aligning teacher education with contemporary K-12 reform visions. Paper prepared for the National Commission on Teaching and America's Future. Teachers College: New York, 1995.

[36] Maine just began piloting statewide assessments in 1996.

[37] National Center for Education Statistics, Schools and Staffing Survey, 1993-94. State-by-State Data, Table 3.1. Washington, D.C.: U.S. Department of Education.

[38] Ibid., Table 3.5.

[39] For a description of Minnesota's reforms see Linda Darling-Hammond, Arthur E. Wise, and Stephen Klein, A License to Teach. Boulder: Westview Press, 1994.

[40] Allington and McGill-Franzen, 1992; Darling-Hammond, 1991; Orfield & Ashkinaze, 1991; Smith, 1986; Berry, 1995.

[41] Holmes & Matthews, 1984; Shepard & Smith, 1986

OVERCOMING STRUCTURAL BARRIERS TO GOOD TEXTBOOKS

By:
Harriett Tyson

Biography

Harriet Tyson is an education writer, researcher, and consultant. She is the author of "A Conspiracy of Good Intentions: America's Textbook Fiasco" (Council for Basic Education, 1988) and "Who Will Teach the Children: Progress and Resistance in Teacher Education," (Jossey-Bass, 1994), as well as dozens of articles and reports on teachers and teaching, textbooks, and curriculum. She is a former high school teacher and was a member and president of the Montgomery County (Maryland) Board of Education. She has worked as a writer, editor, project manager, or researcher for a number of Washington-based organizations including the Council for Basic Education, the Institute for Educational Leadership, the Association for Supervision and Curriculum Development, the Council of Chief State School Officers, and the Rand Corporation.

This paper was commissioned by the National Education Goals Panel, Purchase Order #4331FJ700011 for release at its meeting on July 30, 1977. The opinions and recommendations expressed in this paper are those of the author and do not necessarily reflect those of the Goals Panel or its members.

Overcoming Structural Barriers to Good Textbooks

Introduction

The American system of textbook production and purchasing is inherently splintered. On the supply side, there are private businesses that must capture a significant share of the national market in order to remain in business. On the demand side, there are 50 states, each with a Constitutional responsibility for governing its public education system. Twenty states exercise varying degrees of control over textbooks, and thus the 15,000 school districts in the nation have varying degrees of autonomy over textbook selection. Finally, there are three million teachers, seen by publishers as their ultimate market, even though most of the books they choose have already been powerfully shaped by centralized forces in a few populous states.

This juxtaposition of a national industry and decentralized educational governance has produced a de-facto national curriculum. The irony here is that many state leaders who strongly advocate state control over curriculum willingly submit to the hodge-podge national curriculum embodied in most textbooks, including those in mathematics and science–the focus of this paper.

A Splintered Vision: An Investigation of U.S. Science and Mathematics Education,[1] is the most recent research study to report that mathematics and science textbooks are as splintered as the system itself. This study has been preceded by nearly three decades of research on textbooks, virtually all showing that textbooks flit from topic to topic, covering very few of them in the depth a beginner would need to understand, remember, and integrate the knowledge.

Despite the development of national and state standards, and of standards-driven curricula and tests, the problem of superficial textbooks is still with us and appears to be getting worse, at least temporarily. But it should be said at the outset that mere topic reduction would not lead to higher levels of student achievement. The goal is not merely textbooks with fewer topics, or even lengthier treatment of "key" topics, but books with a coherent vision of the disciplines presented as an unfolding story, allowing even children in the early grades to connect the bits and pieces to larger concepts.

A Splintered Vision presents a quantitative analysis of the textbook problem and characterizes American textbooks as "a mile wide and an inch deep." It identifies textbooks as a major obstacles to higher levels of academic performance by American students. This paper presents a structural analysis of the textbook problem, raises qualitative issues, and then sets forth some recommendations.

The very structure of the textbook market, the commonly used methods of examining and selecting textbooks, and publishers' responses to those methods, affect the

---

[1] Schmidt, William H., McKnight, Curtis C., and Raizen, Senta A., A Splintered Vision: An Investigation of U.S. Science and Mathematics Education (Dordrecht/Boston/London: Kluwer Academic Publishers, 1997)

character and quality of textbooks in all categories. But the core disciplines are inherently different. Each one requires a different mix of fact, imagination, and theory; of process and product; of skills and concepts. Math and science, more than other disciplines, demand mastery of prerequisite skills if students are to succeed at the next highest level of difficulty. Across the disciplines, there are varying degrees of unity among practitioners about what and how to teach the young. The confluence of professional forces and market forces–to be described in the next section–therefore has varying effects on textbooks in each discipline.

The Textbook Market

It is a truism that American textbooks are driven by "the market." This truism, however, belies the complexity of how the various players in this commercial/educational drama–states, school districts, teachers, book publishers, test publishers, academics, standards-setting groups, and pressure groups–interact and unwittingly conspire to maintain textbooks that are "a mile wide and in inch deep." For would-be reformers, a nuanced understanding of a multi-layered market is an essential starting point.

The Adoption States

Twenty states (down from 22 a decade ago) are called "adoption states" because they "adopt" a list of state approved textbooks and bear the cost of textbooks for all students in the state. As seen in Appendix I, nearly all adoption states are in the South, Southwest, and West.

The rationale for state-wide adoption and funding has varied over the 100 years that the system has been in place. In the early 1900s, textbook purchasing at the local level was notoriously corrupt; therefore part of the impetus of state-wide adoption was to stamp out corruption. Also, widespread poverty in the agricultural states moved state leaders to provide free textbooks for students whose parents couldn't afford them. Student mobility was a problem, and the adoption states typically selected one book for each grade level and subject matter in order to ensure continuity in the education of mobile students. Finally, state leaders, then and now, believed that state selection of textbooks helped local districts who lacked the expertise and resources to make wise choices for themselves.

As state-wide adoption has evolved, so have its rationales and practices. In the 1950s, complaints from publishers about restraint of trade and appeals from local educators for more choice prompted the adoption states to adopt a list of approved books for each grade level and subject matter, rather than a single book. States began to set aside funds (usually minimal) that local districts could use for unapproved books and supplemental materials, and some established waiver procedures (usually cumbersome) by which a district could obtain state funds for off-list books. These somewhat grudging liberalizations of state policy took some of the steam out of bitter local controversies over reading pedagogy, social content, and biological evolution.

With the emphasis on accountability in the 1970s came a new rationale for state-wide adoption: if the states were to be held accountable for student performance, then it was incumbent upon state leaders to call for and purchase books that covered everything in the state curriculum and testing program. In the 1990s, with the introduction of state standards and standards-based curricula, "alignment" has become the principal criterion for textbook selection in the adoption states: a "good" textbook is one which is tightly aligned with everything in the state's instructional program.

Paradoxically, adoption-state policies have simultaneously become looser. In the 1980s and 1990s, the adoption states have adopted longer lists (more choices for local educators), or taken the cap off the number of books that can be approved, or made waivers easy to get. Florida sets aside 50% of its textbooks funds for the purchase of non-adopted books, and Texas will soon designate two approved lists, "Conforming" (100% aligned) and "Non-conforming" (50% or more aligned), and allow districts to select from either list.

These recent liberalizations in adoption state policies seem to mediate the tensions between state control and local demands for flexibility. The policy message seems to be: "We, the state, will recommend books that are aligned with state goals. If local educators believe they can meet the goals with non-aligned books, they are free to buy them, but they will be held accountable for results."

The new flexibility given to local school districts has not altered the basic pattern in the adoption states: local educators strongly prefer state-approved books because they are told that those books provide the best possible match with the state's required curriculum and testing program. The purchase of state-approved books is seen as a moral imperative by many educators because they believe it is unfair to test students on material not covered in the book. This concern with alignment has become more urgent in recent years with the rapid growth of testing programs and policies that hold teachers or schools accountable for student test scores.

Texas, California, and Florida

Some adoption states are far more attractive to publishers than others. California, Texas, and Florida offer the potential for large profits; collectively, they represent about 25% of the total national market. (See Appendix II for "Percent of Total Sales" by State) If the publisher's book can clear the adoption hurdle in one or more of those states, the company's viability is virtually guaranteed. Conversely, if a company fails to win state approval, it is shut out of the entire market in that state, and may even be forced out of business. Adoption contests are a treacherous business, especially in California. Therefore publishers study the curriculum frameworks, bid specifications, selection criteria, and politics in those states with the concentration of someone facing the prospect of an immediate hanging.

With very few exceptions, publishers cannot afford to develop a textbook tailored to any one state's demands. In deciding what to put in a book, each publishing house takes

into account the aggregate demands of a handful of market areas. How each house defines this aggregation is a trade secret, but it is clear that the combined curricular demands of California, Texas, and Florida dominate the scope and sequence of nearly all textbooks published by mainstream houses.

But there are other influences as well. Although New York is not an adoption state, it is a large market and some publishers seem to give a nod to the requirements of the New York State Regents Examination. The multicultural content of textbooks in all categories reveals the influence of a few major cities in both adoption and non-adoption states.

The combined mass of facts, topics, ideas, concepts, vocabulary, cognitive tasks, pedagogical features, and social imperatives is enormous. Moreover, the mass is often riddled with internal inconsistencies because major markets want different things at different times and often project contradictory views on content, pedagogy, and sequence.

Florida, for example, wants histograms taught in 5th grade mathematics; everywhere else, histograms are taught later. In order to please Florida, but not annoy teachers elsewhere, a publisher will tuck a histogram into a side-bar activity.

Math is math, whether in Los Angeles or Tokyo, and the underlying principles and processes of science are everywhere the same. But these self-evident truths mask unresolved conflicts about what approaches to science and mathematics are best for particular students in particular places under particular circumstances.

There are legitimate resolutions of these conflicts, as seen in the publishers' earnest attempts to reconcile traditional and conceptual mathematics. But there are also illegitimate resolutions of conflicts. For example, a 5th grade life science book will feature anatomically correct drawings of the digestive and circulatory systems; but in the study of the reproductive system, the book will feature pictures of a fully clad man and woman instead of an anatomically correct drawings.

It is important to notice, however, that the big adoption states, by themselves, issue curriculum documents that contain more topics than could be respectfully treated in any standard-sized book. Thus even if the publishers could afford to produce a separate book for just one state, the book would still be overstuffed and the text would still be too compressed.

In every publishing house, the allocation of space in the book is a hard-fought battle. Authors want more space for text. Marketing departments and art directors fight for more pictures because graphics sell books. Because American teachers have less time to prepare than teachers elsewhere (another major finding of A Splintered Vision), publishers must allocate nearly half the space in the book to instructional activities. The famously thin Japanese science textbooks can be thin not only because there is a national consensus about which topics are "key" and deserve full-blown expositions, but also because Japanese teachers have time to develop their own instructional activities and materials.

There is a circularity to the national textbook market. State curriculum writers, test publishers, and textbook publishers consult one another's documents when developing new products. Those in charge of each component of the instructional program are rightly concerned about alignment, which is thought to be desirable by nearly everyone. Yet the circular motion of the overall enterprises tends to promote the accretion of topics, rather than greater focus and depth. Moreover, typical methods of textbook evaluation–discussed on the next section–rivet the publishers' attention on exhaustive, conspicuous inclusion.

In this decade, a new source of topic expansion has arrived on the scene. National subject-specialty organizations have issued standards documents, and in response, states have interpreted those national standards documents and developed standards documents and curricula of their own. Publishers have begun to respond, but cautiously. For example, probability, estimation, and graphic representation–topics inspired by the National Council of Teachers of Mathematics (NCTM), and reflected in some, but not all state and local curricula–have been added to elementary and middle-grades books. But instead of integrating these topics into the study of whole numbers (which goes on for years and years in the U.S.), they are presented separately, as though they were different branches of mathematics.

Collectively, but not intentionally, the adoption states require the creation of textbooks that break up knowledge into little pieces, the better to reflect the particulars required by the each important market. Not much space can be given over to organizing principles, or to helping students see the connections among ideas. In the case of high school biology and chemistry books, there is an overwhelming mass of unfamiliar terminology. But not much space is given to explanations that would make the terms meaningful, or to the underlying structure of the discipline. Even highly skilled readers are often defeated by these books.

There are bright spots in these textbooks, and variations in quality among them, but the prolific, ever-changing, and contradictory demands of the big state markets constrain the possibility of significant qualitative variations among textbooks. "Niche" publishers, foreign and domestic, nibble around the edges of the national market. New companies rise up like desert flowers to exploit sudden shifts in market demands, and wither as the major publishers catch up with the demand. In the main, though, blockbuster textbooks aimed at the combined big adoption state markets capture the lion's share of the vast American market.

Local School Districts

Local school districts in the 30 non-adoption states select their own textbooks, but even the most populous districts have little influence on what goes into the books. New York City, for example, is a larger market than most adoption states, but the publishers have no incentive to cater to it. Why? First, New York City does not project any particular set of demands. (If it did, the "national" textbook would be even more cluttered than it already is.) Second, virtually every book submitted to New York City survives the

screening process and is "on the list." Therefore each publisher competes against all the others and can expect only a small market share.

Local Selection Mechanisms

In local school districts, committees examine the offerings and try to select the ones best suited to the district's needs. Some selectors know their subjects; other don't. Some selectors are trained for the task; others are not. Some are given adequate time to really study the books; most are not.[2]

In the rare cases when selectors are trained, given enough time to actually read the books, and make the very best selections, their decisions can be overturned by district administrators for reasons that have little to do with quality. District officials sometimes impose a single book in each category on the entire system, hoping for managerial simplicity and economies of scale. Often they respond to deals offered by competing companies: free teacher manuals, free training for teachers on how to use the book, free class sets, workbooks, lab manuals, and more. Free training in mathematics and science is very appealing to administrators because many teachers are poorly educated in those subjects and in-service training budgets are always vulnerable.

The cost to the publishers of mounting sales campaigns in 15,000 school districts, along with the cost of all the giveaways and inducements, makes textbooks very expensive and discourages their replacement even when better books become available.

Teachers

Teachers, either as individuals, faculty members, or members of adoption committees, often make the ultimate decisions about textbook purchases. Their influence on content coverage is small, but they have a big influence on the instructional components of textbook programs.

Publishers conduct endless pre-publication focus groups to find out what teachers like and what makes them balk. Teachers are often paid to "pilot" a new textbook and give publisher feedback, reporting on lessons that do or don't work, and saying which exercises and experiments are feasible under real-world conditions. A standards-driven mathematics book, for example, might presume that students have graphing calculators or access to spread sheet software when they actually don't; a publisher might modify the exercises in the book to take account of situations where students don't have the required technology. Through their contacts with teachers, publishers continually refine and reshape their products.

Market research by publishers on teacher preferences show that American teachers want comprehensive textbooks that cover many topics briefly. Reform groups report

---

[2] Squire, James R., and Morgan, Richard T., "The Elementary and High School Textbook Market Today," in Textbooks and Schooling in the United States, Part I. D. Elliott and A. Woodward, Eds. (Chicago: University of Chicago Press, 1990).

similar findings. For example, Project 2061's workshops and surveys of science teachers found that "relatively few teachers strongly agreed with some central reform ideas, such as 'less is more,' or that science education reform should be driven by learning goals."[3]

Why teachers prefer encyclopedic books is not known. But it is known that teachers are generally obedient to the demands of their superiors, and probably for that reason, they want textbooks that mirror the curricula and tests defined by those superiors.

How Teachers Use Textbooks

Decades of research on teachers' use of textbooks shows that the overwhelming majority use textbooks "as their main curriculum guide and source of lesson plans, especially teachers at the elementary school level who are responsible for five or six subject areas." [4] The data on textbook use in A Splintered Vision generally support previous studies. William Schmidt, the senior author of A Splintered Vision, observes that experienced teachers are more likely to make judgments about which topics to dwell on and which ones to skip, while teachers who are poorly prepared in mathematics and science, are in difficult teaching assignments, or are frightened by accountability mechanisms, tend to go from the front to the back of the book, skipping little or nothing. As a result, their teaching reflects the once-over-lightly approach of the books.

For the purposes of this examination of the "market," it is sufficient to note that teachers like textbooks the way they are, regardless of their degree of dependence on them.

Small Comforts, Big Sales

Textbook salesmen compete for teachers' business by providing an ever-expanding array of "extras" that make teaching more convenient and less hectic. The mainstay is the teachers manual, which provides suggested enrichment activities for advanced students, activities for slow learners and special education students, questioning strategies, tips on how to reach students with varying learning styles, and bibliographies. There are also posters, transparencies, audio and video tapes, lab manuals, instructions on how to use the book in a modular scheduling situation, and "wrap-around" kits for laboratory experiments. All of these extras cost publishers a great deal, and the cost is passed on to the buyer.

A company without the resources to produce these extras has little chance against a well-capitalized company that can offer a an array of labor-saving aids. And those companies are the very ones whose books have sold well in the big adoption states because they satisfied lengthy topics demands.

---

[3] Zucker, Andrew; Young, Viki; and Luczak, John, Evaluation of the American Association for the Advancement of Science's Project 2061: Executive Summary. (Menlo Park, CA: SRI International, 1969)

[4] Woodward, Arthur, and Elliott, David L., "Textbooks: Consensus and Controversy," in Textbooks and Schooling in the United States: Eighty-ninth Yearbook of the National Society for the Study of Education, Part I (Chicago: University of Chicago Press, 1990)

How Textbooks Are Examined

The criteria for selection, and the means of matching the criteria to the books, are matters of paramount importance for those who wish to improve textbooks. So a quick review of the recent history of adoption criteria, and how they are applied, is necessary to understand why the problem of unfocused textbooks tends to get worse, not better.

The Evolution of Selection Criteria

Prior to the 1960s, textbook examination was a casual, in-house affair. Central office staff eye-balled the alternatives and usually selected one textbook for each grade or subject. They tended to see textbooks more as commodities than as extensions of state curricular policy or as instruments of test score improvement.

In the early 1960s, textbook selection practices changed. Black leaders in large Northern cities pressured school boards to reject textbooks that contained racial stereotypes, and to develop quantifiable methods for determining racial fairness.

Textbook selection suddenly became more public as school districts began to include parents and pressure group leaders on newly formed selection committees. Educators devised checklists with rating scales and asked selectors to judge the books' fairness to blacks, and in the years following, their fairness to women, ethnic minorities, the handicapped and the elderly. Pictures became the publishers' primary vehicle for satisfying public demands for concrete evidence of fairness.

Checklists of the 60s and 70s included other dimensions of the books as well. Typically, reviewers were asked to rate "Content" on a scale of 1 to 5, as well as "Author Credentials," Durability," "Eye Appeal, " and "Readability."

"Readability" was determined by a technical formula which was blind to both sense and style. The readability score became a make-or-break criterion for textbook adoption, and because of that, publishers began to write prose that would yield the correct score on a readability formula analysis.

These selection criteria diverted publishers' and reviewers' attention away from substance and quality, and toward matters both bogus and superficial. The checklists described above are still used in some places because they carry an air of objectivity, give the raters something concrete to do, and don't cost very much to administer. [5]

Selection criteria have improved only slightly in the last two decades. For example, instead of making a global judgment about "content," reviewers are now asked to make a global judgment about "alignment." In Appendix III, a typical 1990s-style criteria sheet is compared to a standards-driven, research-based model developed by Project 2061.

---

[5] Comas, Jackie, "Review of Seventy Textbook Adoption Criteria Sheets from both Adoption and Non-Adoption States," unpublished study, Indiana University, 1982

The Influence of Textbook Research on Selection Practices

During the 1970s and early 1980s, there was an avalanche of research converging on the idea that many of the problems students were having with textbooks lay in the textbook, not the children. Many studies showed that the "dumbed-down" prose that had been written to survive a readability formula analysis was actually harder, not easier, for students to understand.[6] Superficial treatment–the practice of merely "mentioning" most topics–was documented across the disciplines.[7] Researchers also dramatically demonstrated that context–often slighted in textbooks–was crucial to both understanding and remembering. The overall organization of books and chapters, the quality of writing, the pertinence of graphics, the nature of questions, and dozens of other textbook features were shown either to support or obstruct comprehension.

This torrent of research did have some beneficial impact on textbook selection, and therefore on textbooks. California began to discourage the use of readability formulas and to focus reviewers' attention on the quality of writing. Other states and localities followed suit. Wherever school systems took textbook reviewing seriously, the training of reviewers began to include information on the educational value of well-crafted, interesting prose. When teachers began to judge textbooks on the basis of whether a student would actually enjoy reading the book and find meaning in it, publishers tried harder to make textbook prose clear and interesting. There was a tiny increase in the number of "high order" questions, and a much larger increase in the number of questions labelled as such.

But the chorus of researcher complaints about topic glut and trivial treatment didn't make a dent on publishers because their principal customers continued to churn out curriculum documents that would have taken Erasmus 20 years to teach well.

The 1970s marked the beginning of the era of accountability, and "alignment," or "congruence," or "correlation" of textbooks with state curriculum and tests became more important to state and local educators. But in this decade, alignment has become the Alpha and Omega of selection criteria, even if the means of assessing it are crude.

The logic of aligning all the components of instruction is unassailable. But the methods used to judge alignment have been, and continue to be, mechanical, superficial, and destructive. Three dysfunctional methods, discussed below, intensify the problem of too many topics and shallow coverage.

---

[6] Armbruster, Bonnie B., Osborn, J., and Davison, A., "Readability Formulas May be Dangerous to your Textbooks," Educational Leadership, Vol. 42, no. 7, April 1985: Klare, G.R., "Judging Readability," Instructional Science, 1976, and Klare, G.R., "A Second Look at the Validity of Readability Formulas," Journal of Reading Behavior, 1976..

[7] Tyson-Bernstein, Harriet, "A Conspiracy of Good Intentions." (Washington, D.C: Council for Basic Education, 1988.

The Correlational Analysis

States and school districts require publishers to provide a correlational analysis--a document which cross-references their particular requirements with the contents of the textbook. Long strings of page citations indicate where each required topic or skill is "taught." (See Appendix IV, a page from a correlational analysis of a first grade mathematics book) Publishers routinely supply printed correlations for the adoption states, and generate them for local districts on request. When the head office cannot meet the demand, salesmen sometimes hire a private contractor to generate a quick correlational analysis for a local school district in order to clinch a sale. When districts don't trust the publisher's analysis, they often hire private contractors to conduct an independent correlation.

Few states or districts actually use these expensive and rather spurious documents to examine textbooks under consideration. (To get a flavor of how spurious they can be, a publisher establishing his claim to teach map skills cited a page with a photograph of a teacher pointing to a map.) But publishers use them against one another. The publisher with more page citations for a particular topic or skill will proudly point out that his rival's book has fewer citations, and often wins a sale through this adversarial use of correlation.

In such a climate, publishers are rewarded for conspicuous inclusion and have little incentive to imbed particulars in larger themes and structures, to waste many pages on thoughtful explanations, to incorporate compatible strands, or to invest in rich development of organizing principles.

Computerized Key Word Searches

In some places, textbook adoption committees have purchased computer programs which determine the degree of alignment between the curriculum and the books. These programs do the work of correlational analysis more independently and cheaply, but also more superficially. As in the case of correlations, the evidence of alignment rests on chapter titles, topic headings, required terminology, entries in the index and glossary, and passage length (which is taken as a proxy for depth). Adoption authorities are happy when their required material is "there," but they seem oblivious to the fact that everybody else's material is also "there."

Untrained reviewers, hasty judgments

While states and school districts spend millions on textbooks, they often spend merely hundreds on the training of reviewers and the selection process itself. Textbook adoption authorities at all levels struggle to find the money to release teachers long enough to train them and given them time for thoughtful evaluation. Thus far, few of them have been able to convince their superiors that superficial reviews produce superficial textbooks; or conversely, that depth in the review process will summon depth in textbooks.

Signs of Progress, Signs of Hesitation

The national and state standards documents have not had a direct impact on textbooks because they are usually written at too high a level of generalization to be useful to publishers. But state curriculum frameworks and bid specification documents are becoming the engines of change because they are more detailed and better lend themselves to the publisher's task: the translation of standards into day-by-day lessons and activities. In science, emerging state curriculum frameworks show evidence of the influence of Science for All Americans, Benchmarks for Science Literacy, and National Science Education Standards, but their influence is still partial and sometimes diluted.[8] Nevertheless, there does seem to be a gradual move toward coherence and publishers are responding with innovative, kit-based teaching materials for elementary and middle-school grades. High school science is proving more resistant to change. The National Council of Teachers of Mathematics (NCTM) Standards have wide support among leaders in mathematics education and business, and most state and local mathematics leaders say that their standards and curricula have incorporated NCTM principles. Mathematics textbooks are generally thought to be more interesting to students than they were a generation ago, mainly because there is a better connection between math and its applications in the world. But many parents are unconvinced, and many teachers lack the required conceptual understanding. An idealistic interpretation of the NCTM Standards in California's last mathematics framework has left many children without computation skills, and set off still another swing of the pedagogical pendulum. It remains to be seen how far it will swing in the other direction. Because the trajectory of the NCTM approach, in California and elsewhere, is not yet clear, most publishers are still playing it safe.

Texas is in the process of developing a promising new set of curricular requirements and a better evaluation system. The emerging "Texas Essential Knowledge and Skills" science documents (TEKS) are slimmer than those they will replace because there has been an effort to make hard choices and create curricula that teachers can actually teach during a school year. The state has hired a contractor to develop criteria for judging what constitutes "coverage" of the TEKS, and to develop a training program for reviewers. Presumably, something beyond simple topic alignment will emerge.

Similarly, Florida's new 2 1/2 day training program for textbook evaluation teams will be driven by state standards and will focus reviewers attention on whether the benchmarks in the standards are actually taught, not merely mentioned.

A more substantive and analytic approach to textbook selection in Texas and Florida could have a powerful and positive influence on textbooks everywhere.

---

[8] Zucker, Andrew A., Young, Viki M., and Luczak, John M., "Evaluation of the American Association for the Advancement of Science's Project 2061: Executive Summary." (Menlo Park: SRI International, 1996).

CONCLUSIONS

The higher level of coherence and challenge embodied in national mathematics and science standards reports are gradually changing the ways the states define their own standards, curriculum, and tests. While it is too early to predict the nature of a national consensus on mathematics and science education, the national standards movement seems to be a potent force in the direction of consensus. It is reasonable to expect that textbook publishers will respond to that emerging consensus over the next decade. The weakest link in chain of processes, though, is textbook evaluation. The most powerful and direct way to draw forth better textbooks is to create and sustain a well-funded, unhurried, and thoughtful system of textbook evaluation.

The National Education Goals Panel Can Encourage Better Textbooks

In a market-driven system, the only strategies that have proven successful are those that change buyers' preferences and practices. The recommendations below seek to change the market, which alone can change the textbooks.

RECOMMENDATIONS

Recommendation I: In convincing language, with concrete examples, and in every possible venue, articulate the case for more focused, standards-driven curriculum and textbooks. The public and the teachers are not yet convinced. (Examples: Many parents think that the study of estimation in the early grades is a waste of time because there are no "right answers." Many teachers believe that graphic representation is too difficult for elementary children.)

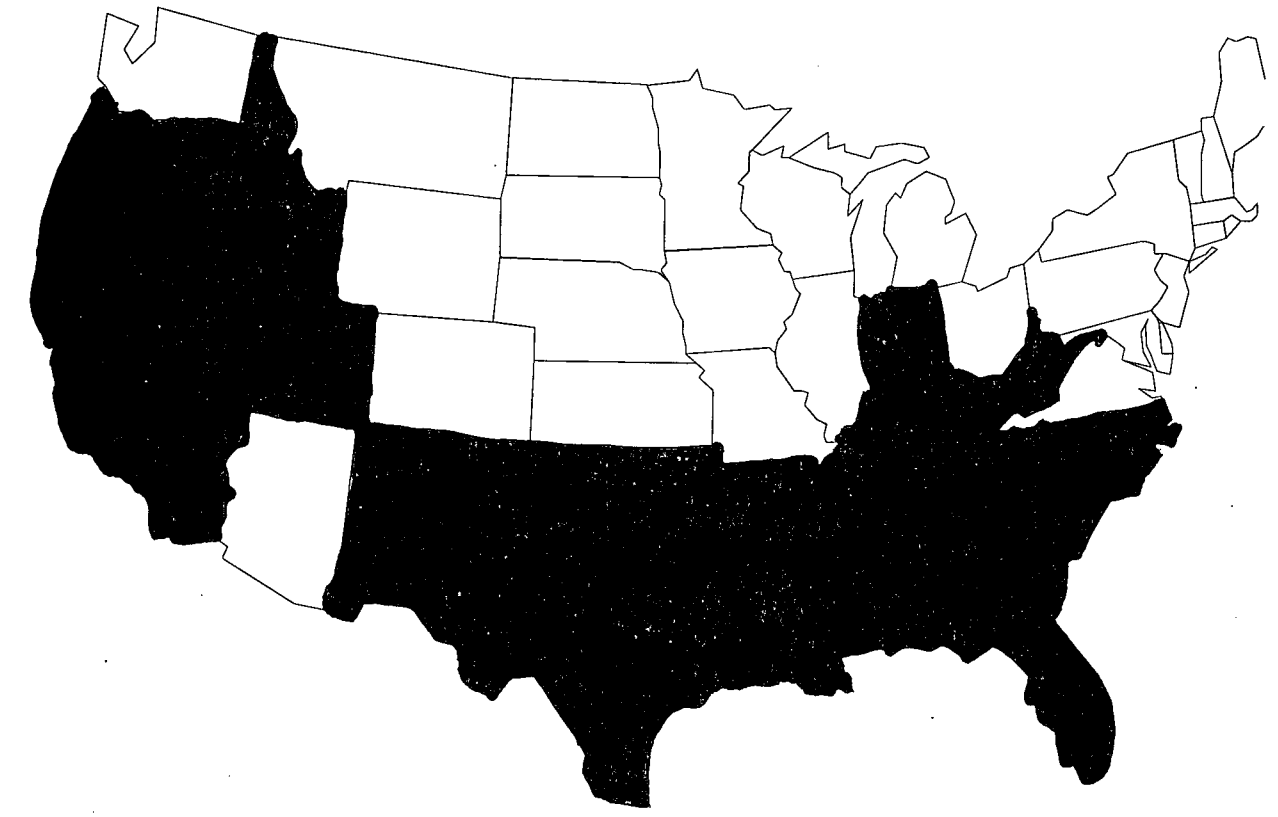
Recommendation II: Finance, or otherwise encourage, state development of selection criteria and selector training models which are standards-driven, intellectually defensible, and informed by research. A deeper and more qualitative adoption process is the single most powerful way to improve textbooks. (See Appendix V for a brief essay, "How to Recognize Quality in Textbook Evaluation.")

Recommendation III: Provide qualitative evaluations of instructional materials to local school districts. Instead of merely sending them a list of recommended books and numerical rankings representing their degrees of "alignment," distribute reports that discuss both strengths and weaknesses of analyzed materials and provide evidence to support all judgments. (See Appendix VI for an example of an excellent analytic evaluation.)

Recommendation IV: Stop demanding correlational analyses and end the use of computerized key-word searches as a method for determining curricular alignment. These methods not only drive up the cost of books, but reinforce the atomization of textbook content.

Source: Association of American Publishers

MARKET SEGMENTATION



OPEN TERRITORY

STATE ADOPTIONS

This map indicates the adoption and non-adoption states as of 1988. Since that time, Arizona and Virginia have ceased to be adoption states

APPENDIX II

Source: Association of American Publishers

THOUSANDS OF STUDENTS AND DOLLARS										
	EST. INDUSTRY SALES ($)		PERCENT OF TOTAL SALES		ENROLLMENT		SALES PER CAPITA ($)		RANK IN PER CAPITA SALES	
	1995	1994	1995	1994	FALL '95	FALL '94	1995	1994	1995	1994
ALABAMA	42184	33882	1.76	1.62	828	823	50.95	41.17	13	27
ALASKA	5086	4997	0.21	0.24	133	134	38.24	37.29	39	34
ARIZONA	38916	41594	1.63	1.99	823	788	47.29	52.78	21	4
ARKANSAS	22983	24522	0.96	1.18	493	482	46.62	50.88	25	8
CALIFORNIA	204888	187885	8.56	9.01	6169	6080	33.21	30.90	47	46
COLORADO	21688	20320	0.91	0.97	726	704	29.97	28.86	48	49
CONNECTICUT	30203	28286	1.26	1.36	602	589	50.17	48.02	14	13
DELAWARE	6548	5979	0.27	0.29	136	133	48.15	44.95	18	19
DISTRICT OF COLUMBIA	6463	5993	0.27	0.29	99	99	54.28	60.54	5	3
FLORIDA	116184	106222	4,95	5.09	2468	2385	47.08	44.54	22	20
GEORGIA	69879	50918	2.92	2.44	1438	1388	48.59	36.68	17	36
HAWAII	7775	7776	0.32	0.37	224	220	34.71	35.35	44	39
IDAHO	10591	8361	0.44	0.40	255	250	41.53	33.44	34	45
ILLINOIS	135370	118657	5.65	5.69	2291	2261	59.09	52.48	6	5
INDIANA	58115	52439	2.43	2.51	1098	1078	52.93	48.64	10	11
IOWA	21997	19547	0.92	0.94	567	560	38.80	34.47	36	40
KANSAS	24353	23014	1.02	1.10	512	505	47.56	45.57	20	17
KENTUCKY	32469	27163	1.36	1.30	713	727	45.54	37.36	30	33
LOUISIANA	38748	47508	1.62	2.28	960	969	40.36	49.03	35	10
MAINE	6832	6987	0.29	0.34	241	233	28.35	29.99	49	48
MARYLAND	36484	34713	1.52	1.66	946	923	38.57	37.61	38	32
MASSACHUSETTS	48906	43571	2.04	2.09	1068	1043	45.79	41.77	28	26
MICHIGAN	87848	73158	3.67	3.51	1880	1836	46.73	39.85	23	31
MINNESOTA	31674	31867	1.32	1.53	945	924	33.52	34.49	46	44
MISSISSIPPI	29477	20796	1.23	1.00	577	575	51.09	36.17	12	37
MISSOURI	58760	51492	2.45	2.47	1020	1017	57.61	50.63	8	9
MONTANA	7972	7675	0.33	0.37	178	175	44.79	43.85	31	22
NEBRASKA	15718	15095	0.66	0.72	339	334	46.37	45.19	27	18
NEVADA	10451	9082	0.44	0.44	280	264	37.32	34.41	40	42
NEW HAMPSHIRE	7679	7254	0.32	0.35	214	211	35.88	34.38	43	43
NEW JERSEY	107934	107176	4.51	5.14	1440	1404	74.95	74.43	1	1
NEW MEXICO	25826	22736	1.08	1.09	355	351	72.75	64.77	2	2
NEW YORK	159170	159413	6.65	7.65	3414	3321	46.62	48.00	24	14
NORTH CAROLINA	57387	43268	2.40	2.08	1257	1240	45.65	34.42	29	41
NORTH DAKOTA	7170	6632	0.30	0.32	129	128	55.58	51.81	9	6
OHIO	99632	88153	4.16	4.23	2146	2105	46.43	41.88	26	25
OKLAHOMA	38239	27934	1.60	1.34	653	641	58.56	43.58	7	23
OREGON	20679	22625	0.86	1.09	573	563	36.09	40.19	42	30
PENNSYLVANIA	106834	101617	4.44	4.87	222	2167	48.08	46.89	19	16
RHODE ISLAND	7629	7065	0.32	0.34	178	175	42.86	40.37	32	29
SOUTH CAROLINA	34228	31186	1.43	1.50	704	710	48.62	43.92	16	21
SOUTH DAKOTA	8288	7928	0.35	0.38	157	155	52.79	51.15	11	7
TENNESSEE	49153	41402	2.05	1.99	989	982	49.70	42.16	15	24
TEXAS	273994	142126	11.45	6.82	4024	3932	68.09	36.15	4	38
UTAH	16988	4791	0.71	0.71	490	487	34.67	30.37	45	47
VERMONT	3128	2785	0.13	0.13	118	115	26.51	24.22	50	51
VIRGINIA	43624	55422	1.82	2.66	1189	1161	36.69	47.74	41	15
WASHINGTON	26177	27473	1.09	1.32	1043	1022	25.10	26.88	51	50
WEST VIRGINIA	23140	12014	0.97	0.58	325	327	71.20	36.74	3	35
WISCONSIN	44404	41662	1.85	2.00	1044	027	42.53	40.57	33	28
WYOMING	3975	4986	0.17	0.24	103	103	38.59	48.41	37	12
TOTAL DOMESTIC U.S.	2393840	2035147	100.00	100.00	50775	49825	47.15	41.85		

APPENDIX III

Source: Project 2061, American Association for the Advancement of Science

COMPARISON OF A TYPICAL EVALUATION CHECKLIST OF THE 1990S WITH A STANDARDS-DRIVEN, RESEARCH-BASED CHECKLIST DEVELOPED BY PROJECT 2061

"Other Brand" Criteria	2061 Critera
Does the content align well with all the content standrds?	Do the activities address the substance of the specific benchmark(s) or only the benchmark's general topic? Do the activities reflect the level of sophistication of the specific benchmark or are the activities more apporpriate for targeting benchmarks at an earlier or later grade level?
Do the materials reflect current knowledge about the effective teaching and learning practices based on research related to science education?	Does the material alert teachers to commonly held students ideas (both troublesome and helpful) such as those described in *Benchmarks* Chapter 15: The Research Base?
Do the materials develop an appropriate breadth and depth of science content?	Criteria in analysis clusters I-V all contribute to judging breadth versus depth.
Are the assessment practices technically sound?	Do assessment items match the substance of specific learning goals? Does the material inlcude assessment tasks that require application of ideas and avoid allowing students a trivial way out, like using a formula or repeting a memorized term without understanding? Are some assessments embedded in the curriculum along the way with advice to teachers as to how they might use the results ot chose or modify activities.

APPENDIX IV

PAGE FROM A CORRELATIONAL ANALYSIS OF A FIRST GRADE MATH BOOK PREPARED FOR A LOCAL SCHOOL DISTRICT BY ANONYMOUS PUBLISHER

	OBJECTIVES	*LEVEL*	*LESSON/APPLICATION PAGE REFERENCES*
B.	Process Skills		
26.	Determines addition facts (sums to 18) and related subtraction facts using strategies such as counting all of a set, part/part/whole, counting on, counting back, counting up, doubles, property of zero, and commutativity of additon	01	43A, 43-44, 44A, 45A 45-46, 46A, 47A, 47-48, 48A, 49A, 49-50, 51A, 52, 53A, 53-54, 54A, 55 A, 55-56, 56A, 57A, 57-58, 58A, 59A, 61, 62, 63, 65, 66, 71A, 71-72, 72A, 73A, 73-74, 74A, 75A, 75-75, 76A, 77A, 78, 78A, 81A, 81-82, 82A, 83A, 83-84, 84A, 85A, 85-86, 86A, 87A, 87-88, 88A, 90, 90A, 81A, 92, 93, 95, 98, 100A, 101A, 101-102, 102A, 103A, 103-104, 104A, 105A, 105-106, 106A, 108A, 110, 11A, 111-112, 112A, 113A, 113-114, 114A, 115A, 115-116, 116A, 123-124, 125-130, 130A, 131A, 131-132, 132A, 133A, 133-134, 134A, 135A, 135-136, 136A, 139, 140, 141A, 141-142, 142A, 143A, 143-144, 144A, 145A, 145-146, 146A, 151-152, 153, 176, 192, 208, 234A, 235A, 235-236, 236A, 237-238, 238A, 239A, 239-240, 240A, 241A, 241-242, 242A, 243A, 243-244, 244A, 248, 249A, 249-250, 250A, 251, 251-252, 252A, 253, 253A, 254, 254A, 255A, 255-256, 256A, 263, 264, 265, 298, 209, 336, 354, 354A, 357A, 365A, 367A, 369A, 385-386, 387A, 387-388, 388A, 389A, 389-390, 390A, 391A, 391-392, 392, 393A, 393-394, 394A, 395, 395A, 400, 401A, 401-402, 402A, 403A, 403-404, 404A, 405A

APPENDIX V

HOW TO RECOGNIZE QUALITY IN TEXTBOOK EVALUATION

If you ask your local or state school administrators about their textbook evaluation process, they will probably tell you that they have a very good one. To many educators, a "good" process is one that matches the topics in the syllabus to the topics in the book, using the blunt instruments described in this paper. To others, a "good" process means a "good" checklist or rating sheet developed by a very fine and representative committee.

Even the best checklist, however, is utterly useless under the circumstances that prevail in nearly all cases. If a committee of 10 teachers is given a stack of 25 books submitted for adoption, told to "rate" each book on a scale of 1-5 according to 16 criteria, and given seven hours (a generous amount in most cases) to do the job, then about 16 minutes can be spent on each book, and one minute spent on assessing each criterion ("factual accuracy" for example). Therefore one question to put to your state or local administrators is:

How many minutes can textbook evaluators spend rating each textbook program on each criteria?

If they cannot answer your question, or sputter about the cost of release time for teachers, then there is a high probability that the process is too superficial either to select the best available textbooks or to influence publishers.

Even if a jurisdiction uses a very fine checklist and gives the evaluators several days to evaluate the textbooks, the value of the exercise is nullified if the raters lack a common understanding of the items on the checklist. Any two evaluators might have quite different understandings of an item such as "inquiry-based activity," or "appropriate graphics." Thus another question to put to the educators in your state or locality is:

Are textbook evaluators given time to develop a common understanding of the meaning of evaluation criteria before evaluating the books?

If raters are merely indoctrinated by an administrator on how to fill out the forms, and have no time to explore examples and counter-examples of quality, then the rating scores are probably meaningless.

In the few places where textbook evaluation is taken seriously, one can observe one or more of the following:

1. Evaluators are selected primarily on the basis of subject-matter knowledge and demonstrated excellence in teaching. "Subjective" criteria, such as taste and judgment, are also important factors in choosing members of a selection committee. Where it is necessary to "balance" a selection committee according to diversity, geographic

representation, seniority, union affiliation, or pedagogical philosophy, these criteria are subordinate to knowledge, effectiveness, and integrity.

2. In addition to working teachers, selection committees include true subject-matter experts (sometimes from universities and sometimes from K-12 curriculum departments), college and trade school instructors who inherit the graduates of the system, and representatives of business and industry whose employees are expected to understand the material being taught.

3. There is a division of labor on the committee: according to their talents, some members may be asked to review the books for accuracy, others for instructional soundness, others for coherence and depth of treatment, others for the quality of writing.

4. If there is not enough time to read entire books, then evaluators agree to review crucial topics in depth. Evaluators might be asked to outline a particular chapter in each book–a good check against poor organization and incoherence.

5. Evaluators are required (not merely permitted) to defend their judgments and conclusions in writing.

6. Textbooks are reviewed from the student's perspective as well as the teacher's. The evaluators address such questions as: "Would a student voluntarily read this book?" or "If a student missed class, could he reasonably be expected to learn the missed material by reading the book?" Sometimes, teachers ask students to study a chapter in a book under consideration and solicit their reactions. The "best" textbook is a waste of money and time if the students cannot or will not read the book.

SPECIAL ISSUES RELATING TO MATH AND SCIENCE

IMPROVING STUDENT LEARNING IN MATHEMATICS AND SCIENCE:

THE ROLE OF NATIONAL STANDARDS IN STATE POLICY

Gail Burrill, President
National Council of Teachers of Mathematics

Donald Kennedy, Chair
Center for Science, Mathematics, and Engineering Education
National Research Council

A report of the
National Council of Teachers of Mathematics
and the
Center for Science, Mathematics, and Engineering Education
National Research Council

Prepared for the National Education Goals Panel
July 1997

NOTICE: The project that is the subject of this report was approved on April 8, 1997 by the Executive Committee of the Governing Board of the National Research Council (NRC), whose members are drawn from the councils of the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine. The project was approved on April 14, 1997 by the Board of Directors of the National Council of Teachers of Mathematics (NCTM).

This report has been reviewed by a group other than the authors according to procedures approved by a Report Review Committee consisting of members of the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine.

This project was supported with funds from the National Science Foundation, the National Education Goals Panel, and the National Council of Teachers of Mathematics. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect those of the funders.

This report is available on-line at http://www.nap.edu and at http://www.nctm.org

Additional copies are available from:

National Academy Press
2101 Constitution Ave., NW, Box 285
Washington, DC 20055
800-624-6242

National Council of Teachers of Mathematics
1906 Association Drive
Reston, VA 20191-1593
703-620-9840

This paper was commissioned by the National Education Goals Panel for release at its meeting on July 30, 1997. The opinions and recommendations expressed in this paper are those of the author and do not necessarily reflect those of the Goals Panel or its members.

NATIONAL ACADEMY OF SCIENCES
NATIONAL RESEARCH COUNCIL
CENTER FOR SCIENCE, MATHEMATICS, AND ENGINEERING EDUCATION

The National Academy of Sciences (NAS or the Academy) is a private, nonprofit, self-perpetuating society of distinguished scholars, engaged in scientific and engineering research, dedicated to the furtherance of science and technology and to their use for the general welfare. Upon the authority of the charter granted to it by the Congress in 1863, the Academy has a mandate that requires it to advise the federal government on scientific and technical matters. The National Research Council (NRC) was organized by the National Academy of Sciences in 1916 to associate the broad community of science and technology with the Academy's purposes of furthering knowledge and advising the federal government. Functioning in accordance with general policies determined by the Academy, the NRC has become the principal operating agency of both the National Academy of Sciences and the National Academy of Engineering in providing services to the government, the public, and the scientific and engineering communities. The NRC is administered jointly by both Academies and the Institute of Medicine.

The Center for Science, Mathematics, and Engineering Education (CSMEE or the Center) was established in 1995 to provide coordination of the NRC's education activities and reform efforts. Specifically, the Center engages in activities relating to issues in kindergarten through twelfth grade education, undergraduate education, school-to-work programs, and continuing education, in the disciplines of science, mathematics, technology, and engineering. The Center reports directly to the Governing Board of the NRC.

NATIONAL COUNCIL OF TEACHERS OF MATHEMATICS

The National Council of Teachers of Mathematics (NCTM or the Council), founded in 1920, is a nonprofit professional association dedicated to the improvement of mathematics education for all students in the United States and Canada. It offers vision, leadership, and avenues of communication for those interested in the teaching and learning of mathematics at the elementary school, middle school, high school, college, and university levels. With more than 110,000 members, NCTM is the largest mathematics education organization in the world.

Each year, the NCTM conducts a large national conference and seven to nine regional conferences, where teachers of mathematics and others interested in mathematics education can attend lectures, panel discussions, and workshops and can see exhibits of the latest mathematics education materials and innovations. Many NCTM members are also members of one or more of the 260-plus local and special-interest groups formally affiliated with NCTM that work in partnership with the Council to meet mutual goals. All NCTM members receive Council publications including regular issues of the News Bulletin and Student Math Notes and one or more of four journals: *Teaching Children Mathematics*, *Mathematics Teaching in the Middle School*, *Mathematics Teacher*, and *Journal for Research in Mathematics Education*. NCTM also publishes books, videotapes, software, and research reports, which are available for sale to members and non-members.

As a professional association, the NCTM derives its strength from the involvement of its members, who are drawn from the broad community of stakeholders interested in the field of mathematics and mathematics education. The standards documents published by the Council, *Curriculum and Evaluation Standards for School Mathematics* (1989), the *Professional Standards for Teaching Mathematics* (1991), and *Assessment Standards for School Mathematics* (1995a), shape the Council's vision of mathematics for all children and provide the foundation for much of this publication.

ACKNOWLEDGMENTS

Improving Student Learning in Mathematics and Science was originally conceptualized as a modest effort to recount the stories and intended strategies of the National Council of Teachers of Mathematics Standards and the National Science Education Standards developed by the National Research Council. Through a productive collaboration between the NRC's Center for Science, Mathematics, and Engineering Education and the NCTM, and with the rich and thoughtful input of the expert panels and reviewers, we have produced a substantial set of recommendations for the improvement of state policy, based on national standards.

The development and completion of *Improving Student Learning in Mathematics and Science* mark a number of "firsts" for the Center and the NCTM. At the Center, this is a first experience with the NRC's "principal investigator" model, in which the primary responsibility for intellectual leadership for a report comes from principal investigators, rather than a traditional study committee. For NCTM, this formal collaboration with the Center marks a first joint venture in presenting standards-related issues with another content discipline. The product that has resulted has benefited greatly from being "the first" in each of these contexts.

We owe special thanks to the members of the expert panels who gave generously of their time and expertise in the Reston and Irvine meetings and who undertook with patience and flexibility their roles in a new NRC process. Other experts who reviewed the preliminary draft by mail were most generous and helpful in improving the substance and potential utility of the report. We thank also the staff of the Center and the NCTM and the leaders at NCTM who worked diligently to meet the deadlines of the National Education Goals Panel and to ensure the quality and accuracy of the report. The efforts of Rodger Bybee, Linda Rosen, Jack Price, Paul Trafton, Susan Loucks-Horsley, Joan Ferrini-Mundy, Jeanette Offenbacher, and Kristance Coates are especially appreciated.

Gail Burrill
Donald Kennedy
July, 1997

TABLE OF CONTENTS

Preface ..... F — 4

Executive Summary ..... F — 5

Introduction: National Standards in Mathematics and Science Education ..... F — 9
- Origins
- Common Features

Strategic Framework for Standards-Based Reform ..... F — 10

NCTM and the National Standards for Mathematics Education ..... F — 14
- Dissemination
- Interpretation
- Implementation
- Evaluation
- Revision

NRC and the National Standards for Science Education ..... F — 21
- Dissemination
- Interpretation
- Implementation
- Evaluation
- Revision

Current Context for Mathematics and Science Education ..... F — 27

Recommendations for State Policy ..... F — 29
Recommendation 1: State Infrastructure
Recommendation 2: Textbooks and Other Instructional Materials
Recommendation 3: Curriculum
Recommendation 4: Teaching
Recommendation 5: Assessment

Conclusion ..... F — 53

References ..... F — 54

Appendix A ..... F — 61

PREFACE

In Spring 1997, the National Education Goals Panel (NEGP) requested a report on standards-based reform from the Center for Science, Mathematics, and Engineering Education (the Center) of the National Research Council (NRC) and a report from the National Council of Teachers of Mathematics (NCTM). The request stemmed from NEGP's belief that the organizations that developed the national standards for science and mathematics had envisioned strategies for implementing those national standards that could significantly inform NEGP's thinking and planning. The Center and NCTM were asked to focus on implementation of national standards at the state level through mechanisms such as state standards, curriculum frameworks, professional development, and textbook adoption.

Improving Student Learning in Mathematics and Science: The Role of National Standards in State Policy analyzes current efforts in and makes recommendations for state policy. We first provide an introduction to standards-based reform, followed by a strategic framework for designing standards-based reform initiatives. This sets the stage for presenting the activities to date of the national standards in mathematics and science education. The report then offers recommendations for state policy in the areas of: (1) state infrastructure; (2) textbooks and other instructional materials, including publishers' reactions to the mathematics and science standards; (3) curriculum, including materials that offer teachers practical guidance for lessons, courses, and school science and mathematics programs; (4) teaching, including efforts to improve teacher credentialing and licensure; and (5) assessment, including efforts to develop tests aligned with standards. The recommendations are for state-level policy makers, including governors, state legislators, chief state school officers, state school board members, and state mathematics and science supervisors.

This report draws on the following papers commissioned by NEGP: *Reflections on State Efforts to Improve Mathematics and Science Education in Light of Findings from TIMSS* (Zucker, 1997), *Overcoming Structural Barriers to Good Textbooks* (Tyson, 1997), and *Persistence and Change: Standards-Based Reform in Nine States* (Massell, Kirst, & Hoppe, 1997).

This report represents the first collaboration of its kind between the NCTM and the NRC. Donald Kennedy, Chair of the Advisory Board of the NRC Center for Science, Mathematics, and Engineering Education, and Gail Burrill, President of NCTM, served as Co-Principal Investigators for the project. Staff of the NRC and several NCTM leaders assisted the Co-Principal Investigators in preparing background materials and preliminary recommendations for the report. These materials and preliminary recommendations were examined and discussed by two expert panels and, later, critiqued via mail by other experts. Both panels were convened in May 1997; the first at NCTM offices in Reston, Virginia and the second at the NRC's Beckman Center in Irvine, California. The expert panelists and mail critics provided advice and suggestions for the final report. These individuals included scientists and mathematicians, policy makers, and educators from every level of the system; they encompassed the educational and policy domains of this report and were chosen with regard to appropriate balance. Individuals who participated in the expert panels and critiqued the preliminary document are listed in Appendix A. The final draft was reviewed following the procedures of the NRC's Report Review.

The decision to do this work as a collaboration between the NCTM and the NRC was a natural and beneficial one. The mathematics and science education communities have common goals and a strong relationship that make this a mutually beneficial partnership. Moreover, the recommendations, which cut across the two disciplines, have the potential to help states move significantly forward in their implementation of high-quality standards-based education.

EXECUTIVE SUMMARY

The National Education Goals—set by the President and the nation's governors in 1989 and endorsed by two presidents, the U.S. Congress, and key business leaders—place a high priority on achievement in mathematics and science by all our nation's students. The national standards for mathematics education developed by the National Council of Teachers of Mathematics (NCTM) and for science education developed by the National Research Council (NRC) have played an important role in helping states address those national goals. This report recommends specific, decisive actions to further state efforts as they guide and support local educators to reform mathematics and science teaching and learning in their schools.

The NCTM's *Curriculum and Evaluation Standards for School Mathematics* (1989), *Professional Standards for Teaching Mathematics* (1991), and *Assessment Standards for School Mathematics* (1995a), and the NRC's *National Science Education Standards* (1996a) provide a vision for what students should know and be able to do and what educators need to do to support that learning. At a time when international comparisons have renewed attention to the need for a coherent, powerful direction for science and mathematics education, it is useful to examine how state initiatives can draw from the national standards as they continue their progress in reform.

The NCTM and NRC have pursued a variety of activities to place the national standards in the hands and minds of those across the nation with responsibility for and interest in mathematics and science education. Their strategies are described using a framework that includes:

- dissemination of standards to key individuals, agencies, and districts;
- interpretation of the standards, that is, providing background, briefings, examples, and supplementary materials to help individuals gain a deeper understanding of standards and standards-based curriculum and the role of standards in educational improvement;
- implementation of changes in curriculum programs; in criteria for selection of textbooks; in recruitment, certification, and continuing education of teachers; and in state and local assessments of students' progress;
- evaluation of changes to monitor and adjust policies, programs, and practices to increase their impact; and
- revision of the standards in response to changing needs and data on their impact.

The strategies used by the NCTM and NRC have established a national foundation for state reform initiatives, which have taken as many directions as there are states, and made steady progress towards the goal of standards-based education. But the task does not end with national standards. There is substantial progress yet to be made, and realizing the goals described in national standards is now in the purview of state governments. Given their constitutional responsibility for education, the states must act vigorously, in order to ensure widespread implementation of standards-based education. This report suggests that the progress currently being made should be continued and, indeed, strengthened, in the

specific areas of curriculum, textbooks and other instructional materials, teaching and assessment, and in building the infrastructure for improvement within states. The following recommendations are offered to state-level policy makers, including governors, state legislators, state school boards, chief state school officers, and state mathematics and science supervisors:

1. **State infrastructure.** Strengthen the state infrastructure for improvement in mathematics and science education with coherent, focused standards and with the policies, structures, and resources to support their achievement.

   1-A. Develop high standards for all students, through consensus, including a process for periodic review.

   1-B. Build a coherent system for mathematics and science education within the state in which every component and level of education is aligned and has a common goal: that all students will meet these high standards.

   1-C. Establish a long-range plan for improvement that involves the broader community as well as mathematics and science educators and provides sufficient support for local educators as they work to implement the standards.

   1-D. Ensure that state-level leadership positions in mathematics and science education exist and are filled by staff with expertise in the disciplines and in supporting change.

   Provide guidance and policy support to districts and schools in restructuring the use of school time to create opportunities for teachers to work together for improvement of mathematics and science education in their system.

2. **Textbooks and other instructional materials.** Develop policies and strategies that promote the use of standards-based textbooks and other instructional materials and that build state and local capacity for selecting and using the materials appropriately.

   2-A. Implement state policies that support the development of selection criteria for instructional materials based on standards and consistent with curriculum frameworks.

   2-B. Commission evaluations of textbooks and other instructional materials and disseminate results to local adoption committees.

   2-C. Implement professional development programs that help school personnel effectively select textbooks and other instructional materials and integrate them into the science and mathematics curriculum and instructional practice.

3. **Curriculum.** Structure policies and support to focus districts and schools on designing science and mathematics curricula that are high-quality, well-articulated, and standards-based.

   3-A. Provide technical, financial, and material support to local districts for the design and implementation of programs in which all students have opportunities to meet standards for mathematics and science.

   3-B. Base high school graduation requirements, university placement tests, and university admission requirements on standards.

   3-C. Put in place in every school classroom new technologies that support standards-based teaching and learning of mathematics and science.

4. **Teaching.** Create policies and practices to ensure that well-qualified, highly-competent teachers, whose practice is grounded in the mathematics and science standards, are in every elementary school, mathematics, and science classroom in the state.

   4-A. Accredit only teacher preparation programs that reflect the recommendations of mathematics and science standards.

   4-B. Incorporate as a requirement for licensing that teachers demonstrate teaching practices that are based on standards and are appropriate to the particular learning situation.

   4-C. Support the continuing professional development of accomplished teachers through mechanisms such as the National Board for Professional Teaching Standards.

   4-D. Fund ongoing, high-quality professional development opportunities for teachers of science and mathematics based on standards for student learning and professional teaching.

5. **Assessment.** Establish testing and assessment programs consistent with the goal of high expectations for all students to learn standards-based mathematics and science.

   5-A. Ensure that assessments of student learning are aligned with standards-based curriculum and assessment principles.

   5-B. Develop at the state level, or encourage local districts to develop, strong accountability systems that go beyond single-measure tests.

   5-C. Collect and use information about learning conditions and the opportunities students have to learn.

5-D. Assist schools and the general community to understand and use the results of assessments and develop action plans based on results.

5-E. Promote teacher assessment and student self-assessment in classrooms, based on standards.

These recommendations represent some ways to blend the experiences and strategies of the NCTM and NRC, as developers[1] of the national standards, with those of the states, as the nation moves towards its goals of high achievement in mathematics and science for all students. The magnitude of the task of reform cannot be overestimated, nor can its potential benefit to our nation's youth.

[1] Throughout this report we have used the term "developer" as an abbreviation for the role that the NCTM and NRC played in the national mathematics and science standards, respectively. The intent is neither to indicate or imply that these organizations developed the standards themselves, nor did their staffs do so. Instead, as described at length in the discussions of the development and dissemination of the standards documents, these organizations orchestrated the work of thousands of individuals and groups who contributed to the development and critique of the standards.

INTRODUCTION:
NATIONAL STANDARDS FOR MATHEMATICS AND SCIENCE EDUCATION

The American public recognizes the critical importance of education and the need for improving student learning. That same public places great confidence on the education they experienced and sometimes questions contemporary innovations, such as standards, activity-based curriculum, technology, and performance assessments. As society examines the values, processes, and problems of popular education, a particular hallmark of the period since the 1980s has been standards-based reform.

Origins

Major reports dating from the turn of the century have had significant influence on mathematics and science education. However, prior to the mid-1980s, there were few instances of professional organizations of K-12 educators producing anything as far reaching as a set of "national standards" for school curriculum and practice in a particular content area. In 1986, the Board of Directors of the National Council of Teachers of Mathematics (NCTM) recognized a convergence of forces leading to a need for new directions in K-12 mathematics education. The demands of the information society and new societal goals for education, including mathematically literate workers, lifelong learning, opportunity for all, and an informed electorate, provided the impetus for the creation of three standards documents in mathematics. These were the: *Curriculum and Evaluation Standards for School Mathematics* (NCTM, 1989); *Professional Standards for Teaching Mathematics* (NCTM, 1991); and *Assessment Standards for School Mathematics* (NCTM, 1995a), hereafter called NCTM Standards. The standards documents promote the mathematical empowerment of all students through the creation of curricula and learning environments very different from what had been current practice. A history of their development can be found in McLeod, Stake, Schappelle, Mellissinos, and Gierl (1996).

In 1991, the National Research Council (NRC) was asked by the president of the National Science Teachers Association (NSTA) to coordinate efforts to develop national standards for science education. Between 1991 and 1995, the NRC produced several drafts of the standards and set in motion a process designed to develop national consensus for the standards. The NRC's *National Science Education Standards* (1996a), hereafter called the NRC Standards, present a vision of a scientifically literate populace by outlining what students need to know, understand, and be able to do after 13 years of school science. The NRC document also contains standards for teaching science, professional development of teachers, assessment, science content, school programs, and the educational system. Collins (1995) has provided a history of their development.

Common Features

The mathematics and science standards have a number of features in common:

- They emphasize ***all*** students; that is, explicit statements of equity permeate the documents.

- They emphasize ***understanding***; that is, students must comprehend the material they study and not merely memorize a series of facts.

- They focus on developing a ***depth of knowledge*** about fundamental mathematical and scientific content and processes.

- They include ***content, teaching, professional development, and assessment***; that is, they recognize the need to define more than what students should know and be able to do.

- They emphasize ***content more than curriculum***; that is, the documents do not define the order, structure, and organization of school mathematics and science programs. Curriculum decisions are left to states and local school districts.

- They emphasize a ***comprehensive, focused, and coherent approach*** to mathematics and science education.

National standards reflect the consensus of experts from around the country at the time of standards development, about what students should know, understand, and be able to do in mathematics and science and propose educational approaches. The national standards documents were developed by the professional communities of mathematicians, scientists, educators, and teachers, with extensive input and review. They are intended to suggest strategies for the improvement of mathematics and science teaching and learning in the K-12 arena. Research about mathematics and science teaching and learning guided the standards development (NCTM, 1991; NRC, 1996a; Romberg, 1992; Schoen, 1988). The documents represent valued goals; measures of their effectiveness will be available only after the idea of standards is widely accepted and enacted.

It is important to note that the NCTM Standards are under revision, with release of the revised document scheduled for the year 2000. This revision was part of the original plan for the development of the NCTM Standards and will preserve the spirit of the original documents. There is ongoing discussion in the mathematics and mathematics education communities about the important details of this revision.

A STRATEGIC FRAMEWORK FOR STANDARDS-BASED REFORM

Developing national standards is an important and complex undertaking. Yet, once these standards are developed, they do not immediately influence policy and practice. Research on dissemination and change clearly indicates that actions by many individuals and organizations are needed if meaningful and lasting changes are to occur in a system (Hutchinson & Huberman, 1993). And, the larger the system (e.g., the nation vs. a school),

the larger and more coordinated the effort needs to be. The framework provided in this section is intended as an organizing tool for considering how standards-based reforms can be undertaken by a system (Bybee, 1997).

FIGURE 1: A Strategic Framework for Standards-Based Reform

Dissemination	Goal: Developing Awareness	"Getting the word out"
Interpretation	Goal: Increasing Understanding and Support	"Getting the idea"
Implementation	Goal: Changing Policies, Programs, and Practices	"Getting the job done"
Evaluation	Goal: Monitoring and Adjusting Policies, Programs, and Practices	"Getting it right"
Revision	Goal: Improving the Efficacy and Influence of Standards	"Doing it all again"

From: Bybee, R.W. (1997). "A strategy for standards-based reform of science and mathematics education." Unpublished manuscript.

Similar to many models for change and improvement, the Strategic Framework for Standards-Based Reform (see Figure 1) has several different dimensions, and each dimension has particular goals. In the framework, the developer of the standards plays a role, as do other participants in the education system. For example, national organizations such as the National Research Council (NRC) and the National Council of Teachers of Mathematics (NCTM) played a major part in initial dissemination of the national standards, but they do not implement the standards. The framework is intended as an organizer for thinking about what strategies are needed and for clarifying where responsibility and authority lie for making changes in the various components of the educational system. Although the framework is designed as a means of thinking about national standards, it is equally appropriate as a means of thinking about state standards.

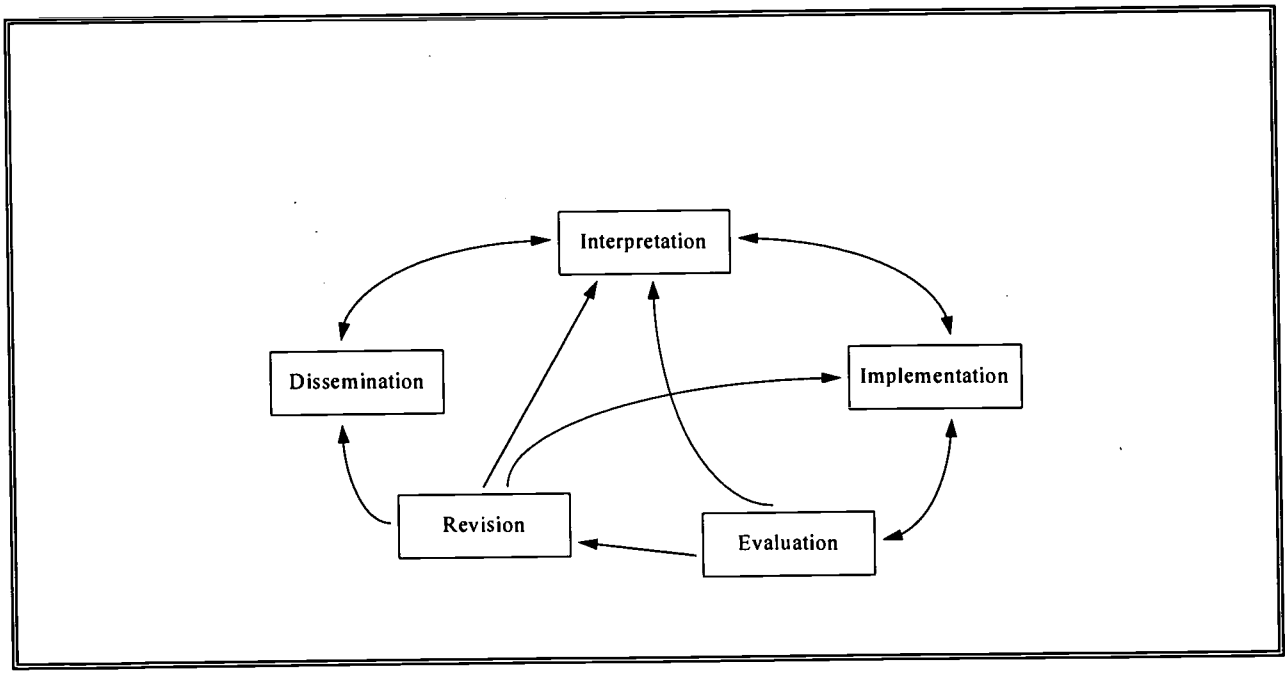
Dissemination involves developing a general awareness of the existence of the standards document among those responsible for policy making, programs, and teaching. It includes addressing the questions, "What are the standards?" "Why are they needed?" and "How could they be used to shape policy and practice?" ***Interpretation*** is about increasing understanding of and support for standards. It involves careful analysis, dialogue, and the difficult educational task of challenging current conceptions. Deeper and richer understanding of standards is the goal. ***Implementation*** involves changing policies, programs, and practices to be consistent with standards. People modify district and school science and mathematics curriculum, revise criteria for the selection of instructional materials, change teacher credentialing and recertification, and develop new

assessments. Enacting new policies, programs, and practices builds new understandings that can feed back into interpretation. In the ***evaluation*** dimension, information gathered about impact can contribute directly to improvement. Monitoring of and feedback to various parts of the system result in an evolution of policies, programs, and practices. At some point, as a planned element of the process, ***revision*** of standards occurs, incorporating the new knowledge developed through implementation and evaluation and drawing heavily on input and discussion generated in the field by the original documents.

There exists some logical sequence to the dimensions. For example, people need to become aware of standards before they deepen their understanding through interpretation activities. Likewise, implementation without understanding can lead to change that is mechanical, superficial, and—in the extreme—can imperil reform with the dismissal that "it doesn't work." Effective implementation requires interpretation and understanding. Revision without adequate evaluation will not reflect what is learned from the original effort.

Note, however, that while the framework may seem linear, its dimensions are intertwined. For example, since practice informs understanding, implementation can lead to a new or deeper interpretation of the standards or elements of them. Evaluation and reflection pervade all other dimensions. Figure 2 attempts to capture the simultaneously cyclical, iterative, and non-linear nature of the framework's dimensions.

FIGURE 2: Relationships Among the Dimensions of the Strategic Framework



The different dimensions of the framework are played out with different audiences, as shown in Figure 3 (Bybee, 1997). These audiences are organized into four categories that reflect each audience's primary role in the system: policy, program, practice, and political and public support.

FIGURE 3: Participants in Standards-Based Education

Policy	Govenors and State Legislators State Education Departments State and Local School Boards School Districts Schools
Programs	Colleges and Universities Publishers Curriculum and Assessment Developers School Districts Business and Industry Informal Educators Professional Organizations
Practices	Teachers Students
Political Support	Scientists and Engineers Business and Industry Federal, State, and Local Governments Parents General Public Teacher Unions

Adapted from: Bybee, R.W. (1997). "A strategy for standards-based reform of science and mathematics education." Unpublished manuscript.

The framework helps to address the question of how different stakeholders participate in standards-based reforms. Creating a matrix using the different dimensions on the horizontal axis and the possible participants on the vertical axis, activities can be arrayed in the cells. For example, an *interpretation* activity for *colleges and universities* could be the development of an addendum that focuses on the role of inquiry in the NRC Standards. The addendum would help postsecondary faculty and administrators understand the standards more deeply so they could improve the design of their teacher preparation programs. Not all participants need to be engaged in every dimension. Some audiences, such as the general public, might be made aware of the standards with no further engagement. Although many audiences can be involved in many dimensions, the

challenge of standards-based reform is to strategically engage the key participants in such a way as to create the most leverage for change in the system.

Although the developers of standards likely have major responsibility for dissemination, they can be assisted by state agencies, special coalitions, or cadres of leaders especially equipped to do so. Responsibility and authority for implementation do not necessarily lie with the organizations that developed standards. The organizations can provide support and expertise, as well as help in networking various implementers, but they are not always positioned to change policies and practices directly. State supervisors, curriculum developers, teacher educators, and classroom teachers assume major responsibility for implementation. Revision again becomes the responsibility of the developers, with substantial input and interaction with others in the system.

In the next section of this report, we use dimensions of the Strategic Framework to describe the strategies that the NCTM has used to support the NCTM Standards and to describe what directions the organization is now taking. The strategies planned and launched by the NRC's Center for Science, Mathematics, and Engineering Education (the Center) in light of NCTM's seven years of prior experience with national standards are described in the following section. Note that NCTM is a professional association of more than 110,000 members, with affiliated groups, an ongoing structure of conferences, and a large publication enterprise. The Center, as a unit of the NRC, works through its boards and committees of volunteers, together with staff, to advise in policy areas. The organizations are different in structure, mission, and scope of activity and their strategies differ accordingly.

NCTM AND THE NATIONAL STANDARDS FOR MATHEMATICS EDUCATION

The mission statement of the National Council of Teachers of Mathematics (NCTM or the Council), developed in 1995, centers on standards:

> The mission of the National Council of Teachers of Mathematics is to provide vision and leadership in improving the teaching and learning of mathematics so that every student is ensured an equitable Standards-based mathematics education and every teacher of mathematics is ensured the opportunity to grow professionally. (NCTM, 1995b)

The NCTM Standards evolved over several years, beginning with the 1980 report, *An Agenda for Action* (NCTM, 1980), an important precursor to the NCTM Standards documents. A set of events and circumstances took place in the 1980s that spurred the need for standards and for national direction in mathematics education. The education directorate at the National Science Foundation (NSF) was eliminated in 1982. *A Nation at Risk* (National Commission on Excellence in Education [NCEE], 1983) called for broad reconsideration and reform of the U.S. education system. Also, recommendations for standards and the need for national guidance for mathematics education emerged out of

the Conference Board on the Mathematical Sciences, leading to the founding of the Mathematical Sciences Education Board (MSEB) in 1985 at the National Research Council. Internal work at NCTM was also pointing toward a need for direction (McLeod et al., 1996). In 1986, the NCTM Board of Directors commissioned the first of the three sets of standards, the *Curriculum and Evaluation Standards for School Mathematics* (NCTM, 1989). The development of the document was funded entirely with NCTM resources.

The *Curriculum and Evaluation Standards for School Mathematics* was conceived as a vision of ideal practice and developed by a committee of NCTM members who thought carefully about the issues on behalf of the field. The decision to produce three separate standards documents reflects the understanding of the NCTM leadership that it was important to work on all parts of the educational system. A major aspect of the development process was consensus-building across the country and across all dimensions of the mathematics education community. A 1987 draft was circulated to 10,000 members of NCTM; input was sought through professional meetings, regional affiliated groups, and NCTM's internal committees. The input was seriously considered and analyzed as the *Curriculum and Evaluation Standards for School Mathematics* was prepared. The resulting document carried the endorsements of a large number of professional organizations, although the entire concept of "standards" was new to the field at the time, so it is difficult to know how endorsement was construed. After the document was released, activities centered on the dissemination, interpretation, and implementation. These were coordinated by an NCTM Standards Coordinating Committee that provided oversight for the Council's activities.

The MSEB, chaired in the late 1980s by Shirley Hill, a past president of NCTM, was an important collaborator with the NCTM in the standards process. In particular, the publication of *Everybody Counts* (NRC, 1989) is often credited with effectively making the case for the need to improve mathematics education with a broad range of audiences—and thus helping to set the stage for openness to the NCTM Standards in a wider arena.

Dissemination

Dissemination of the NCTM *Curriculum and Evaluation Standards for School Mathematics* has taken many different forms. The document was provided free to all NCTM individual members and sold by the organization. As of June 1997, NCTM has distributed or sold over 647,000 copies of the Standards documents.[2] An executive summary of the *Curriculum and Evaluation Standards for School Mathematics* was prepared and distributed to members of Congress, governors, university administrators and mathematics department chairs, school principals, PTA presidents, and school board chairs. Separate flyers were prepared for parents and policy makers as well as teachers and a general audience. A public relations firm was engaged to promote the release of the document. NCTM leaders received "public relations" training. The Council produced a kit

[2] This count includes 335,000 copies of *Curriculum and Evaluation Standards for School Mathematics;* 172,000 copies of the *Professional Standards for Teaching School Mathematics;* and 140,000 copies of the *Assessment Standards for School Mathematics.*

which included speaker's guide that included a video of prominent individuals, such as musician Wynton Marsalis explaining the importance of mathematics and the NCTM Standards.

The NCTM cooperated with other groups in dissemination. The Association of State Supervisors of Mathematics (ASSM) undertook "Leading Mathematics Education into the 21st Century," a joint project of the ASSM, NCTM, National Council of Supervisors of Mathematics (NCSM), Council of Presidential Awardees of Mathematics, and the MSEB. The project involved five regional conferences across the country, at which NCTM leaders and standards writers made presentations about the document to the participants, who were then expected to return to their local areas as teams and do further dissemination. This project produced a comprehensive speaker's kit and led to over 50,000 documented contacts with teachers over two years.

The *Professional Standards for Teaching Mathematics* (NCTM, 1991) and *Assessment Standards for School Mathematics* (NCTM, 1995a) were developed with much input from the field and the documents were widely circulated while in draft form. About half of the funding for the *Professional Standards for Teaching School Mathematics* was provided by the National Science Foundation (NSF). The *Assessment Standards for School Mathematics* was funded with NCTM resources only. Copies of these documents have been given free to each NCTM member. Copies of all three sets of standards are currently available from NCTM and are also available on the World Wide Web.[3] In addition, the Council has produced two short publications, *Making a Living, Making a Life* (1996b), intended for a general audience and explaining the importance of standards-based mathematics for all children, and *Mathematics: An Introduction to the NCTM Standards* (1996a), intended for those in the mathematics education community to use as a starting point for discussion about standards.

The NCTM curriculum standards have been in the field for eight years. Various national surveys have assessed the level of awareness among teachers about the documents. In a 1993 survey, Weiss, Matti, and Smith (1994) found that 56 percent of secondary teachers, 28 percent of teachers at the 5-8 grade level, and 18 percent of teachers at the k-4 grade level were "well aware" of the NCTM Standards. In the Third International Mathematics and Science Study (TIMSS) conducted in 1995 (National Center Educational Statistics [NCES], 1996), results showed that at eighth grade, 95 percent of U.S. teachers claim to be either very aware or somewhat aware of current ideas about teaching and learning mathematics, which could be taken to mean familiarity with the NCTM Standards. Awareness levels appear to be increasing.

Interpretation

For the NCTM Standards documents to have influence in the field, it was clear that there was a need to have illustrations and examples of how the ideas of the documents could be brought to life in classrooms. The Addenda Project was initiated in 1988 to

[3] Available through the Eisenhower National Clearinghouse at www.enc.org/reform/journals/ENC2280/nf_280dtoc1.htm

"provide teaching lessons to exemplify the Standards" (McLeod et al., 1996). NCTM's efforts to provide assistance to the field in the area of interpretation also occurred through its journals and conventions. A journal for middle school teachers, *Teaching Mathematics in the Middle School,* was initiated by NCTM, and the journal for elementary teachers was renamed from the *Arithmetic Teacher* to *Teaching Children Mathematics,* thus reflecting the enriched content emphasis of the NCTM Standards for elementary students. Each journal devoted a standing column to understanding the Standards, and special focus issues were produced dealing with standards topics such as data analysis or discrete mathematics. Review criteria for selection of articles for the NCTM school-level journals included alignment with the Standards. (This criterion is currently under discussion.) Sessions at the regional and annual meetings held by the Council were focused on standards themes. A cadre of NCTM leaders were trained in making standards-based presentations.

While NCTM initiated the types of interpretation activities appropriate for a large professional reorganization, other entities were again part of the process. The MSEB produced *On the Shoulders of Giants* (Steen, 1990) and *Measuring Up* (NRC, 1993b) to help teachers understand and think about assessment in ways consistent with the NCTM Standards. *On the Shoulders of Giants* provided a new way for mathematics educators to think deeply about content issues raised in the NCTM Standards. *Measuring Up* offered insights and examples of assessment tools that are aligned with the NCTM Standards. Textbook publishers chose to incorporate standards ideas in a variety of ways. Beginning in 1991, the NSF funded several major curriculum development projects at the elementary, middle and secondary levels in mathematics that were to be standards-based. As these projects are just now nearing completion, the field will soon have a set of examples of curricular interpretations of the NCTM Standards. As of 1996, forty states had content standards for mathematics based on their interpretations of the NCTM Standards and many are aligning assessment programs with these standards (CCSSO, 1996a, 1997a). Since 1990, the frameworks used in the National Assessment of Educational Progress (NAEP) have been adjusted to reflect elements of the NCTM Standards, including emphasis on "mathematical power," "reasoning," and "communication" (Reese, Miller, Mazzeo, & Dossey, 1997).

A by-product of these various interpretations of standards is that the field has more specific examples of what standards-based practice might mean. Mathematicians, in particular, are now becoming increasingly aware of the role that the Standards can play and are taking special interest in the revision of the NCTM Standards.

Implementation

The NCTM is not positioned to "implement the Standards." Rather, the role of the organization is to provide leadership in thinking about implementation, to serve as an organizational focus and catalyst for the ideas of others, and to facilitate interaction between members in their attempts at implementation.

Prior to the release of the NCTM Standards, each major committee of the Council was charged to present a set of possible projects or initiatives that would promote implementation of the Standards. The NCTM Board selected several of these options and supported the development of plans that were then carried out by NCTM members through their home institutions, with funding from a variety of sources. These initiatives included a project to develop secondary teachers' understanding of discrete mathematics,[4] one of the new content areas introduced by the Standards. A project on number sense[5] helped teachers develop number sense in their students. A geometry project[6] produced materials to help teachers reflect on the geometry in their curriculum. The Research Catalyst Conferences[7] were designed to bring new researchers together with mentors to design lines of research around standards-specific topic areas.

Each of the more than 200 NCTM-affiliated groups was asked by the NCTM Regional Services Committee to prepare a plan indicating what they were doing in their group to move the Standards forward. These plans were shared and discussed at the regional caucuses and delegate assembly during the annual NCTM meeting. The Mathematics Education Trust—NCTM's foundation—funded small projects designed and submitted by teachers to facilitate implementation by individual members. At each regional NCTM meeting, a President's reception was held for affiliated group leaders from that region. Those leaders were asked to share their progress towards implementation.

Implementation activities have also been connected to other organizations. Over the years, NCTM has worked closely with ASSM and with the NCSM on linking initiatives to promote understanding of the NCTM Standards. The NCTM instituted a yearly publisher's conference where presentations on the Standards were given and opportunities were provided for discussion between NCTM representatives and publishing editors. The NCTM used its involvement in the folio review for teacher preparation of the National Council for Accreditation of Teacher Education (NCATE) to ensure that the review documents and process were consistent with the NCTM Standards.

However, studies have found that while teachers believe they are implementing standards, independent assessments of their lessons do not reveal standards-based practice (Cohen, 1990). For example, in the U.S. sample of videotaped teachers from the Third International Mathematics and Science Study (TIMSS), 75 percent of the teachers indicated that the videotaped lesson was in accord with current ideas about teaching and learning mathematics (Stigler et al., in press). Yet, analysis of those lessons along standards-like dimensions failed to show quality, as defined by the researchers. Although evidence points to awareness of and belief in the NCTM Standards, it is less clear that

---

[4] The Discrete Mathematics Project was funded by the National Science Foundation's Teacher Enhancement Program. It was based at Boston College, under the direction of Margaret Kenney.

[5] The Number Sense Project was based at Western Maryland College, with funding from the U.S. Department of Education, under the direction of Francis (Skip) Fennell.

[6] The Geometry Project was based at Western Illinois University, funded by NSF, under the direction of Melfied and Judith Olson.

[7] The Catalyst Conferences were funded by NSF, under the direction of Patricia Campbell at the University of Maryland.

implementation and deep understanding are in place. Changing behaviors and practices is inherently tied to deep systemic structure.

Evaluation

The NCTM's Research Advisory Committee recognized very early on in the standards development process the need to plan for studies that would monitor and assess the impact of standards. An NCTM Monitoring Task Force produced a report that outlined plans for monitoring and recommended that NCTM help catalyze such work, but not necessarily play the lead role (Gawronski, Porter, & Schoen, 1989). As an early effort, NCTM commissioned a study by Weiss, *The Road to Reform in Mathematics Education* (1992), which reported on early awareness levels among teachers about standards. The Recognizing and Recording Reform in Mathematics (R^3M) Project[8] was initiated by NCTM as an effort to study sites that were engaged in substantial efforts at improving their mathematics programs. The study described early efforts at mathematics education change, some of which were initiated before standards were available. The R^3M findings indicated that the pedagogical elements of standards were taking hold in classrooms in more visible ways than the mathematical elements and that standards documents were used more for validation rather than direction in some early implementation efforts (Ferrini-Mundy & Schram, 1997).

Various organizations have studied questions of the overall effects of standards-based reform (CPRE, 1996; Massell et al., 1997). The findings generally are that such reforms are slow to take hold in substantial ways in schools. In very specific projects that have introduced interventions in schools that might be considered standards-based, there is a trend of evidence of improved student achievement (Campbell, 1995; Cobb et al., 1991; Hiebert & Wearne, 1993; Stein & Lane, 1996; Stein, Lane, & Silver, 1996). Results of evaluations of the new NSF-funded mathematics curriculum projects, including the Interactive Mathematics Project (Webb & Dowling, 1996, 1997) and the Connected Mathematics Project (Hoover, Zawojewski, & Ridgeway, 1997), indicate strong achievement on both traditional and reformist assessment measures. The NCTM and MSEB have worked collaboratively over the years to consider the question of monitoring, although no comprehensive effort has ever been undertaken. The MSEB will be involved in a new project of the NRC's Center for Science, Mathematics, and Engineering Education, called Efficacy and Influence, that focuses on the national mathematics and science standards, and possibly those for technology, geography, and health. The first stage of this project will be to conceptualize a framework and perspective for addressing the question of how to study the effects of standards-based reform. The NRC will work with other researchers and evaluators who are studying the standards-related effort to consider how information collected annually might feed directly into improvement and revision efforts. A synthesis report will be produced in mathematics.

[8] The R^3M Project, funded by the Exxon Education Foundation, was based at NCTM and directed by Joan Ferrini-Mundy.

Revision

In 1994, the NCTM Board of Directors charged a Commission on the Future of the Standards to plan the review and updating of the NCTM Standards. The April 1996 report of the Commission called for a revision of the Standards documents to be released in the year 2000. The new document should preserve the main messages of the original Standards, while bringing together the "classroom" parts of the three Standards documents into a single document. A major part of the revision process involves an organized strategy for working with other professional organizations. In the initial phases of the revision process, several prominent professional organizations were invited to form "Association Review Groups." These groups have been invited by the Commission and the Writing Group leaders to respond to specific questions about the format and substance of the NCTM Standards, in an effort to obtain the field's sense of what is needed in revision. The first questions posed to the Association Review Groups were:

1. Do the current statements of the Standards adequately communicate your view of the discipline?

2. Do the Standards convey a sense of consistency and growth in content themes as the student moves across the grade levels?

3. Do the Standards adequately reflect the needs of a student graduating in the twenty-first century and the needs of a student planning postsecondary study in a mathematics-related discipline?

4. What suggestions can you make for blending content, teaching, and assessment?

A second round of questions has focused on issues of algorithms and proof. Responses from the mathematics and mathematics education communities vary widely, and all criticisms and suggestions will be considered seriously in the revision process.

The Commission also has gathered input from NCTM members at focus groups held at regional and annual meetings. Several resource and advisory groups are being identified to support the writers and the process with specific expertise and input.

The revision is a highly publicized process within the mathematics education community. The Commission has indicated that, in this version, the grades should be divided into four grade bands: Pre K- 2, 3-5, 6-8, and 9-12+. The finer grade-band divisions will allow for more specific focus on goals for students in these grades. The Writing Group faces interesting challenges in trying to preserve the main messages of the original NCTM Standards while attempting to look forward into the 21st century and seeking consensus across a field that is quite diverse in its views. The conflicts that are listed by Kirst and Bird (1996) relative to the development of content standards are especially useful for states and for national organizations to consider. Some highlights of their list include:

- Who must be involved in the process to feel it is inclusive? Students? Business? If you exclude groups, this will lead to charges of bias. If you include every group that is suggested, this will lead to a cumbersome and slow process.

- If you choose standards that achieve a broad consensus in the field, the "leading edge thinkers" will object. You will be accused of certifying "what is" rather than "what ought to be."

- If you choose a standard that achieves consensus in the field you will not be able to satisfy demands for "less is more"—consensus expands topics rather than reducing them. (Kirst & Bird, 1996, p. 31)

The NCTM Standards revision marks a new phase in the standards movement. Reflection on the revision process will be important to its effectiveness. The revision provides new opportunities for a professional organization to design ways of building consensus and looking forward for the improvement of mathematics education.

Perhaps of greatest significance in the NCTM story is the ground-breaking initiation of the standards movement. Not only did mathematics teachers have ready access to the NCTM Standards, but they were championed by national proponents such as Governor Roy Romer of Colorado and Senator Mark Hatfield of Oregon. The stage was set for national focus on standards.

NRC AND THE NATIONAL STANDARDS FOR SCIENCE EDUCATION

The *National Science Education Standards* were written in response to a nationally recognized need for goals and standards that could improve the quality of science education for all students. Support for national standards by state governments originated in 1989, when the nation's governors and President Bush established six national education goals, which were adopted by Congress and later expanded to a total of eight goals. In 1994, Congress enacted the *Goals 2000: Educate America Act* and formed the National Education Goals Panel (NEGP) to support and monitor progress toward the goals.

Several important events preceded the development of the science standards. In the 1980s, several organizations developed innovative instructional materials. Among these were the American Chemical Society, the Biological Sciences Curriculum Study, the Education Development Center, the Lawrence Hall of Science, the National Science Resources Center, and the Technical Education Resources Center. In 1989, the American Association for the Advancement of Science (AAAS), through its Project 2061, published *Science for All Americans* (AAAS, 1989), defining scientific literacy for all high school

graduates. Three years later, the National Science Teachers Association (NSTA), through its Scope, Sequence, and Coordination Project, published *The Content Core* (1992).

In 1991, the National Research Council (NRC) was formally asked by the president of NSTA to assume a leading role in developing national standards for science education. The NRC was encouraged by leaders of several other science and science education associations, the U.S. Department of Education, the National Science Foundation (NSF), and the NEGP. The effort, funded by the U.S. Department of Education, NSF, and the National Aeronautics and Space Administration (NASA), was led by the National Committee on Science Education Standards and Assessment (NCSESA), advised by the Chair's Advisory Committee of representatives of the major science education organizations, and carried out by three working groups (content, teaching, and assessment) composed of science teachers, educators, scientists, and others involved in science education. Early drafts of the NRC Standards were reviewed by numerous focus groups and additional groups of experts, plus large numbers of educators across the country. More than 40,000 copies of a complete draft were distributed in December 1994 to approximately 18,000 individuals and 250 groups for review. The comments and recommendations received from these reviewers were used to prepare the final document.

Formally released in December 1995, the *National Science Education Standards* (NRC, 1996a) define the science content that all students should know and be able to do and provide guidelines for assessing the degree to which students have learned that content. The NRC Standards detail the teaching strategies, professional development, and support necessary to deliver high-quality science education to all students. The NRC Standards also describe policies needed to bring coordination, consistency, and coherence to science education programs.

In early 1996, the NRC consolidated its education activities into the Center for Science, Mathematics, and Engineering Education (the Center). The Center took on support for the new *National Science Education Standards* as an important priority. Because the NRC is unlike the NCTM, an organization whose large membership is distributed throughout the United States and whose capabilities include a network of state affiliates who could engage in support for the mathematics standards, the Center needed its own unique strategy for supporting the science standards. That strategy, which takes advantage of the Center's position within the NRC as well as lessons learned from the NCTM experience with national standards, is elaborated in a general way in the Strategic Framework discussed earlier in this report. Within the Strategic Framework, the Center's focus has been on building awareness of the NRC Standards and support for their use throughout the country.

Dissemination

Dissemination of the NRC Standards has taken many forms. The document was immediately available on the World Wide Web.[9] After the January 1996 publication, the

[9] Available at www.nap.edu/readingroom/books/nses/

NRC sent copies to all members of Congress, governors, state science and technology policy advisors, state science supervisors, NSF-funded systemic initiatives, and directors of Annenberg Challenge Sites. Following the Education Summit hosted by national business leaders in March 1996 that endorsed the need for common, clear, state and/or community-based standards, the Center provided copies of the NRC Standards to participating governors and CEOs along with a letter that linked the Education Summit's recommendations with the NRC Standards.

The NRC Standards have been distributed to members of the National Academy of Sciences, the Council of Scientific Society Presidents, and leadership of all professional organizations for science education, including the American Association for the Advancement of Science, the American Association of Physics Teachers, the American Chemical Society, Council of State Science Supervisors, National Association of Biology Teachers, National Association of Geology Teachers, and the National Science Teachers Association. This effort had the specific goal of informing the scientific and educational communities of the NRC Standards.

As of June 1997, over 131,000 copies of the NRC Standards have been distributed. To further dissemination efforts, the Center recently produced a brochure, *Introducing the National Science Education Standards* (NRC, 1997a), that describes what is in the NRC Standards and addresses typical questions about the Standards. In the months since the brochure's publication, nearly 10,000 copies have been distributed.

Dissemination of the NRC Standards document has been complemented by presentations about the Standards. Over 400 presentations were made to approximately 33,000 people by approximately 100 presenters before the actual release of the Standards. Hundreds more presentations have been made since. In the fall of 1995, before the release, a series of ten regional workshops was hosted by the Center for science education leaders throughout the country. The workshops initiated a Speakers' Bureau to support participants in their efforts to disseminate the NRC Standards in their own communities. The Center assembled a presentation guide from the material shared in those workshops and distributed the guide to the 375 people who attended.

The Center has worked closely with many other groups to disseminate the NRC Standards. With NRC assistance, the NSTA launched the "Building a Presence in Every School" project. The goal of this project is to place a copy of the NRC Standards in every school in the country, supported by a resource teacher within the school and a state-wide network. This program was initiated in Texas, with support from the Exxon Education Foundation. The NSTA continues to add states and sponsors to this highly ambitious effort. Other special audiences targeted for dissemination initiatives include commercial publishers of science instructional materials and parents. A convocation for publishers was held at the National Academy of Sciences in June 1996 to brief them on the NRC Standards and discuss ways their materials could support standards-based teaching and learning. The Center is currently producing a publication aimed at parents and the

general public that sets the stage for their involvement in standards-based education by familiarizing them with rationale for standards and introducing them to the NRC Standards.

Interpretation

Interpretation efforts focused on curriculum and instructional materials began early and are continuing into the implementation phase. A November 1995 conference, co-sponsored by the Center and the BSCS and funded by NSF, brought together curriculum developers, state and district science educators, and teacher educators and professional developers to study the NRC Standards and their implications for curriculum development. That conference resulted in a book, *National Standards and the Science Curriculum: Challenges, Opportunities, and Recommendations* (Bybee, 1996).

Understanding the role of assessment in standards-based education is an important interpretation issue as well. This was a focus of a conference, "Science Education Standards: The Assessment of Science Meets the Science of Assessment," sponsored by the NRC's Board on Testing and Assessment in February 1997.

In addition, the NRC has had a particular interest in teacher development. At the request of NSF, the NRC developed a letter report, *Science Teacher Preparation in an Era of Standards-Based Reform* (1997b), that provides a vision for teacher education and professional development. The role of scientists and engineers in standards-based reform also has been a focus of the NRC. The Resources for Involving Scientists in Education (RISE) Project is completing a Web site to inform scientists and engineers who are interested in contributing to standards-based reform. Information on the Web site will include examples of how scientists have worked in various projects with teachers, schools, and districts and descriptions of the various roles scientists and engineers can play—all in an effort to help them and those with whom they work understand better their potential contributions to standards-based reform. Exploring the roles of business and industry in standards-based reform was the focus of a December 1996 forum at the National Academy of Sciences, entitled "How Industry Can Use the Standards to Promote School Reform," that was hosted jointly by the NAS Academy Industry Program (AIP) and the Center. Past meetings have included approximately 200 business leaders and have centered on involving business and industry in the reform of science education.

A publication nearing completion examines the critical issue of equity as presented in the NRC Standards. Aimed at parents and the general public, the tentatively titled *Science for All Students*, will highlight various ways that the NRC Standards address equity and what an explicit emphasis on equity looks like in educational settings.

In 1996, the NRC launched a project to engage the informal education community— including museums, botanical gardens, zoos, and science and technology centers—in support of standards-based education. The central goals for the project include: 1) the enhancement of existing community resources found in science museums, botanical gardens, and in other youth-serving programs through study and dialogue about

the NRC Standards; and 2) the development of local action plans that build cooperation among key community constituencies through use of the NRC Standards.

Borrowing a concept from the NCTM for supporting documents to accompany the Standards, the NRC is initiating a major effort to create a series of addenda that illuminate important standards, such as those addressing science as inquiry, science and technology, and the history and nature of science. These publications will provide teachers and professional developers with an understanding of the knowledge base in these areas, images of standards-based curriculum and instruction, and examples of educational resources that will help in implementing the NRC Standards.

Implementation

Most of the issues addressed by the Center through interpretation activities have been carried into implementation. Here the NRC has provided leadership through the development of products and the convening of groups to support state and local initiatives. To further the work in curriculum and instructional materials, for example, a conference on "Using the *National Science Education Standards* to Guide the Evaluation, Selection, and Adaptation of Instructional Materials" was held at the National Academy of Sciences in November 1996. Three hundred and fifty federal, state, and local science educators attended this meeting. A set of guidelines for aligning instructional materials with the NRC Standards is currently under development. A new project, funded by the Robert W. Woodruff Foundation, will develop criteria for selection of materials and will design and pilot a process to do so with district-level teams throughout the country as they critique, select, and adapt textbooks and instructional materials for their respective districts and schools.

In February 1996, the NRC and the Council of Chief State School Officers convened a symposium to explore the implementation of the NRC Standards with respect to teacher preparation and credentialing. It was designed for leaders in science education, university science deans and scientists, and state education officials responsible for teacher certification. Participants attended as part of a state team; the teams examined the NRC Standards and created action plans to further their own efforts. Proceedings of the symposium, including the state action plans, were published in *Improving Teacher Preparation and Credentialing Consistent with the National Science Education Standards* (NRC, 1996b).

The NRC is currently planning collaborative efforts with associations of science leaders from states (Council of State Science Supervisors [CSSS]) and districts (National Science Education Leadership Association [NSELA]). These initiatives will explore and document the various processes that different states and districts are using to move from national standards to state frameworks and, eventually, to influence changes in textbooks and instructional materials, curriculum, assessment, and teaching. In the future, the Center plans to host a summer institute for state leaders in mathematics as well as science that will provide state teams with the opportunity to apply new understandings about national

standards to their state reform initiatives. Staff of the Center will work with NSELA leadership to formulate specific directions for collaborative work.

Evaluation

The evaluation of the NRC Standards actually began as part of the process to establish a national consensus before the Standards were revised to their final form. Forty thousand copies of the penultimate draft were distributed for national review by individuals and groups that had expressed an interest in being part of the process. Approximately 4,000 responses were received from individuals and special focus groups; respondents included teachers (K-12 levels), science educators (district coordinators, science supervisors, curriculum developers, teacher educators), scientists (college, university, industry), policy makers (school boards, state government officials), and other role groups (business, parents) (NRC, 1995b).

Among these self-selected respondents, there was significant agreement on the content in the *National Science Education Standards*. The survey asked for agreement with characteristics of the content standards, including the intent, consistency, developmental appropriateness, vision of good science, and clarity. Across all respondent groups, there was at least 59 percent agreement or strong agreement. In most cases, the level of agreement was much higher.

Another series of questions in the national review asked about the various areas in the NRC Standards: teaching, professional development, assessment, content, program, and system. For all areas except the system standards, more than half of the respondents judged that the Standards were complete and accurate, that they would help policy makers and practitioners make decisions, and that they presented an acceptable vision. The teaching and content standards received the most supportive ratings.

Respondents were asked to choose one area for which the NRC Standards were likely to have the greatest influence. Program development and evaluation, teaching practice, policy formulation, and content selection received the most votes, in that order. These are important themes in the improvement of science education and ones that the NRC had intended the Standards to influence.

In January 1997, the NSTA completed a survey of 5,000 randomly selected NSTA members for their reactions to the NRC Standards (NSTA, 1997). Of the 1,900 members who responded, 87 percent were teachers. (There were no data to indicate whether those responding were representative of those surveyed.) When asked if they thought that the NRC Standards could improve the way science is taught in their classrooms, 80 percent of the teachers who answered the question responded "yes." Further, 75 percent of teachers responding thought the NRC Standards would improve the way science is taught in their schools. Very importantly, the survey asked what the teachers perceived as barriers to implementing standards in actual practice. The three top barriers cited by teachers were:

adequate time for planning and working with other teachers; financial support for relevant professional development; and instructional materials, resources, and facilities.

Results such as these are not unexpected. Like the NRC survey results, they indicate that educators are aware of the NRC Standards and the implications for their practice. Further, they underscore that science teachers understand that critical requirements for the success of standards-based reform include time, professional development, and instructional materials. These data have influenced the work of the NRC, as described in the discussion of strategies for interpretation and implementation above. Implications for state policy are discussed in the Recommendations section of this report.

The Efficacy and Influence project of the Center, mentioned earlier in the discussion of evaluation of the NCTM Standards, will serve as a guide for ongoing monitoring of science standards implementation.

Revision

Although the NRC Standards were released quite recently, it is never too early to begin planning for revision. From the beginning, the various advisory committees encouraged the NRC to view the Standards as a living document, one that would undergo revision at appropriate intervals. The formal process of revision for the NRC Standards will likely begin in the year 2000, for release in 2002. It will include, as before, broad participation by those involved with and interested in science education and will incorporate the lessons learned from the mathematics community's current revision of the NCTM Standards.

CURRENT CONTEXT FOR MATHEMATICS AND SCIENCE EDUCATION

In the late 1980s, "state and district policy makers (along with many professional subject matter associations and private foundations) turned their attention from the number of academic courses to the quality of the core academic content being taught in public schools" (Massell et al., 1997, p. 1). The standards movement—as launched by the work of the National Council of Teachers of Mathematics (NCTM) and continued in science by the National Research Council (NRC)—is an impetus and tool for this redirection of attention. It is a vehicle for moving toward Goal 5 of the National Education Goals—"By the year 2000, United States students will be first in the world in mathematics and science achievement." Now, in the late 1990s, attention is focused again on the quality of core academic content. President Clinton has called for a national voluntary test in eighth grade mathematics and has directed the National Science Foundation and the U.S. Department of Education to prepare an action strategy for the improvement of K-8 mathematics education. Mathematics and science education continue to benefit from high levels of visibility and attention in the public and policy arenas.

Some of the current attention to mathematics and science education is the result of international comparisons. The release of the Third International Mathematics and Science Study (TIMSS) reported that U.S. eighth grade students were slightly below average in mathematics and average in science achievement in comparison with their counterparts in more than 40 other countries around the world (NCES, 1996); fourth graders were average in mathematics and above average in science (NCES, 1997). TIMSS also reported on factors that may influence mathematics and science performance, including the nature of educational systems, the role of curriculum, time spent in school, and the breadth and depth of topics covered in school mathematics and science programs.

National and international benchmarking, which can draw from the goals of standards, is a focal point for public policy discussions of education at the state level. Results from TIMSS and from the 1996 National Assessment of Educational Progress (O'Sullivan, Reese, & Mazzeo, 1997; Reese et al., 1997) have stimulated discussions of how well students are doing in mathematics and science in comparison to those in other countries and states. A study of tests taken by high school students around the world, conducted by the American Federation of Teachers and the National Center for Improving Science Education (AFT& NCISE, 1997), has furthered the discussion of whether our expectations for students are sufficiently high.

At the same time, barriers and challenges to reform of science and mathematics education have persisted. Achieving public consensus has at times been problematic (Massell et al., 1997). Throughout the reform literature there is discussion of the need for teacher professional development to support the proposed changes of the standards documents (NCTM, 1991; Zucker, 1997). Textbooks and instructional materials are also needed as support for standards-based reform (Tyson, 1997). Questions of how teacher and student motivation and beliefs interact with reform and issues of administrative support merit further examinations as potential challenges to reform (Tyson, 1997).

There is current debate in the field about the directions and goals of mathematics education reform. This debate is due, in part, to different interpretations of the NCTM Standards—e.g., whether the Standards pay attention to basic skills. The debate might also be viewed as an effort to promote a more balanced perspective about what is important in mathematics teaching and learning. Various organizations have been established, such as Mathematically Correct, that are calling for alternative goals in mathematics education to those promoted in the NCTM Standards documents. Research mathematicians have been commenting extensively on their views about K-12 mathematics education (Andrews, 1997; Bass, 1997). The NCTM Standards revision process, through its Association Review Groups, provides an organized means of gathering various points of view, which will be considered in the revision process. The differences in views and values that are emerging in these mathematics debates are likely to remain visible at the state and local levels in the processes of reconsidering mathematics and science education reform.

In a general way, events that are calling attention to mathematics and science achievement have special promise for directing renewed attention to mathematics and

science standards, in particular the relationships between national and state standards. The March 1996 Education Summit of the nation's governors and business leaders focused attention on the topic of state standards. The Council of Chief State School Officers has conducted a review of state standards describing characteristics of state standards and frameworks (CCSSO, 1997a). On July 1, 1997, the National Education Goals Panel's ACHIEVE panel began its work on assessing the quality of voluntarily-submitted state-level standards. Specific activities in mathematics and science education, both ongoing and new, also contribute to this moment of opportunity. The NSF's systemic initiative efforts at the state, city, and regional level—as well as similar efforts supported by states and local communities—are infusing resources into the system and involving large numbers of mathematics and science teachers, together with the business community and the public, in focused work on high standards for the learning and teaching of all students (Zucker, 1997).

The stage is set for continued work on standards-based education throughout the country. Significant portions of the mathematics and science education communities have focused their energies on standards; national and international studies of student learning point to progress, but identify areas that require substantial improvement as well; and national, state, and local resources are being directed on reform of all components of the system. The National Education Goals Panel has provided the NRC and NCTM with a rare opportunity: to pause and reflect on the past, and suggest specific ways to move forward the states' agendas of high standards for ***all*** students. Although both the NRC and NCTM can provide support for these agendas, the steps necessary to ensure widespread implementation of standards-based education must now be taken by state governments. The recommendations in the following section are intended to suggest productive directions for states.

RECOMMENDATIONS FOR STATE POLICY

In the sections that follow, we propose recommendations in five areas: state infrastructure, textbooks and other instructional materials, curriculum, teaching, and assessment.[10] Many of these areas are highly visible to the public and so are of particular concern as reform initiatives continue. These are also areas in which the activities and interests of the states, the National Council of Teachers of Mathematics (NCTM), and the

[10] The recommendations that follow use the following definitions: ***Content standards*** specify the content knowledge and skills all students will know and be able to do upon completing particular grades or courses in K-12 education; the content standards state clearly the knowledge and skills to be learned, and at what developmental level content is to be presented (CCSSO, 1996a). ***Curriculum framework*** is a document published by a state education agency or state board of education [or school district] that generally includes desired subject content or standards for a core academic subject in K-12 education. It often serves as a bridge between national professional standards and local curriculum and instructional strategies. It may refer educators to other materials and resources to support local efforts (CCSSO, 1996a). ***Curriculum*** is the way content is designed and used with students. It includes the structure, organization, balance, and presentation of the content in the classroom (NRC, 1996a). ***Instructional materials*** are the physical components of the curriculum, including textbooks, software, kits, calculators, and teachers' guides (NRC, 1996a).

National Research Council (NRC) intersect. As the work of states in standards-based education continues, there are many ways in which they can draw on the past experiences and current initiatives of the NCTM and NRC, be supported in specific areas of work, and influence ongoing NCTM and NRC activity. The recommendations for state policy that follow are discussed in terms of these overlaps and the potential for mutual support now and in the future.

The overarching recommendations are:

1. **State infrastructure.** Strengthen the state infrastructure for improvement in mathematics and science education with coherent, focused standards and with the policies, structures, and resources to support their achievement.

2. **Textbooks and other instructional materials.** Develop policies and strategies that promote the use of standards-based textbooks and other instructional materials and that build state and local capacity for selecting and using the materials appropriately.

3. **Curriculum.** Structure policies and support to focus districts and schools on designing science and mathematics curricula that are high-quality, well-articulated, and standards-based.

4. **Teaching.** Create policies and practices to ensure that well-qualified, highly-competent teachers, whose practice is grounded in the mathematics and science standards, are in every elementary school, mathematics, and science classroom in the state.

5. **Assessment.** Establish testing and assessment programs consistent with the goal of high expectations for all students to learn standards-based mathematics and science.

These recommendations are interrelated. States require strong leadership for coordination in all aspects of standards-based reform. Instructional materials, especially textbooks, are the primary tools used by many teachers and seen by most parents as fundamental resources for student learning. They contribute to the curriculum, broadly defined, through their organization and delivery of content. Teachers are seen by most reformers as the central agent in promoting high quality mathematics and science education for *all* students. Effective assessment can be simultaneously a tool for improving curriculum and teaching and for measuring progress toward the goal of achieving rigorous standards for all students. Together, the five overarching recommendations listed above form a whole that can best be coordinated around standards, with each piece requiring attention and action separately. The recommendations have potential value for all disciplines and could gain more support if applied across the entire system, not just in science and mathematics.

Making a set of recommendations for state policy may imply that states are all alike, and this is not true indeed. From state to state, the mechanisms of governance are different, as are the responsibilities taken on at the state level. States have many vehicles

for promoting improvement of education, including regulation, support, and persuasive power. States combine these in unique ways, depending on their structures, traditions, and resources. As a consequence, it has been a challenge of this report to make recommendations that are not so global as to be unattainable, but that are specific enough to be useful to most states in spite of their differences. In addition to being as specific as possible, this report includes a number of examples of how individual states and others are approaching some of the recommendations.[11] In these ways, this report seeks to provide some practical guidance for state policy as states increase their efforts toward standards-based reform in mathematics and science.

Recommendation 1: State infrastructure

Strengthen the state infrastructure for improvement in mathematics and science education with coherent, focused standards and with the policies, structures, and resources to support their achievement.

International studies and the efforts of states to bring about systemic reform have underlined the need for a strong state infrastructure focused on improvement (Elmore, 1996; O'Day, Goertz, & Floden, 1995). This recommendation addresses the importance of focusing all elements in the system on the achievement of high-quality state standards. Policies guiding education, funding programs, and state procedures all must be coordinated and directed toward this common goal. The theme for state capacity building and indeed all of the recommendations in this report is, as stated succinctly by the National Commission on Teaching and America's Future, "*get serious about standards* [emphasis added]" (1996).

In order to get serious about standards, states need to go beyond their statutory duties of creating their own standards, curriculum frameworks, assessment systems, etc. and include mechanisms for ongoing learning about the standards in every one of their activities. Understanding of the standards is needed by every state official as well as the many stakeholders who participate on state committees and development efforts.[12] Conscious efforts to provide professional development build the capacity to fulfill the current state role as well as plan effectively for the future. Getting serious about standards requires states to:

1-A. Develop high standards for all students, through consensus, including a process for periodic review.

Most states have a document, or documents, that contain state content standards for science and mathematics education. These documents tend to draw

[11] Throughout this section we have provided examples of how some states are implementing all or part of a recommendation. These were chosen not because they are exemplary per se, but because they represent interesting ways to address the issues that are raised. We do not have extensive data about the effectiveness of these strategies.

[12] Note that useful materials promoting awareness and stimulating discussion of mathematics and science standards have been developed by the Annenberg/CPB Math and Science Project.

heavily on national standards (CCSSO, 1997a). They vary considerably in specificity and scope (CCSSO, 1997a), in quality (Lawton, 1996; Zucker, 1997) and in their "ambitiousness" (Tirozzi, 1997). They also differ in the process used in their development. State standards that were well-developed with careful attention to involvement of educators throughout the state, as well as important stakeholders like parents, business representatives, scientists and mathematicians, and community members, appear to have benefited from critical public support and buy-in (Massell et al., 1997; Zucker, Shields, Adelman, & Powell, 1995). In such a consensus process, participants become a knowledgeable force of advocates, thus building the capacity of the state to improve the system for science and mathematics education.

For example, North Carolina uses a process external to the state agency to build consensus around state documents. A qualified, independent organization statistically samples both educators and the lay public regarding proposed documents, soliciting input from all groups. The organization then uses feedback from this survey to validate or make recommendations for improvement of documents in a report to the State Board of Education. This process, as well as strategies such as well-publicized focus groups and expert advisory committees, provides many opportunities for input and ensures that no particular special interest group has undue influence on the development of important state documents.

In the development of standards, states may find the experiences of NCTM and NRC helpful, in addition to their links to the professional communities. National standards can be a reference point against which states can evaluate the degree of rigor in their own standards, including whether they have incorporated and, if so, adhered to such principles as "less is more," that is, depth of understanding is more important than breadth of coverage. The efforts of NCTM and NRC described earlier might help suggest ways to bring the forces in the state together in the dissemination, interpretation, and implementation of their own standards.

1-B. Build a coherent system for mathematics and science education within the state in which every component and level of education is aligned and has a common goal: that all students will meet these high standards.

One of the benefits of having a common set of standards, built through a consensus process, is that they can focus and guide action within a state. This was the intention of both NCTM and NRC, whose national standards include attention to all components of reform including content, teaching, and assessment. They go beyond statements of what students should know and be able to do; they describe the teaching, assessment, programs, professional development, and the system support needed for students to learn that content. Further, the national mathematics and science standards address all levels of the education system, seeking "vertical integration" of what students learn in the early grades with what they learn in

middle and high school and with how their teachers are prepared. Both sets of national standards suggest what needs to be done in classrooms, schools, districts, states, and at the national level.

States must similarly and continuously seek a "systemic" approach to science and mathematics reform, in which parts of the system work in concert with each other. Changes in one part influence adjustments in others; the common thread is the achievement of a shared set of standards (Smith & O'Day, 1991). Curriculum frameworks, funds for instructional materials, state assessments, preservice and inservice professional development programs, funding and other support for Title I and special education—all can be designed or redesigned and interrelated, using the national standards as a foundation.

In Texas, for example, the Statewide Systemic Initiative (SSI) worked to build coherence among programs and leverage resources by convening local and regional teams of Title I educators and administrators with other local educators and mathematics reform specialists. The SSI supported not only conversation and communication among these groups, but also funded team projects in which Title I mathematics programs were connected to standards-based, school-wide mathematics improvement efforts.

Most states have devoted a great deal of effort over the past several years to "systemic change," with varying levels of success. In some cases, federally-funded programs run parallel to the state's own initiatives; this may or may not influence local reform. For example, in some states, the NSF-funded state systemic initiatives are independent of and not well integrated with efforts of the state department of education. Efforts to reform professional development in a state might be significant, but the Eisenhower-funded programs might perpetuate traditional, but less-effective, approaches to science and mathematics professional development.

Similarly, although standards may be written for ***all*** students, Title I and special education programs within a state may not be incorporating standards ideas. However, current Title I legislation requires that districts pay attention to state standards and that states ensure that they do. States need to identify and eliminate these "discrepancies" between different programs and initiatives and replace them with common focus and vision if the states are to achieve the goal of meaningful learning for all students.

1-C. Establish a long-range plan for improvement that involves the broader community as well as mathematics and science educators and provides sufficient support for local educators as they work to implement the standards.

Standards-based education requires an ongoing process in which the system is not fixed "once and for all," but rather in which the quality and coherence of the system are enhanced via a common set of standards for mathematics and for

science. Through the evaluation and revision process, the system's capacity to improve will increase.

Students take 13 years to go through the K-12 education system, and we cannot expect to both have and fully understand the impact of standards until at least one cohort of students has experienced a new and improved educational experience. The kinds of support needed are well documented in the literature (Fullan, 1991; Loucks-Horsley et al., 1990), and are becoming better understood in evaluations of current efforts at state reform (Zucker, 1997).

Standards-based education in mathematics and science is in many ways an opportunity for scientific inquiry. Studies, such as those of previous reform efforts (National Advisory Committee on Mathematical Education, [NACOME], 1975) and current international comparisons (NCES, 1996; 1997), indicate a need for initiatives that are more coherent, systemic, sustained, and based on a commonly held set of high standards for student learning. Although reports of current "systemic" initiatives indicate that steady progress is being made in implementing key components of reform (Massell et al., 1997; Zucker, 1997), it is still unknown as to whether, under what conditions, and in what configurations such initiatives are successful in increasing the science and mathematics learning of students. The long range plan suggested by standards is based on the best knowledge available to date, but such a plan must have feedback and evaluation mechanisms at many points and at many levels to inquire into its influence and impact, and to inform its revision and mid-course adjustment. Ongoing dialogues between state reform leaders and constituents provide one form of data. Careful measures of implementation of various components of the system, such as professional development and new assessment practices, provide another kind of data. Finally, data on student learning and the conditions under which they learn are needed to address such far-reaching questions as the following: Under what conditions, if any, can all students meet the standards? What are the costs of their doing so? What are the consequences of all students meeting the standards? Any long-range plan must take into account the tentative nature of the data currently available on which to base planning decisions, build in mechanisms to collect its own data, and approach the design and implementation of the initiative as an inquiry into standards-based reform.

The issue of expanding the community beyond those involved in science and mathematics education is critical. Earlier we noted the importance of including the broader community in the development of standards; ongoing involvement and support are needed as well. Working closely with business and other groups such as the PTA, states need to build the awareness and commitment of the public to the directions of standards-based education. Research suggests, however, that states are not doing well in this regard. "Lack of public support and understanding of standards-based reforms remained major obstacles to the stability of standards,"

notes Massell and associates (1997, p.6). Better strategies are needed to garner the support of various publics for standards-based reforms.

In Washington State, raising public support for standards is the primary purpose of Partnership for Learning, a non-profit organization sponsored by Washington business and community leaders. The Partnership works to increase public awareness about the state's effort to raise academic standards in the public schools. Resources made available by the Partnership include brochures, a parent's guide to academic achievement, public opinion data, a newsletter, and a web site with links to other resources around the country related to standards and assessments.

Some states have maintained coalitions in mathematics and science that were initiated by the MSEB in 1990, with start-up support from the Exxon Education Foundation. These have established a "self-sustaining" leadership structure. A parent organization, the National Alliance of State Science and Mathematics Coalitions (NASSMC), now supports efforts in individual states to build broad capacity for standards-based reform, bringing together the varied resources of education, science and mathematics, and the business community. These efforts and others that work to expand the community must be folded into the state infrastructure to enhance the capacity of the system.

It would be irresponsible to recommend the broad and long-term changes required to implement high standards for all students without acknowledging the time and resources required at every level of the system—classroom to state house. Where resources are limited, as they are in education, there is competition for those that exist. Every content area can make a compelling case for their share and more. Certainly demands on teachers are keen, and seem to increase daily; elementary teachers are especially pressured to invest their time and energies in reform of each of the disciplines that they teach.

State policy makers need to examine carefully the issue of resources for educational reform. There are no definitive estimates of what it will cost to achieve high standards for all students. However, there is reason to believe that substantial progress towards meeting that goal could be made by reallocating current resources. As noted above, our educational systems lack coherence; major programs such as Title I and the Eisenhower funds are not always well coordinated. The result can be costly duplication of effort. The report of the National Commission on Teaching and America's Future (NCTAF, 1996) makes a compelling case for reallocating educational dollars. The report urges rethinking of school structures and roles to increase the number of instructional staff (and thus decrease teacher/student ratios), redirecting professional development funds to eliminate ineffective one-shot workshops, and supporting more useful forms of professional development to help teachers learn how to use new curriculum and assessments. It urges investment in "strategic improvements" such as teacher preparation, recruitment, licensing, and

induction to eliminate the costs of replacing 30 percent of new hires in their first few years of teaching and "band-aid" approaches to staff development for those who have not learned to teach effectively. The cost analyses contained in the NCTAF report constitute a useful place to begin examining how resources are currently being used in and how they might be used differently to support standards-based reforms. Similar estimates could be made for how resources for curriculum and assessment are being used and how they might be reallocated.

1-D. Ensure that state-level leadership positions in mathematics and science education exist and are filled by staff with expertise in the disciplines and in supporting change.

As of 1997, only 65 percent of the states have positions at the state-level in mathematics education; 80 percent have similar positions in science education. Some of these positions are funded through external sources such as Eisenhower/Title II or NSF Statewide Systemic Initiatives; such positions may not be permanent. In several states, after the retirement or resignation of an individual holding this position, there may be a considerable time lag in hiring a replacement or the position may be eliminated altogether due to budget constraints. Some of these positions include additional general responsibilities, such as technology, assessment, or professional development; others combine mathematics and science. Individuals in these positions may have a broad range of responsibilities and serve in a variety of roles: working on state policy, coordinating mathematics and science programs, overseeing the development of state curriculum frameworks, organizing for the adoption of instructional materials, developing or influencing state assessments, and giving guidance to state superintendents. In a few cases, the main responsibility of state-level mathematics or science consultants is to consult with schools by invitation only; they are not involved in state policy.

Whatever the configuration of their roles, what these individuals know and can do is critical to their state's success in science and mathematics reform. Just as the current reforms call for teachers who deeply know the mathematics and science they need to teach, so too the current reforms require similar expertise in positions of leadership. Decisions about standards and curriculum frameworks, curriculum and instructional materials, teaching and professional development, and assessment design, as well as plans for implementation, hinge to a large extent on the nature of the disciplines, how they are learned, and how they are best taught. The issues differ by discipline; for example, those making decisions about mathematics need to understand the "gatekeeper" role played by algebra courses. Science decision makers need to understand the implications of the lack of science competence of elementary teachers and the importance of carefully organized systems that provide teachers with the materials they need to teach science. State leaders have to make the final decisions about what becomes state policy and procedure, what is published in state documents, and what is funded through state initiatives. They need to make important discipline-related links to programs such as Title I and Title

II (the Eisenhower Professional Development Program). Without expertise in science and mathematics curricula, teaching, and programs resident in state departments of education, the decisions made may be to the detriment of the reform movement.

Expertise in the disciplines is necessary but not sufficient for state-level staff, who are increasingly moving into roles of technical assistance and away from the more traditional roles of monitoring compliance with state laws and procedures. This is important for state capacity building, but it does not happen simply by changing job descriptions; many staff do not currently have the capabilities to make this change. New knowledge and skills required include design of professional development, facilitation, consultation, organizational development, public relations, and change management. Specific professional development in these areas is required. Further, just as teachers must develop skills and dispositions for lifelong learning (NRC, 1996a), so, too, staff in state positions need to have the capacity to respond to new demands in appropriate, timely, and creative ways. Their knowledge, connections, and interactions with the NCTM and NRC capacity-building efforts, such as work with the Council of State Science Supervisors (CSSS) and the Association of State Supervisors of Mathematics (ASSM), can increase their understanding of issues in their content areas, and inform their policy decisions.

1-E. Provide guidance and policy support to districts and schools in restructuring the use of school time to create opportunities for teachers to work together for improvement of mathematics and science education in their system.

The issue of restructuring time for teachers and administrators to work together for improvement is one that is critical to the success of standards-based initiatives. International studies indicate that teachers in countries scoring higher than the U.S. on international comparisons have far fewer student contact hours than American teachers (NCES, 1996; Raizen & Britton, 1996). Hours spent without student contact are typically devoted to teachers working together on teaching materials, lesson plans, and other areas of curriculum. The literature on school improvement repeatedly validates the importance of school staff having opportunities to talk about teaching practice; observe each other's teaching; and plan, design, research, evaluate, and prepare teaching materials together (Little, 1993; Rosenholtz, 1989).

Widespread experimentation is occurring in schools and districts to restructure school schedules to provide time for staff collaboration, provide release time for teachers or purchase time outside of the school day and/or year, and make better use of available time (Watts & Castle, 1993). Some states are creating policies to address this issue.

For example, in the early 1990s, the Connecticut Academy for Education in Mathematics, Science and Technology (1996) supported a task force that developed

a report entitled, *The Case for More Time and Better Use of Time in Connecticut Schools*. Recognizing that the use of time was critical to any efforts to improve mathematics and science in schools, the monograph summarized issues and recommended ways to improve the use of time for both students and teachers, by increasing actual time and using existing time in innovative ways. A year after the release of the report, a Connecticut Academy survey discovered that many schools in the state were implementing various recommendations of the task force, including block or flexible scheduling, interdisciplinary study, and programs scheduled outside of the regular school day. Many schools were creating more teacher time through reducing non-academic duties and lengthening both the teacher's and student's school day and school year.

State policies can assist local educators by providing more professional development time, supporting creative uses of in-school time (which may involve granting waivers of some state laws), and providing assistance to schools in designing and implementing alternative school schedules.

Recommendation 2. Textbooks and Other Instructional Materials

Develop policies and strategies that promote the use of standards-based textbooks and other instructional materials and that build state and local capacity for selecting and using the materials appropriately.

Textbooks and other instructional materials are a staple in the classroom. As teaching tools, they embody the content and values to be learned by students, and so can be a significant force in helping students achieve high standards in mathematics and science. Yet, in many states, textbooks and instructional materials are a "weak link" in their improvement initiatives; educators recognize their potential value, but find the availability of high quality materials limited (Zucker, 1997). SRI's study of 25 states with NSF funding for statewide systemic initiatives indicates that:

> To improve student achievement, high quality textbooks (or other instructional materials, such as kit-based elementary science programs) need to be identified (or developed if necessary) and decision makers need to be well informed about them. (Zucker, 1997, p. 5)

Teachers use textbooks as their main curriculum guide and source of lesson plans, especially at the elementary grades (Woodward & Elliott, 1990). Research on textbooks consistently shows that they "flip from topic to topic, covering very few in the depth a beginner would need to understand, remember, and integrate the knowledge" (Tyson, 1997, p. 2).

Reports of international studies, such as *A Splintered Vision* (Schmidt, McKnight, & Raizen, 1997), *Pursuing Excellence* (NCES, 1996), *Characterizing Pedagogical Flow* (Schmidt et al., 1996), and *Changing the Subject* (Black & Atkin, 1996), characterize the

U.S. curriculum as one that is "a mile wide and an inch deep." The findings support the need for textbooks and other instructional materials that have fewer topics in any given year and put more emphasis on developing understanding of basic mathematical and scientific concepts and processes.

States have a great deal of influence over the nature of textbooks. This is especially true in the 20 states that "adopt" a list of state-approved textbooks and bear the cost of textbooks for all students in the state (Tyson, 1997). The influence of states contributes to the "mile-wide and inch-deep" nature of textbooks. Publishers, responding to the demand of the market, include everything that adoption states require (in particular, the high-population states of California, Texas, and Florida that have restrictive state adoption procedures). The result is broad coverage of mathematics and science topics, including a vast amount of review, which then becomes the focus of instruction.

This report views the influence of the states on the market for instructional materials, especially textbooks, as potentially positive. For students to achieve high standards, the materials from which they learn must be designed to promote understanding of key areas of mathematics and science. Thus states need to demand materials that are more compatible with the standards they want their students to achieve.

There are specific actions and policy shifts that can be initiated at the state level to help improve selection processes and capacity.

2-A. Implement state policies that support the development of selection criteria for instructional materials based on standards and consistent with curriculum frameworks.

In some states, such as those with state adoption panels, development of selection criteria occurs at the state level. In other states, selection criteria are developed at the local level. In either case, decision makers should promote the development of selection criteria that are aligned with standards and curriculum frameworks. It is important that the set of district- and state-approved criteria for selection of instructional materials go beyond textbooks to include innovative print materials, kits, calculators, software, manipulatives, and other tools that enhance the opportunities for students to learn mathematics and science.

"Alignment with standards" has already taken on many meanings. For example, some publishers have claimed alignment of their science textbooks with the NRC Standards by making a quick match with the list of content standards. It is essential for those selecting materials to ask the harder question: Will students gain fundamental understandings from this material? A careful analysis is required that examines how activities and information in the instructional materials connect to help students build such understandings.

State-level educators need to think carefully about what it means to be "standards-based" as they develop their selection criteria and/or assist districts to develop their own. Every state has well-qualified professionals ranging from classroom teachers to curriculum specialists to university faculty who have thought about the NCTM and NRC Standards. Many have experience with the large-scale curriculum development efforts funded by NSF that attended to standards in their development. This expertise should be used as states design strategies and build capacity for materials selection. Part of this capacity building is encouraging district selection committees not to "undo" states' good selection criteria, by applying outdated or restrictive criteria.

As an example of state activity, Ohio's Statewide Systemic Initiative, *Discovery*, and the Eisenhower National Clearinghouse collaborated to review current middle grades science curricula, assessing the areas in which they align with the NRC Standards. Several sets of materials were reviewed, each by an educator familiar with the NRC Standards, using the *Discovery*-developed *Middle Level Standards Based Inventory (grades 5-9)*. Checked by independent reviewers and the material's developer or publisher, these summaries assist teachers, administrators, and parents in quickly accessing information about the NRC Standards and science curriculum materials.

2-B. Commission evaluations of textbooks and other instructional materials by qualified professionals, and disseminate results to local adoption committees.

Efforts to describe and, in some cases, evaluate instructional materials and their alignment with standards are beginning to occur in some state agencies and other state, regional, and national organizations. But robust reviews are still rare and many selection committees do not have access to them. State departments of education can fund and then disseminate reviews that will help state and local adoption committees make informed selections. Such reviews might be done by independent evaluators, with funding from agencies such as NSF or private foundations.

2-C. Implement professional development programs that help school personnel effectively select textbooks and other instructional materials and integrate them into the science and mathematics curriculum and instructional practice.

Administrators and teachers are "the market" for textbooks and other instructional materials. Commercial publishers continually point out that their market analyses indicate uneven demand for "standards-based materials." Administrators and teachers influence the nature of the materials available to them; they are important members of material selection committees and they need to be prepared for these positions. According to Tyson (1997), "training" evaluators of instructional materials is critical. She recommends developing selector training models that are "standards-driven, intellectually defensible, and informed by

research. A deeper and more qualitative adoption process is the single most powerful way to improve textbooks" (p. 23).

As teachers and administrators become more analytical consumers of instructional materials, teachers will learn how to use them. Textbooks used wisely can complement a well-designed curriculum. Often, however, textbooks *are* the curriculum, and teachers use them in a lockstep fashion (Woodward & Elliott, 1990). This is sometimes due to teachers' belief systems or the culture of the school in which they teach. As observed in TIMSS, experienced teachers are more likely to make judgments about which topics to develop and which to omit, in keeping with a curriculum design, while teachers with less preparation in science and mathematics, in difficult assignments and highly accountable situations, will proceed systematically from the front to the back of the textbook, covering each topic. They teach more and the students learn less (Schmidt et al., 1997).

A number of efforts are underway to assist school personnel with assessing and selecting instructional material aligned with standards. The NRC, for example, has held a series of conferences for curriculum developers, commercial publishers, materials adoption committees, and science educators from various levels to explore issues related to materials development, analysis, selection, and adaptation. A set of guidelines for the evaluation, selection, and adaptation of instructional materials aligned with the science standards is soon to be completed. A new NRC project, funded by the Woodruff Foundation, will further develop these guidelines into a set of criteria for material evaluation, and design and pilot a process for doing so by teams of local educators and scientists. NCTM, as well as MSEB, is seriously considering ways to help teachers understand the nature of the materials from which they choose to teach.

Recommendation 3. Curriculum

Structure policies and support to focus districts and schools on designing science and mathematics curricula that are high quality, well-articulated, and standards-based.

Students need well designed, comprehensive, and coordinated experiences to help them learn important mathematics and science concepts. Although the term "curriculum" has different meanings for different people, in this report we view curriculum as the way content is designed and used with students. A textbook is *not* the curriculum.

The results of TIMSS (NCES, 1996; Schmidt et al., 1996) and other international studies (Black & Atkin, 1996) indicate the need for a more coherent curriculum for U.S. students. Changes that will bring greater coherence to the school mathematics and science curriculum include the following: vertical integration of experiences across grade levels and between elementary, middle, and high school; coordination of mathematics and science learning, when appropriate; equitable opportunities for all students; and a well-thought curriculum framework that will influence selection and implementation of

instructional materials. All of these changes should focus on achievement of a common set of standards. States can support these changes in several ways:

3-A. Provide technical, financial, and material support to local districts for the design and implementation of programs in which all students have opportunities to meet standards for mathematics and science.

Interpretation and implementation of standards call for a thoroughly-conceptualized and carefully-orchestrated plan. It is not enough to create standards; support for understanding the content, changing practice, and making assessments part of learning is critical. The resources necessary to implement a standards-based curriculum may be more than those required of a more traditional program. States can provide districts with information about best practices in other districts and states so that they can, for example: develop strategies for reallocating existing funds; phase in a new program unit by unit, or grade by grade; equip materials support centers in cooperation with other districts; and create partnerships with business and industry to design, implement, and subsidize standards-based programs (National Science Resources Center [NSRC], 1997).

Many states have developed curriculum frameworks that take standards one step closer to the classroom, informing teachers and administrators about the meaning of standards, and suggesting how to design and organize instructional materials and learning experiences so their students will achieve the knowledge and skills described in the standards. Some states assist or encourage districts to align specific instructional units and courses of study with standards. This encourages vertical (K-12) and horizontal (within grade level) integration of the school program for mathematics and science. Working together, teachers and administrators can trace a standard through their curriculum and ask the question: When and how will students have the opportunity to develop this understanding or ability? This process can ensure that important concepts are introduced and further developed through the grades, although the courses of study may look substantially different from district to district

As an example, Michigan's state curriculum framework provides districts with specific guidance in designing their curriculum so that it is aligned with the state benchmarks and objectives. Their science framework gives several examples of how districts can construct their own elementary, middle, and high school curriculum frameworks using commercially available programs, individual units developed by the Michigan Department of Education, chapters from textbooks that have incorporated hands-on activities, teacher-developed investigations, and special projects of various kinds.

Any effort to improve the curriculum through design of a framework and selection of new instructional materials should also include a plan for the implementation of the new program—a plan that addresses the long-term nature of

the change process; the need to identify and coordinate the actions of a variety of players and system components; and the attention required by individual teachers and administrators, school-based teams or departments, whole schools, and districts (Fullan, 1991; Hall & Hord, 1987). Further, implementation of changes needs to be based soundly on accurate data about the needs of teachers and student learning. As noted in the discussion of long-term state policy planning, local plans must have data-driven milestones to monitor progress and trigger mid-course corrections.

3-B. Base high school graduation requirements, university placement tests, and university admission requirements on standards.

There are many obstacles to comprehensive change based on standards. For example, students whose K-12 curriculum emphasizes depth of study over breadth of coverage may not do well on traditional entrance or placement exams for university study. If their coursework does not resemble the courses a university requires for admission, they will not be admitted.

Changing to a standards-based approach to mathematics and science education brings with it criteria for success other than completion of courses and number of years of study. States need to consider new criteria based on standards and ways to demonstrate success, such as performance assessments or portfolios, for graduating from high school. Further, they need to explore with colleges and universities alternatives to current admission requirements and placement tests, in order to dispel the disincentives that currently exist for educators to use standards as their goal for achievement.

Standards-based university admissions policies are beginning to emerge. For example, the North Carolina School for Science and Mathematics produces highly qualified seniors who do not take traditional high school courses, but instead participate in rigorous, applications-based, hands-on courses in mathematics and science. The school worked with top universities across the nation to accept their students based on portfolios of their work reflecting standards. Students kept chemistry and physics lab manuals and records of their mathematics work to demonstrate what they had completed in high school. Using these sources, students consistently placed out of college courses, often receiving college credit for their work.

3-C. Put in place in every school classroom new technologies that support standards-based teaching and learning of mathematics and science.

Technology includes computers, calculators, and other learning tools that can help students achieve high standards in mathematics and science. Further, technological tools can help teachers enhance their strategies for instruction. Research indicates that technology can help learners understand mathematics and science concepts more deeply and effectively (Heid, 1988; Hembree & Dessart,

1986), and that there are promising ways that technology can serve teachers' needs. Initiatives in every state are currently underway to address the enormous challenge of resources needed for technology. The issues of procuring equipment, wiring schools, preparing teachers, ensuring equitable access, and addressing the frequent obsolescence of both hardware and software need to be addressed as part of a plan to move schools into the 21st century.

Recommendation 4. Teaching

Create policies and practices to ensure that well-qualified, highly-competent teachers, whose practice is grounded in the mathematics and science standards, are in every elementary school, mathematics, and science classroom in the state.

The development of standards at national, state, and local levels has heightened awareness once more of the critical role of the teacher in student learning. But it is also the case that many of today's teachers are not adequately prepared or supported to perform in ways required by the standards. Further, the projection that, in the next decade, the U.S. will need to hire more than two million teachers due to increases in enrollment and replacement of teachers who retire or leave in the early years of teaching (NCTAF, 1996) demands immediate attention to preparation programs and licensing procedures..

There are some promising efforts underway to improve the quality of teachers and teaching that incorporate national standards. These efforts, or initiatives similar to these, can become part of a state's strategy. The report *What Matters Most: Teaching for America's Future* (NCTAF, 1996), is an especially useful resource for states and others who are interested in this area. Our first three recommendations centered on teaching reflect one of its statements: "...the three-legged stool of quality assurance—teacher education program accreditation, initial teacher licensing, and advanced professional certification—is becoming more sturdy as a continuum of standards has been developed to guide teacher learning across the career" (p. 29). Related to these three stages in teachers' careers, which are addressed as well in several NRC reports, (NRC, 1995a, 1996b, 1997b) we recommend that states takes steps to move in the following directions:

4-A. Accredit only teacher preparation programs that reflect the recommendations of mathematics and science standards.

4-B. Incorporate as a requirement for licensing that teachers demonstrate teaching practices that are based on standards and are appropriate to the particular learning situation.

4-C. Support the continuing professional development of accomplished teachers through mechanisms such as the National Board for Professional Teaching Standards.

The national standards have a bearing on each of these recommendations. In mathematics, the *Professional Standards for Teaching Mathematics* (NCTM, 1991) provide discussion about modeling good mathematics teaching, knowledge of mathematics, and developing as a teacher of mathematics. The NRC Standards include a section on "standards for professional development for teachers of science." The documents describe in detail what teachers need to know and be able to do, and the nature of teacher development programs that best develop teachers' knowledge and skills. Both sets of standards address the depth of content knowledge required for teaching at different levels of schooling—not in terms of courses, but in terms of knowledge and skills. Both also address how teachers can learn to teach their content, the characteristics of preparation programs that help them do so, and the clinical experiences needed to apply what they learn in actual classrooms and schools.

Three quality control mechanisms for improving teaching currently available to states draw heavily on the mathematics and science standards. Nationally, these include the National Council for Accreditation of Teacher Education (NCATE), which accredits teacher preparation programs; the Interstate New Teacher Assessment and Support Consortium (INTASC), which is developing performance-based licensure for teachers; and the National Board for Professional Teaching Standards (NBPTS), which is developing challenging performance assessments for certifying accomplished teachers (NBPTS, 1994). State and regional accreditation and licensure entities also exist. States can take advantage of these national efforts by either becoming partners with them or developing their own similar mechanisms tailored to specific state needs and/or standards.

The NRC and NCTM have both learned from and contributed to the work of NCATE, INTASC, and NBPTS, and the issues these efforts are addressing. For example, an NRC colloquium for state teams centered on teacher credentialing and licensure discussed the implications of the national science standards and resulted in action plans by each participating team (NRC, 1996b). NCTM is responsible for developing the guidelines and reviewing the NCATE folio mathematics and mathematics education components. (Folios are the self-studies of the teacher preparation programs being accredited.) NRC has issued two reports on the preparation of teachers of mathematics (NRC, 1995a) and of science (NRC, 1997b). These reports address a particular concern of the NRC that states and institutions of higher education are beginning to attend to: the critical need for undergraduate mathematics and science courses to be "standards-based" in both content and instruction. Until this occurs, teachers will not be adequately prepared to teach these disciplines.

States are actively addressing these issues of quality control in teaching. For example, representatives of major teacher education institutions in Texas have developed a set of voluntary standards entitled *Guidelines for the Mathematics Preparation of Elementary Teachers*. These guidelines support the state's recently

adopted standards-based K-12 mathematics curriculum. After development of these standards, institutions across the state applied for funding from the Texas Statewide Systemic Initiative, the Higher Education Coordinating Board, and other funding sources to develop programs to implement the standards. Across the state of Texas, future elementary teachers will receive dramatically different mathematics preparation, focusing on deep understanding of important mathematical ideas. Parallel efforts in elementary science and in secondary mathematics and science are now under way.

As another example, through its Beginning Educator Support and Training (BEST) Program, Connecticut offers a variety of state-level innovations to improve the qualifications of beginning teachers and increase the likelihood that they will receive a solid foundation for sustained excellence in the classroom. During the first year of teaching, novices receive help from a school-based mentor or mentor team. Beginning teacher clinics, conducted by state-trained assessors through observation or videotape, help teachers prepare for the assessment of essential, basic teaching competencies. First and second-year teachers' abilities are assessed using the INTASC standards. Teachers develop portfolios of their work, including videotapes of specific lessons that reflect the teaching expected by new student standards, analysis of student work, and written descriptions of ways in which they adapt instruction to the needs of individual learners.

Ensuring the quality of preparation programs and teachers entering the profession is one thing; assisting those already in teaching positions to help their students achieve national standards is the role of ongoing professional development. Therefore, a final recommendation related to teaching centers on this area:

4-D. Fund ongoing, high-quality professional development opportunities for teachers of science and mathematics based on standards for student learning and professional teaching.

Professional development is a common strategy used by states to support reform in science and mathematics education. For example, it is a high priority in 18 of the 25 states receiving NSF resources for statewide systemic initiatives. Although Zucker (1997) points out that, "delivering high-quality professional development is something that we as a nation know how to do," it is not always done well, nor may the nature of current professional development efforts serve the agenda of standards-based reform (Little, 1993).

Research on professional development indicates that formats common to science and mathematics teacher professional development, such as training workshops and institutes, may not always be appropriate for the changes that are both broad-scale (i.e., across departments and schools) and deep (through curriculum, teaching, and assessment), as required by current reforms (Fullan & Hargreaves, 1991; Little, 1993). Rather than relying on the "expert-driven" model

that takes teachers out of their schools to learn from outsiders, teachers need more opportunities that bring them together to learn in the context of their own programs, with their own students in mind (Ball, 1997; Ferrini-Mundy, 1997). Loucks-Horsley and her associates (in press) have described 15 different strategies for professional development, including professional networks, case discussions, mentoring for beginning teachers, and study groups, that can be combined in unique ways to meet the ongoing learning needs of teachers in their efforts to help students meet new and rigorous standards. Cohen and Hill (in preparation) have found in their research in California that professional development that is based on particular curricular materials is related strongly to student achievement.

Several states, including Colorado and Michigan, have developed standards for professional development in mathematics and science as guidelines for professional development planning by local educators and external "providers." In addition to encouraging new formats for professional development, these standards emphasize professional development as part of a teachers' daily work through opportunities for joint planning, curriculum and assessment work, research, and problem solving with colleagues. They also stress the importance of tying professional development to the curriculum teachers are teaching so they can put into practice what they are learning.

States are also sponsoring their own professional development programs. For example, a key component of the Arkansas Statewide Systemic Initiative is the teacher training and professional development programs that have been developed around the NCTM Standards, the NRC Standards, and the Arkansas Science and Mathematics Curriculum Frameworks. A professional development program of particular interest is the K-4 Crusade, a two-semester, standards-based course that is offered at 11 of the state's universities and is open to all K-4 teachers and administrators. Although it is not a mandatory program, the state's accreditation standards require that all teachers participate in 30 hours of professional development every year. The goal of the K-4 Crusade is to provide teachers with high-quality content, teaching strategies, critical-thinking skills, technology, and hands-on materials to strengthen their teaching practices. The belief behind the program is that high-quality professional development programs help teachers communicate curriculum materials to students more effectively and, consequently, may play a role in increasing a student's ability to learn.

California provides an example of a different approach to professional development for mathematics and science reform. In that state, professional networks are sponsored by several entities, including the state, the university system, and federal programs such as the NSF-funded statewide systemic initiative. The Subject Matter Projects, which offer summer institutes and follow-up support, occur in 11 curricular areas and focus on individual teacher development. The Mathematics Renaissance and California Science Implementation Network each work with hundreds of schools and their staffs in middle school mathematics and

elementary school science, respectively. These networks have a broad infrastructure staffed by teacher leaders who work to build school as well as individual teacher capacity for teaching aligned with the state frameworks and national standards.

Both the NCTM and NRC have had and will continue to have initiatives aimed at helping teachers learn what they need to know to better teach their students, through development of reports, and opportunities for dialogue. NCTM in particular has a standing committee focused on professional development. In addition, each of the 14 other NCTM standing committees has been charged to design a professional development strategy for the Board's consideration.

Recommendation 5. Assessment

Establish testing and assessment programs consistent with the goal of high expectations for all students to learn standards-based mathematics and science.

Assessment is a major component of efforts to promote improved student learning in mathematics and science. There are a number of instances where assessment has been used as a driver for reformed teaching practice, for example, in the states of Connecticut and Texas. The national standards argue for aligned changes in all areas of program, practice, and policy; changes in assessment need to be coordinated with state standards and frameworks. State roles in assessment are, as in teaching, many-fold. First, for purposes of accountability, states create state assessment systems and require or encourage their use by local educators. States sometimes impose high-stakes assessments with consequences for schools and districts. Also, states can support the development or identification and use of new forms of assessment by teachers and administrators, primarily for instructional purposes. States also can encourage teacher professional development in the area of assessment. All of these roles are addressed in the following recommendations:

5-A. Ensure that assessments of student learning are aligned with standards-based curriculum and assessment principles.

From the beginning of the standards-based reform movement, state policy makers have worked to create assessments that are aligned with their new content standards and curriculum frameworks. As with the development of standards and frameworks, progress in assessment development has been steady and incremental, although the speed of change has varied among states (Massell et al., 1997). A recent report of the Council of Chief State School Officers (1996b) indicates that, for the 1994-95 school year, 33 states had science assessments and 46 had mathematics assessments. Most assessments combined different forms of test items, with many using open-ended and response tasks. (See Figure 4 for more detail.)

FIGURE 4: Status of State Assessments, 1994-95 School Year

For science, 33 states had assessment programs. Nineteen of these used criterion-referenced tests; the same number used norm-referenced tests (the overlap means that some states used a combination of both). Of the 25 states that used non-traditional exercises, 5 used enhanced multiple choice items; 15 used extended response or short, open-ended response items; and 7 used individual performance tests. Twenty states have set performance standards or acceptable levels of school or student performance. For mathematics, 46 states had assessment programs. Thirty-one of these used criterion-referenced tests; the same number used norm-referenced tests (the overlap means that some states used a combination of both). Of the 35 states that used non-traditional exercises, 12 used enhanced multiple choice items; 31 used extended response or short, open-ended response items; and 8 used individual performance tests. Twenty-nine states have set performance standards or acceptable levels of school or student performance.

From: Council of Chief State School Officers (1996b). *State student assessment programs database for the 1994-95 school year.* Washington, D.C.: Author.

Gauging the alignment of new assessments with standards is a complex process (Webb, 1997). Interestingly, U.S. Department of Education Assistant Secretary for Elementary and Secondary Education, Gerald Tirozzi, noted that state standards as measured by states' own assessments may not be high enough (1997). According to Tirozzi, in several states, large percentages of students scored well on tests based on their state standards, while a far lower percentage did well on NAEP tests, which are perceived to be based on national standards. Although states generally are working on standards, existing state assessments may not yet be good indicators of the impact of these efforts.

As in other areas of the reform movement, many of the complexities of assessment have been revealed only as attempts to develop reliable, valid, and useful measures have progressed, and these measures have been implemented, either as pilots or full-scale. The SRI study of the 25 states funded by NSF for statewide systemic initiatives notes progress, but reports a mismatch in many states between the state goals established for student learning in standards and curriculum frameworks, and the content of state-mandated tests (Zucker, 1997). This is due, in part, to two difficulties in assessment development (Massell et al., 1997). The first difficulty stems from states' interests in having their assessments serve multiple purposes, in particular, both instructional improvement and accountability. This has resulted in technical problems as states have explored the promising uses of

performance assessments, such as ensuring reliability and validity. In an attempt to deal with these technical issues, some states have pooled their fiscal and intellectual resources in collaboratives focused on designing and piloting performance assessments, such as the New Standards Project and the State Collaborative on Assessment and Student Standards (SCASS) initiative of the Council of Chief State School Officers (CCSSO, 1997b).

One strategy to address political issues centered on assessment is to adopt a "mixed assessment model," which incorporates both multiple choice and performance items and targets basic as well as higher-order skills. Thus assessment has joined standards in this recent move towards "balance" in approach to reform, which seems to be leading to more public support and achievement of some, if not all, policy objectives (Massell et al., 1997).

Alignment of assessments with standards-based curriculum is a simple idea, but, as noted, fraught with challenges. Our recommendation is that policy makers "stay the course" in working towards this goal, continuing to make progress, if slower than some have hoped.

5-B. Develop at the state level, or encourage local districts to develop, strong accountability systems that go beyond single-measure tests.

An issue that every state and district must address is how to show progress in standards-based reforms while the plan is unfolding. Gains in student learning are unlikely to be demonstrated immediately, given that assessment systems aligned with standards are under development and changes may not have occurred or stabilized in teaching practices. States should establish intermediate milestones, such as specific changes in district policies and curriculum, numbers of students enrolled in reformulated courses, and changes in teaching practices, then monitor these indicators and hold themselves accountable over time. An explicit plan with defined milestones to indicate progress can help sustain support by the public, policy makers, business, and professional educators.

Kentucky provides an example of a state that has devised a new approach to statewide assessment. The Kentucky Instructional Results and Information System (KIRIS) represents a comprehensive use of performance assessments as part of the state's accountability system. Over time the state has developed an accountability index that incorporates information from student performance tasks, multiple choice items, and mathematics portfolios.

As another state example, the Texas Academic Excellence Indicator System (AEIS) is a report card for schools and districts that provides a comprehensive set of indicators for school success. The accountability system provides appropriate rewards to schools and districts for high performance and equity, and sanctions for low performance and inequity, by reporting performance not only for a school or

district, but also for various ethnic, gender, and socio-economic groups within the school or district. Schools must show comparable performance across all subgroups, with state-defined target performance rates raised each year to ensure growth toward equally high performance among all groups. AEIS indicators include, among others, student performance on the state assessment program and on other standardized measures, correlations between grades and performance, data on participation in advanced academic programs, and data on dropouts and attendance. This accountability system is based on the state's mandated standards-based curriculum as measured on the state assessment.

Although multiple measures are critical to understanding and documenting student learning, states and districts must guard against overtesting. Burdening students, teachers, and schools with undue data collection takes away from important instructional time and attendance.

5-C. Collect and use information about learning conditions and the opportunities students have to learn.

With the standards movement largely directed at helping students reach ambitious learning goals, it is easy for assessment to be viewed primarily as measures of student learning. Yet teachers, principals, and local educators responsible for designing and delivering high quality science and mathematics education cannot make informed decisions without meaningful data about what actually goes on in classrooms: data on curriculum, instruction, and classroom conditions. As Martin, Blank, and Smithson (1996, p. 2) point out, "Clearly, a key ingredient to sound policy and program decisions is accurate and relevant information." A major component of the State Collaborative on Assessment and Student Standards (SCASS), a project of the Council of Chief State School Officers, addresses the issue that education systems are not well organized to systematically collect and report the kinds of data that are helpful for such decisions.

Both national and international studies have pointed out the importance of having such data—called students' *opportunity to learn*—in order to interpret student test scores (Porter, Kirst, Osthoff, Smithson, & Schneider, 1993; Schmidt et al., 1996; Stigler et al., in press). The connection between student learning and the teaching, curriculum, assessment, and support that are required for it to be successful is an important theme in both the NRC and NCTM Standards. It is also key to achieving the "science and mathematics for all" vision, for without opportunities for learning, *all* students cannot develop the concepts and skills described in the content standards for mathematics and science. A recent report of the NRC (1997c), which commented on the proposed national test in mathematics, makes this argument also: "It will be very difficult to interpret test results meaningfully, and to make constructive use of them, without a measure of what opportunities students have had to learn the mathematics that is being tested" (p.3).

Many states have addressed the need to assess students' opportunity to learn. Some have done so through involvement with SCASS. In New Jersey, state leadership has "openly embraced opportunity-to-learn standards as part of a strategic plan to improve education and address equity" (Massell et al., 1997, p. 48).

5-D. Assist schools and the general community to understand and use the results of assessments and develop action plans based on results.

Reflection and understanding based on observation and evidence are at the core of science and mathematics. Assessment of student progress should be based on multiple sources of evidence. State reporting systems caution against reading too much into a single score and against using assessment results for purposes that do not match those for which the assessment was designed.

Public understanding and support are especially important in the area of assessment. Educators face a number of challenges in developing and maintaining public support for new assessments. In some cases, students who score well on traditional assessments have not done well on new ones, resulting in opposition to the new tests. Because test development is so technical, the strategy of involving people so as to gain their ownership and support is problematic. New laws in both Texas and California incorporate non-educator involvement in test development; it is unclear how this will influence future directions in these states and in other locations. Public relations efforts to help promote understanding of unfamiliar assessment strategies are needed (NRC, 1997c).

States have an important role in providing resources, supporting, and encouraging local educators to build systems at district, school, and classroom levels to gather appropriate information from assessment for use in design and improvement of standards-based education for their students. This role can be played in different ways, from the more direct requirement for school plans based on data, to the support of professional development for teachers and administrators to learn alternative approaches to classroom assessment. At the national level, an action strategy for improving middle grades mathematics education is being developed simultaneously with the national eighth grade mathematics exam. This may prove to be an example of how assessment and a strategy for improvement can be linked.

5-E. Promote teacher assessment and student self-assessment in classrooms, based on standards.

Both the NRC and NCTM assessment standards make a strong case for assessment in the service of instruction. Some of the issues involved are addressed by two NRC publications, *Measuring What Counts: A Conceptual Guide for Mathematics Assessment* (1993a) and *Measuring Up: Prototypes for Mathematics*

Assessment (1993b), developed with contributions from NCTM leaders. These sources establish crucial research-based connections between standards and assessment, and provide examples of new assessment exercises that can be appropriately embedded in instruction. Because new forms of assessment, measuring the new learning goals represented in the Standards, are substantially different from teachers' common practice, professional development is crucial. Not only must teachers change their practices, they must also help their students, parents, and the community understand the purposes, procedures, and benefits of such changes. To the extent that assessments drive instruction, assessments that provide authentic pictures of student learning can be important sources of both pressure and information for educators as they work to implement standards.

CONCLUSION

The national standards in mathematics and science developed by the National Council of Teachers of Mathematics and the National Research Council comprise an important foundation for the changes that must occur if our students are to achieve to world-class levels and become the informed and literate citizens needed for the 21st century. States have made substantial and steady progress in their constitutionally mandated role of educating their students, launching reform initiatives in the important areas of curriculum, textbooks, teaching, and assessment, and building their infrastructures to support change. Support from the President, the nation's governors, and key business leaders has converged with the results of international studies that give substantial guidance for mathematics and science education reform.

The actions identified in this report represent a way to meld the experiences and strategies of those who wrote and support the national standards with activities of the states as they move forward in standards-based reform, to the ultimate benefit of all students in the United States.

REFERENCES

American Association for the Advancement of Science (AAAS). (1989). *Science for all Americans*. Washington, DC: Oxford University Press.

American Federation of Teachers and the National Center for Improving Science Education. (1997). *What students abroad are expected to know about mathematics*. Washington, DC: Author.

Andrews, G. A. (1997). Commentary on assessment standards for school mathematics. *Notices of the American Mathematical Society. 44(4)*, 458-462.

Ball, D. L. (1997). Developing mathematics reform: What don't we know about teacher learning—but would make good working hypotheses. In S. N. Freil & G. W. Bright (Eds.). *Reflecting on Our Work: NSF Teacher Enhancement in K-6 Mathematics* (pp.77-112). Lanham, MD: University Press of America, Inc.

Bass, H. (1997). Mathematicians as educators. *Notices of the American Mathematical Society, 44*(1), 18-21.

Black, P., & Atkin, J. M. (Eds.). (1996). *Changing the subject: Innovations in science, mathematics, and technology education*. London and USA: Routledge.

Bybee, R. W. (Ed.). (1996). *National standards and the science curriculum: Challenges, opportunities, and recommendations*. Dubuque, IA: Kendall/Hunt.

Bybee, R. W. (1997). *A strategy for standards-based reform of science and mathematics education*. Unpublished manuscript.

Campbell, P. (1995). *Project IMPACT: Increasing the mathematics power for all children and teachers (Phase I, Final Report)*. College Park, MD: Center for Mathematics Education, University of Maryland, College Park.

Cobb, P., Wood, T., Yackel, E., Nichols, J., Wheatley, G., Trigatti, B., & Perlwitz, M. (1991). Assessment of a problem-centered second-grade mathematics project. *Journal for Research in Mathematics Education, 22*, 3-29.

Cohen, D.(1990). A revolution in one classroom: The case of Mrs. Oublier. *Educational Evaluation and Policy Analysis, 12(3)*, 311-329.

Collins, A. (1995). *National science education standards* in the United States: A process and a product. *Studies in Science Education, 26*, 7-37.

Connecticut Academy for Education in Mathematics, Science, and Technology. (1996). *The case for more time and better use of time in Connecticut schools.* Middletown, CT: Author.

Consortium for Policy Research in Education (CPRE). (1996). *Public policy and school reform.* Philadelphia, PA: CPRE Publications.

Council of Chief State School Officers (CCSSO). (1996a). *Key state education policies on K-12 education content standards, graduation, teacher licensure, time and attendance.* Washington, DC: Author

Council of Chief State School Officers (CCSSO). (1996b). *State student assessment programs database for the 1994-95 school year.* Washington, DC: Author

Council of Chief State School Officers (CCSSO). (1997a). *Mathematics and science content standards and curriculum frameworks: States' progress on development and implementation.* Washington, DC: Author.

Council of Chief State School Officers (CCSSO). (1997b). *SCASS science project: Consensus guidelines for science assessment.* Washington, DC: Author.

Elmore, R.F. (1996). Getting to scale with good educational practice. *Harvard Educational Review, 66 (1),* 1-26.

Ferrini-Mundy, J. (1997). Reform efforts in mathematics education: Reckoning with the realities. In S. N. Freil & G. W. Bright (Eds.), *Reflecting on Our Work: NSF Teacher Enhancement in K-6 Mathematics* (pp.113-132). Lanham, MD: University Press of America, Inc.

Ferrini-Mundy, J., & Schram, T. (Eds.). (1997). *The recognizing and recording reform in mathematics education project: Insights, issues, and implications* (Journal for Research in Mathematics Education, Monograph Number 8). Reston, VA: NCTM.

Fullan, M., & Hargreaves, A. (1991). *What's worth fighting for? Working together for your school.* Andover, MA: The Regional Laboratory for Educational Improvement of the Northeast and Islands.

Fullan, M. (with Steigelbauer, S.). (1991). *The new meaning of educational change (second edition).* New York: Teachers College Press.

Gawronski, J., Porter, A., & Schoen, H. (1989, September). *Final report of the NCTM task force on monitoring the effects of the Standards.* Reston, VA: NCTM.

Hall, G. E., & Hord, S. M. (1987). *Change in schools: Facilitating the process.* Albany, NY: State University of New York Press.

Heid, M. K. (1988). Resequencing skills and concepts in applied calculus using the computer as a tool. *Journal for Research in Mathematics Education, 19,* 3-25.

Hembree, R., & Dessart, D. (1986). Effects of hand held calculators in precollege mathematics education: A meta-analysis. *Journal for Research in Mathematics Education, 17,* 83-89.

Hiebert J., & Wearne, D. (1993). Instructional tasks, classroom discourse in students in second grade arithmetic. *American Educational Research Journal, 301,* 393-425.

Hoover, M. N., Zawojewski, J. S., & Ridgeway J. (1997). *Effects of the connected mathematics project on student attainment.* Paper presented at the national AERA Conference, Chicago.

Hutchinson, J., & Huberman, M. (1993, May). *Knowledge dissemination and use in science and mathematics education: A literature review.* Prepared for the Directorate of Education and Human Resources, Division of Research, Evaluation and Dissemination, National Science Foundation by The Network.

Kirst, M. W., & Bird, R. (1996). *The politics of developing and maintaining math and science curriculum standards.* Madison, WI: National Institute of Science Education

Lawton, M. (1996, August 7). AFT report: States lagging on standards. *Education Week,* 1.

Little, J. W. (1993). Teacher's professional development in a climate of educational reform. *Educational Evaluation and Policy Analysis. 15(2),* 129-151.

Loucks-Horsley, S., Kapitan, R., Carlson, M. O., Kuerbis, P. J., Clark, R. C., Melle, G. M., Sachse, T. P., & Walton, E. (1990). *Elementary school science for the 90's.* Alexandria, VA: Association for Supervisor and Curriculum Development and Andover, MA: The Network, Inc.

Loucks-Horsley, S., Hewson, P. W., Love, N. & Stiles, K. E. (in press). *Designing professional development for teachers of science and mathematics.* Thousand Oaks, CA: Corwin Press.

Martin, M., Blank, R., & Smithson, J. (1996). *SCASS science assessment: Measures of the enacted curriculum.* Washington, DC: Council of Chief State School Officers.

Massell, D., Kirst, M., & Hoppe, M. (1997). *Persistence and change: Standards-based reform in nine states.* Brunswick, NJ: Consortium for Policy Research in Education.

McLeod, D. B., Stake, R. E., Schappelle, B. P., Mellissinos, M., & Gierl, M. J. (1996). Setting the standards: NCTM's role in the reform of mathematics education. In S. A. Raizen & E. D. Britton (Eds.), *Bold ventures, case studies of U.S. innovations in mathematics education* (pp. 13-133). Boston, MA: Kluwer.

National Advisory Committee on Mathematical Education. (1975). *Overview and analysis of school mathematics grades K-12*. Washington, DC: Conference Board of the Mathematical Sciences.

National Board for Professional Teaching Standards (NBPTS). (1994). *What teachers should know and be able to do*. Detroit, MI: Author.

National Center for Educational Statistics (NCES). (1996). *Pursuing excellence: A study of U.S. eighth grade mathematics and science teaching, learning, curriculum, and achievement in international context.* Washington, DC: U.S. Government Printing Office.

National Center for Educational Statistics (NCES). (1997). *Pursing excellence: A study of U.S. fourth-grade mathematics and science achievement in international context.* Washington, DC: U.S. Government Printing Office

National Commission on Excellence in Education (NCEE). (1983). *A nation at risk: The imperative for educational reform*. Washington, DC: U.S. Government Printing Office.

National Commission on Teaching & America's Future (NCTAF). (1996). *What matters most: Teaching for America's future*. New York: Author.

National Council of Teachers of Mathematics (NCTM). (1980). *An agenda for action*. Reston, VA: Author.

National Council of Teachers of Mathematics (NCTM). (1989). *Curriculum and evaluation standards for school mathematics*. Reston, VA: Author.

National Council of Teachers of Mathematics (NCTM). (1991). *Professional standards for teaching mathematics*. Reston, VA: Author.

National Council of Teachers of Mathematics (NCTM). (1995a). *Assessment standards for school mathematics*. Reston, VA: Author.

National Council of Teachers of Mathematics (NCTM). (1995b). *Strategic plan of the national council of teachers of mathematics*. Reston, VA: Author.

National Council of Teachers of Mathematics (NCTM). (1996a). *Mathematics: An introduction to the NCTM standards*. Reston, VA: Author.

National Council of Teachers of Mathematics (NCTM). (1996b). *Making a living, making a life.* Reston, VA: Author.

National Research Council (NRC). (1989). *Everybody counts.* Washington, DC: National Academy Press.

National Research Council (NRC). (1993a). *Measuring what counts: A conceptual guide for mathematics assessment.* Washington, DC: National Academy Press.

National Research Council (NRC). (1993b). *Measuring up: Prototypes for mathematics assessment.* Washington, DC: National Academy Press.

National Research Council (NRC). (1995a). *The preparation of teachers of mathematics: Considerations and challenges.* Washington, DC: National Academy Press.

National Research Council (NRC). (1995b). *Response document from national review of the national science education standards.* Washington, DC: National Academy Press.

National Research Council (NRC). (1996a). *The national science education standards.* Washington, DC: National Academy Press.

National Research Council (NRC). (1996b). *Improving teacher preparation and credentialing consistent with the national science education standards.* Washington, DC: National Academy Press.

National Research Council (NRC). (1997a). *Introducing the National Science Education Standards.* Washington, DC: National Academy Press.

National Research Council (NRC). (1997b). *Science teacher preparation in an era of standards-based reform.* Washington, DC: National Academy Press.

National Research Council (NRC). (1997c). *Toward excellence in K-8 mathematics.* Washington, DC: National Academy Press.

National Science Resources Center (NSRC). (1997). *Science for all children.* Washington, DC: National Academy Press.

National Science Teachers Association (NSTA). (1992). *Scope, sequence and coordination of secondary school science. Vol. 1. The content core: A guide for curriculum developers.* Washington, DC: Author.

National Science Teachers Association (NSTA). (1997). Spring Reports. Arlington, VA: Author.

O'Day, J., Goertz, M.E., & Floden, R.E. (1995). *Building capacity for education reform.* CPRE Policy Briefs RB-18. New Brunswick, NJ: Consortium for Policy Research in Education.

O'Sullivan, C. Y., Reese, C. M., & Mazzeo, J. (1997). *NAEP 1996 science report card for the nation and the states: Findings from the National Assessment of Educational Progress.* Washington, DC: U.S. Department of Education, National Center for Education Statistics.

Porter, A. C., Kirst, M. W., Osthoff, E. J., Smithson, J. L., & Schneider, S. A. (1993). *Reform up close: A classroom analysis.* Final Report to the NSF on Grant No. SPA-8953446 to the Consortium for Policy Research in Education. Madison, WI: Wisconsin Center for Education Research.

Raizen, S. A., & Britton, E. D. (Eds.). (1996). *Bold ventures. Volume 3. Case studies of U.S. innovations in mathematics education.* Dordrecht, The Netherlands: Kluwer.

Reese, C. M., Miller, K. E., Mazzeo, J., & Dossey, J. (1997). *NAEP 1996 mathematics report card for the nation and the states: Findings from the National Assessment of Educational Progress.* Washington, DC: U.S. Department of Education, National Center for Education Statistics.

Romberg, T. A. (1992) The scholarly basis of the school mathematics reform in the U.S. *The International Journal of Education Reform, 17(95),* 419-437.

Rosenholtz, S. (1989). *Teachers' workplace: The social organization of schools.* New York: Longman.

Schmidt, W. H., Jorde, D., Cogan, L. S., Barrier, E., Gonzalo, I., Moser, U., Shimizu, K., Sawada, T., Valverde, G. A., McKnight, C., Prawat, R. S., Wiley, D. E., Raizen, S. A., Britton, E. D., & Wolfe, R. G. (1996). *Characterizing pedagogical flow: An investigation of mathematics and science teaching in six countries.* Dordrecht, The Netherlands: Kluwer.

Schmidt, W. H., McKnight, C. C., & Raizen, S. A. (1997). *A splintered vision: An investigation of U.S. science and mathematics education.* Dordreht, The Netherlands: Kluwer.

Schoen, H. L. (1988). *NCTM 9-12 Standards: Reflections from research.* Paper presented at the Research Presession of the Annual Meeting of the National Council of Teachers of Mathematics.

Smith, M., & O'Day, J. (1991). Systemic school reform. In S. Fuhrman & B. Melen (Eds.), *The politics of curriculum and testing* (pp. 223-267). New York: Taylor & Francis Ltd.

Steen, L. A. (Ed.). (1990). *On the shoulders of giants: New approaches to numeracy.* Washington, DC: National Academy Press.

Stein, M. K., & Lane, S. (1996). Instructional tasks and the development of student capacity to think and reason: An analysis of the relationship between teaching and learning in a reform mathematics project. *Educational Research and Evaluation, 2(1),* 50-80.

Stein, M. K., Lane, S., & Silver, E. A. (1996, April). *Classrooms in which students successfully acquire mathematical proficiency: What are the critical features of teachers' instructional practice?* Paper presented at the annual meeting of the American Educational Research Association, New York, NY.

Stigler, J. et al. (in press). *The TIMSS videotape classroom study: Methods and preliminary findings.* Washington, DC: U.S. Department of Education.

Tirozzi, G. (1997, April). Presentation made at annual meeting of the National Science Teachers Association, New Orleans, LA.

Tyson, H. (1997, July). *Overcoming structural barriers to good textbooks.* Paper prepared for the National Education Goals Panel.

Watts, G. D., & Castle, S. (1993). The time dilemma in school restructuring. *Phi Delta Kappan, 75,* 306-310.

Webb, N. (1997). *Criteria for alignment of expectations and assessments in mathematics and science.* Madison, WI: National Institute for Science Education and Council of Chief State School Officers.

Webb, N. L., & Dowling, M. (1996). *Impact of the Interactive Mathematics Program on the retention of underrepresented students: Cross-school analysis of transcripts for the Class of 1993 for three high schools.* Project Report 96-2 from the Interactive Mathematics Program Evaluation Project. Madison, WI: Wisconsin Center for Education Research.

Webb, N. L., & Dowling, M. (1997). *Comparison of IMP students with students enrolled in traditional courses on probability, statistics, problem solving, and reasoning.* Project Report 97-1 from the Interactive Mathematics Program Evaluation Project. Madison, WI: Wisconsin Center for Education Research.

Weiss, I. R., Upton, J., & Nelson, B. (1992). *The road to reform in mathematics education: How far have we traveled?* Reston, VA: NCTM.

Weiss, I. R., Matti, M. C., & Smith, P. S. (1994). *Report of the 1993 national survey of science and mathematics education.* Chapel Hill, NC: Horizon Research.

Woodward, A., & Elliott, D. L. (1990). Textbooks: Consensus and controversy. In, *Textbooks and schooling in the United States: Eighty-ninth yearbook of the National Society for the Study of Education, Part I.* Chicago, IL: University of Chicago Press.

Zucker, A. A., Shields, P. M., Adelman, N., & Powell, J. (1995). *Evaluation of the National Science Foundation's statewide systemic initiatives (SSI) program: Second-year report, cross-cutting themes.* Washington, DC: National Science Foundation.

Zucker, A. A. (with Shields, P. M., Adelman, N., & Humphrey D.). (1997). *Reflections on state efforts to improve mathematics and science education in light of findings from TIMSS.* Menlo Park, CA: SRI International

APPENDIX A

EXPERT PANEL MEMBERS AND CONTRIBUTERS TO DRAFT REPORT

J. MYRON ATKIN
Professor
School of Education
Stanford University

DEBORAH BALL
Professor
School of Education
University of Michigan

JERRY BECKER
Professor of Curriculum and Instruction
Southern Illinois University, Carbondale

ROLF BLANK
Director of State Education Indicators
State Education Assessment Center
Council of Chief State School Officers

CATHY BROWN
Mathematics Assessment Specialist
Oregon Department of Education

DAVIS CAMPBELL
Executive Director
California School Boards Association

PAT CAMPBELL
President
Campbell-Kibbler Associates

BETTY CARVELLAS
President
National Association of Biology Teachers

LORING (TERRY) COES
Chair
Department of Mathematics
Rocky Hill School

DWIGHT COOLEY
Teacher
Mary Louise Phillips Elementary School
Fort Worth Independent School District

SHARI A. W. COSTON
Executive Director
Arkansas Education Renewal Consortium
Henderson State University

JOAN DONAHUE
Executive Director
National Alliance of State Science and Mathematics Coalitions

SHELLEY FERGUSON
Teacher
California Mathematics Project

ALICE GILL
Associate Director, Educational Issues Department
American Federation of Teachers

MARY GROMKO
State Science Consultant
Colorado Department of Education

GLEN HARVEY
Executive Director
Learning Innovations

HECTOR HIRIGOYEN
District Mathematics Supervisor
Dade County Public Schools

WILLIAM HUNT
President
Council of Presidential Awardees in Mathematics

HOWARD JOHNSON
Dean
Syracuse University Graduate School

GLENDA LAPPAN
Professor of Mathematics
Michigan State University

STEVE LEINWAND
Mathematics Consultant
Connecticut State Department of Education

JAMES LEITZEL
Professor of Mathematics
University of New Hampshire

WILLIAM LINDER-SCHOLER
Executive Director
SciMath MN

RICHARD LONG
Government Relations Specialist
National Council of Teachers of Mathematics

MARIA ALICIA LOPEZ-FREEMAN
Deputy Executive Director
California Science Project

JOHNNY LOTT
Co-Director
SIMMS Project
The University of Montana

MARI MURI
Mathematics Consultant
Connecticut State Department of Education

GEORGE (PINKY) NELSON
Deputy Director
Project 2061
American Association for the Advancement of Science

MARJORIE PETIT
Deputy Commissioner
Department of Education
State of Vermont

SANDRA POWERS
Dean of Undergraduate Studies
College of Charleston

LINDA ROSEN
Executive Director
National Council of Teachers of Mathematics

ELAINE ROSENFELD
Teacher
San Luis Coastal Unified School District

JOESPH ROSENSTEIN
Professor of Mathematics
Rutgers University

RICHARD SCHOEN
Professor of Mathematics
Stanford University

THEODORE SCHULTZ
Consultant, Education and Outreach Division
American Physical Society

CATHY SEELEY
Director of Policy and Research
Texas Statewide Systemic Initiative

WILLIAM SPOONER
Director, Instructional Services
Department of Public Instruction
Public Schools of North Carolina

SCOTT STOWELL
Science Curriculum Coordinator
Spokane School District

ZALMAN USISKIN
Director
The School Mathematics Project
University of Chicago

BENCHMARKS AND STANDARDS AS TOOLS FOR SCIENCE EDUCATION REFORM

By:
George D. Nelson
Deputy Director, Project 2061
American Association for the Advancement of Science

July 1997

This paper is also available on-line at http://www.aaas.org

This paper was commissioned by the National Education Goals Panel (Purchase Order Number 4331J700014), for release at its meeting on July 30, 1997. The opinions and recommendations expressed in this paper are those of the author and do not necessarily reflect those of the Goals Panel or its members.

Benchmarks and Standards as Tools for Science Education Reform

To many educators, parents, business leaders, and politicians, "high academic standards" have become the last, best hope for saving America's schools. For some, the milestones along the road to reform are clearly marked: develop high academic standards; hold students, teachers, and schools accountable; then administer rewards and punishments as needed. But most realize that standards are tools that must be used skillfully if they are to get the job done. And not everyone agrees on exactly what the job is that needs doing. Is it to meet the goal of having U.S. students lead the world in science and mathematics? Is this goal consistent with the goal of science literacy for all students which has guided the reform effort in science and mathematics for more than a decade? How far can the development of high academic standards carry the reform movement? What other tools are needed? What are the most critical next steps?

For more than a decade the American Association for the Advancement of Science (AAAS) has been deeply involved in the movement to reform science and mathematics education around standards. Through Project 2061, its long-term reform initiative, AAAS has been in the vanguard of efforts to define the knowledge and skills that all students should have in science, mathematics, and technology and to center other education reforms on those goals. Project 2061's strategy is to develop a coordinated set of reform tools educators can use to design curricula keyed to national learning goals but suited to local circumstances—tools that can also be used in selecting and creating instructional materials and assessment instruments and in guiding teacher professional development. Project 2061's strategy encourages educators to consider the interrelated nature of the education system and the implications that reform in one area will have for all the others.

Through its Directorate for Education and Human Resources, AAAS has worked extensively with a wide variety of community-based entities, such as churches, clubs, museums and science centers, and local media. The goals of these efforts are to expand the participation in science and mathematics of women, minorities, and people with disabilities and to increase public understanding and appreciation of science and mathematics.

With its broad interests in science, policy, and education, AAAS has had opportunities to work with many of those who have a stake in reform, from concerned scientists and engineers to textbook publishers; political, corporate, and foundation leaders; parents and families; university and college faculty; state science supervisors; school district superintendents; high school principals; and classroom teachers. Through its interactions with reformers at every level of the education system, AAAS has come to recognize that, in a nation of some 15,000 school districts, there will be no "one size fits all" approach to reform.

Drawing on the experiences of AAAS and, in particular, Project 2061, this paper begins with a brief look at the current state of K-12 science and mathematics education, a review of the development of benchmarks and standards in science and mathematics, and a look at the current state of science and mathematics education. It will then suggest ways that benchmarks and standards can be put to use at the national, state, and local levels; summarize Project 2061's work to support standards-based reform; and recommend some next steps for reforming education in science, mathematics, and other disciplines.

The Call for Standards-Based Reform

Reform sometimes appears to be the great American pastime. Education has been a frequent target of change, and virtually every aspect of schooling has come under scrutiny at one time or another. Reflecting both the benefits and drawbacks of the decentralized nature of the U.S. education system, a dizzying array of reform efforts have shone brightly for a few years then faded. Measuring the impact of any one of these efforts would be difficult, yet there was faith that in the aggregate, they would make a difference. Unfortunately, they have not.

In the area of science and mathematics, the focus of this paper, student achievement as measured by the National Assessment of Educational Progress declined steadily from 1970 through the early 1980s from an already unacceptable level (National Center for Education Statistics 1997). The release in 1983 of *A Nation at Risk: The Imperative for Education Reform* by the National Commission on Excellence in Education warned of a national education crisis, and dozens of reports issued over the next few years supported the commission's conclusions and called for action.

In response to these alarms, a number of new efforts to improve science and mathematics education began, spurred on by the historic 1989 summit of governors, corporate leaders, and educators in Charlottesville, Virginia. Once again, the reform landscape was soon crowded with projects, initiatives, collaboratives, centers, institutes, partnerships, consortia, and more. The most promising of these to emerge over the past decade or so share two common concerns: improving the *quality* of science and mathematics education and increasing the *accessibility* of science and mathematics education to students who had not participated previously. These concerns are reflected in the National Education Goals and their emphasis on high achievement, particularly in science and mathematics, by *all* students. And implicit in the National Education Goals' call for improved academic achievement is the "belief that its attainment is dependent on the development of rigorous academic standards" (National Education Goals Panel 1995).

Science and Mathematics Education Reform

Fortunately, in science and mathematics such standards or benchmarks already exist, although they have yet to be fully implemented in the nation's schools (Zucker,

Young, and Luczak 1996). In 1989, Project 2061 of the American Association for the Advancement of Science released *Science for All Americans*, a report to the nation on what constitutes literacy in science, mathematics, and technology and the steps necessary to achieve it. Later that year, the National Council of Teachers of Mathematics (NCTM) released its *Curriculum and Evaluation Standards for School Mathematics*, the first set of such guidelines to be labeled "standards."

By 1993 Project 2061 had gone on to develop *Benchmarks for Science Literacy*, a coherent set of specific K-12 learning goals to enable educators to help students achieve science literacy by the time they graduate high school. Project 2061's work on *Science for All Americans* and *Benchmarks for Science Literacy* served as a foundation for the subsequent *National Science Education Standards* (*NSES*) published by the National Research Council in 1996.

There is a great deal of congruence between the work of Project 2061 and the National Research Council; some estimates put the overlap of content standards and benchmarks at 90% or more (American Association for the Advancement of Science, 1997). Similarly, Project 2061's benchmarks for mathematics are quite compatible with the national mathematics standards developed by NCTM. With regard to philosophy, intent, and expectations, *Benchmarks*, *NSES*, and NCTM *Standards* share the following characteristics:

- a commitment to reducing the number of topics students are taught, to allow time for them to concentrate on, learn, and retain the most important ideas;
- a common core of ideas and understandings about science and mathematics that *all* students should know, with similar grade placement, level of detail, and difficulty;
- a recognition that some students can and will go beyond the core content—but that currently most do not.

Differences among the documents do exist. To identify where and how the documents differ, Project 2061 has published detailed comparisons of its *Benchmarks* to each set of national content standards in science, mathematics, and social studies (American Association for the Advancement of Science 1997). Nevertheless, the documents' strong similarities suggest that standards developers in other content areas will find these useful models for their own work.

There is now broad consensus on learning goals within the scientific, mathematical, and educational communities. Reformers have devoted a good deal of their resources to building this widespread agreement. For example, Project 2061's *Science for All Americans* and *Benchmarks for Science Literacy* taken together with the National Research Council's science content standards represent the collective wisdom of more than a thousand individual scientists and educators and hundreds of professional organizations, all involved in the development, creation, and review of these national documents.

Although it is too early to measure the impact of science and mathematics standards or benchmarks on student performance, it is important to develop a baseline against which future performance can be measured. A thorough analysis of the currently available data will be invaluable to the reform effort, but is far beyond the scope of this paper. For now, simply drawing attention to some of the more meaningful indicators in science and mathematics education will shed light on changes since 1989.

Student Achievement. According to data presented in the National Science Foundation's *Indicators of Science and Mathematics Education 1995*, student performance on a variety of science and mathematics tests has improved slightly over the past 15 years but is still far from a level that is consistent with science literacy. Differences among the scores of various racial and ethnic groups have narrowed, although black and Hispanic students continue to score below their white counterparts. Few differences now exist between male and female performance at the pre-college level, but males score significantly higher in science and mathematics on college entrance exams (Suter 1996).

Newly released data from the Third International Mathematics and Science Study (TIMSS) for 41 countries highlight the continuing problems in U.S. science and mathematics education. While scores for U.S. fourth graders in both science and mathematics ranked in the top and middle tiers respectively, the performance of U.S. eighth graders was only slightly above the median in science and below it in mathematics (Schmidt, McKnight, and Raizen 1996). A great deal more study of the TIMSS data and the TIMSS tests themselves will be required to understand fully what their implications are for U.S. science and mathematics education. What TIMSS, the National Assessment of Educational Progress (NAEP), and other tests do reveal quite clearly is that science literacy is far from a reality for the vast majority of U.S. students (and of the rest of the world as well).

Curriculum and Instruction. The amount of time that elementary students spend studying science and mathematics increased slightly between 1977 and 1993, according to the 1993 National Survey of Science and Mathematics Education. More encouraging is the news that greater numbers of high school students are taking mathematics and science courses–56% of high school graduates completed chemistry in 1992 compared to 32% in 1982, and 56% completed algebra II in 1992 compared to 37% in 1982 (Suter 1996).

Nevertheless, taking courses does not guarantee results, as the TIMSS and NAEP data so clearly show. Data from the TIMSS analysis of curriculum and instruction around the world demonstrate significant U.S. shortcomings compared to countries with better-performing students. According to the TIMSS findings, U.S. curricula, textbooks, and teaching lack focus, emphasize quantity over quality, and are all "a mile wide and an inch deep" (Schmidt, McKnight, and Raizen 1997). Indeed, many of the recommendations in *Benchmarks for Science Literacy* and the national standards in science and in mathematics education attempt to remedy these same shortcomings in curriculum and instruction. The

seriousness of the challenge faced by education reformers is compounded by a number of other indicators—that the most common classroom resource is the textbook, that the most prevalent instructional activity in high school science classes is listening to the teacher and taking notes, and that one-half of all high school science teachers believe—contrary to cognitive research findings—that students should "learn basic scientific terms and formulas before learning underlying concepts and principles" (Suter 1996).

There has been a great deal of activity at the state level to develop or revise curriculum frameworks that would guide state policies and teacher practice. According to a review of state frameworks in science and mathematics by the Council of Chief State School Officers (Blank 1995), 10 of 16 completed science frameworks claimed to match recommendations from Project 2061's *Science for All Americans* and *Benchmarks* and the National Research Council's science standards.

For its evaluation of Project 2061's impact and influence, SRI International examined 43 state frameworks, content standards, or equivalent documents to determine the level of influence Project 2061 may have had on them. In addition, it convened an expert group of 20 educators to assess the quality of the state documents in terms of their adherence to national standards and benchmarks. According to SRI, "despite statements and charts in framework documents that claim alignment with national documents, the reviewers found some common gaps." In many cases, the frameworks omitted major content areas, simplified concepts, or diluted them. With regard to equity issues, many of the frameworks lacked concrete examples of how the state would ensure science literacy for all students (Zucker, Young, and Luczak 1996).

Teacher qualifications. Nearly 30% of high-school science teachers and 40% of high-school mathematics teachers lack an undergraduate or graduate major in those disciplines or in science or mathematics education. Not surprisingly, less than 5% of elementary school science and mathematics teachers had these majors (Suter 1996). According to the 1993 National Survey of Science and Mathematics Education (Suter 1996), few science and mathematics teachers spend much time in professional development activities in their field. For example, approximately half of high school science and mathematics teachers surveyed had only 16 hours of in-service education over the previous three years. The survey did show, however, that participation increased between 1986 and 1993 (Suter 1996).

To bring about more widespread, meaningful reform of K-12 education—the standards-based reform envisioned by the National Education Goals Panel—requires the incorporation of benchmarks and standards into many of the important tasks educators perform every day. Decisions on virtually every aspect of education must take into account the long-term goals implicit in high academic standards.

What Benchmarks and Standards Can Do

Used wisely, national standards and benchmarks in science and mathematics can give states and school districts a solid conceptual basis for reforming K-12 education.

Although standards alone cannot bring about all the necessary reforms, when used with effective implementation tools, they can make it possible to do some things better. For example, educators at the state and local levels can use benchmarks or standards to:

Define the territory. State and local curriculum framework developers can use benchmarks and standards to describe the knowledge and skills they want their students to have. By aligning state frameworks with credible, widely-accepted national guidelines, state education leaders will be able to build support for their frameworks more rapidly. They will also be able to take advantage of implementation tools that are being developed to support these national guidelines.

Promote K-12 coherence. Research tells us that learning requires making connections between ideas and creating linkages that make sense in a larger context. Unfortunately, as the data from TIMSS indicate, the U.S. curriculum is too often a series of disjointed ideas and experiences, lacking both focus and coherence. This was an important issue for the scientists, mathematicians, and educators who created *Benchmarks*, so they built into the document itself the conceptual coherence and the cross-grade, cross-discipline connections that are needed.

Rationalize curriculum, instruction, and assessment. Decisions about what to teach, how to teach, and how to evaluate what students have learned are among the most important choices educators make. While there are many reasonable criteria for making such decisions, only by carefully evaluating textbooks, teaching strategies, or tests against specific science literacy goals (benchmarks or standards) will we be able to help students achieve those goals.

Provide a foundation for teacher preparation and continuing professional development programs. Using benchmarks and standards as the focus of teacher education and professional development programs can help define a base for teachers' content and pedagogical knowledge and for their understanding of standards-based reform and its implications for teaching and learning. Just as standards and benchmarks can bring coherence to the K-12 curriculum, they can also encourage colleges, universities, and school districts to coordinate their teacher education and professional development efforts. Standards and benchmarks can also help states strengthen their teacher certification and placement requirements.

Guide efforts to improve achievement for *all* students. Setting high academic standards for *all* students—not just for an elite few—contributes to greater equity in the education system. In science and mathematics, the notion that excellence is out of the reach of girls or minority students no longer persists. A core curriculum based on the goal of science literacy for all students will help create a larger and more diverse pool of students who are likely to pursue further education in scientific fields. These same efforts will help *all* students gain the knowledge and skills they will need in a world that is increasingly shaped by science and technology.

Using benchmarks and standards to accomplish these basic tasks will advance science and mathematics education reform significantly, but the effort has just begun. Educators will need an array of other tools and services before they are able to put benchmarks and standards to work effectively.

AAAS Involvement In Science Education Reform

With more than 145,000 scientists, engineers, science educators, policy makers, and interested citizens as members and with 300 affiliated scientific societies, AAAS is the world's largest general science organization. AAAS has been an active participant in K-12 science education reform since the late 1950s, offering programs that disseminate information and ideas to scientists and educators, reaching out to diverse communities, encouraging greater participation by minorities and women in science and engineering, developing instructional materials, and providing leadership and assistance to education reformers. Within AAAS, two major and complementary units—the Directorate for Education and Human Resources and Project 2061—share primary responsibility for education reform.

Through its Directorate for Education and Human Resources (EHR), AAAS has established a wide array of programs designed to connect schools, homes, and communities in ways that will enhance the educational experiences of all students and increase their access to science and mathematics. More than 50 EHR programs serve as nontraditional—and successful—models for bringing important understandings and skills in science to typically underserved groups, including children with disabilities, girls and women, minorities, and low-income and inner-city youth. EHR's extensive network of community-based programs has drawn attention to the need for high standards for all children in science and mathematics and has helped people in all parts of the community contribute to science literacy.

AAAS is also concerned with the long-term, systemic reform of science, mathematics, and technology education. While EHR's programs provide valuable, practical support to communities throughout the country and serve as models for reaching a variety of populations, AAAS' Project 2061 leads national efforts to develop standards and the tools to implement them. Through Project 2061, AAAS is providing a long-term vision for transforming K-12 science, mathematics, and technology education.

Project 2061

In 1985, as Halley's Comet last neared the earth, Project 2061's creators considered the scientific and technological changes that a child just entering school would witness before the return of the Comet in 2061—hence the name. Since then, Project 2061's two landmark reports—*Science for All Americans* and *Benchmarks for Science Literacy*—have greatly influenced the national reform movement by articulating principles to guide reform

and setting specific goals for student learning. In particular, Project 2061's work has been essential to the development of the national science content standards released in 1996 by the National Research Council.

But no matter how well-crafted and well-presented, standards and benchmarks cannot transform schools on their own. Project 2061 is developing a coordinated set of tools to help educators make changes in science and mathematics classrooms, in schools and school districts, and in the education system as a whole. The Project 2061 tool kit now consists of these print and computer-based tools:

Tool	Content
Science for All Americans	Science literacy goals for all high school graduates
Benchmarks for Science Literacy	Grade-specific learning goals leading toward science literacy
Atlas of Science Literacy	Growth-of-understanding maps portray-ing conceptual connections among learning goals
Resources for Science Literacy: Professional Development CD-ROM	Information and activities to help teachers understand & use science literacy goals
Curriculum Evaluation (available in 1998)	Criteria and methodology for judging instructional materials & tests
Designs for Science Literacy (available in 1998)	Guidelines for designing & improving the K-12 curriculum to promote science literacy
Blueprints for Reform and *Blueprints On-line* (available Fall 1997)	Perspectives on the education system & needed reforms

In the following section, this paper will describe the essential tasks of reform and how science educators can use the Project 2061 tools to tackle them.

Defining science literacy. Project 2061 began its work by asking the question, "What knowledge and ways of thinking about science, mathematics, and technology are essential for all citizens?" To answer it, Project 2061 drew on the best thinking of experts in the natural and social science, mathematics, and technology to produce its 1989 report *Science for All Americans*, which includes in its definition of science literacy understandings about:

- the nature of science, mathematics, and technology (i.e., collectively, the scientific enterprise);
- the world as currently depicted by science and mathematics and shaped by technology;
- pivotal episodes in the history of the scientific endeavor;
- themes that cut across science, mathematics, and technology and shed light on how the world works; and
- habits of mind essential for science literacy.

As the Organisation of Economic Cooperation and Development (OECD) states in its recent international study of innovations in science education, "Project 2061 produced a clear and comprehensive vision of what everyone should know about science. *Science for All Americans* persuades its readers that virtually everything the non-specialist adult should know about science is interesting and worth learning.... Above all, it looks achievable" (Atkin, Bianchini, and Holthuis 1996).

Science for All Americans was also persuasive in laying out reform principles, among them:

- The first priority of science education is basic science literacy for all students.
- Science literacy consists of knowledge and skills in science, technology, and mathematics, and their interconnections, along with scientific habits of mind, an understanding of the nature of science, and a comprehension of its role in society and impact on individuals.
- The topics covered in today's science curriculum must be significantly reduced to allow students to learn well the ideas and skills essential to science literacy.
- Education for science literacy requires that students have many and varied opportunities to explore nature in ways that resemble how scientists themselves go about their work.

These principles continue to guide Project 2061's reform efforts and to influence the larger reform movement. In fact, in 1996, they formed the basis of a joint statement issued by AAAS, the National Association for Teachers of Science, and the National Academy of Sciences.

Identifying grade-level learning goals. Having identified goals for adult science literacy, Project 2061 next considered what those goals might imply for student learning in grade ranges along the way. Research on student learning and the expert advice of teams of school teachers informed the development of *Benchmarks for Science Literacy*, published by Project 2061 in 1993. In providing a coherent set of specific learning goals

on which to base education reforms, *Benchmarks* shares many characteristics with the national standards in science and mathematics. However, it has some unique features that set it apart and allow it to complement the standards. For example, *Benchmarks* includes:

- specific learning goals for *four* grade levels (K-2, 3-5, 6-8, 9-12), providing extra (and much-needed) guidance to elementary teachers;
- deliberate *sequencing* of learning goals so that for any topic (e.g., the structure of matter, social trade-offs, the interdependence of life), benchmarks suitable for younger students lay the foundation for increasingly sophisticated benchmarks at later grades; and
- essays and a summary of relevant cognitive research that help to explain the thinking *behind* the content and grade-level placement of benchmarks (these help educators to better understand the significance of the benchmarks for curriculum and instruction).

Both *Science for All Americans* and *Benchmarks for Science Literacy* have helped to shape the nation's expectations for what students should learn, notably influencing the content recommendations in the National Research Council's *National Science Education Standards* and serving as key references and models for other national and federal reform initiatives. The OECD report includes among Project 2061's major accomplishments that "it has generated an example of what nationally driven curriculum reform might look like. As the country began to commit itself to the creation of national standards for the various subjects in the curriculum, Project 2061 was already in a position to offer an illustration, even a prototype, to demonstrate how such standards might play out in practice" (Atkin, Bianchini, and Holthuis 1996).

With a solid consensus on science and mathematics standards and benchmarks at the national level, receptivity at the state level, and increasing awareness at the local level, Project 2061's aim now is to help educators understand and implement changes in curriculum, instruction, and assessment to ensure that students achieve the science literacy goals presented in benchmarks and standards.

Helping educators to understand and promote science literacy goals. The responsibility for promoting science literacy ultimately falls to the classroom teacher. But classroom instruction itself needs to change for students to achieve higher standards in science and mathematics. Many teachers, attempting to cope with an unfocused curriculum and overstuffed textbooks, still teach "a little bit of everything," according to the recent TIMMS report (Schmidt, McKnight, and Raizen 1997). Ideas central to science literacy are lost in needless detail and compete with less crucial topics. Teachers obviously need more help in understanding and applying the recommendations of reform documents like *Benchmarks for Science Literacy* or *NSES*. As SRI International found, "Without high-quality professional development, national standards...may appear to teachers to be little more than attractive, but highly abstract, philosophies" (Zucker, Young, and Luczak 1997).

To help their students move toward higher standards in science, mathematics, and technology, teachers themselves will have to be science literate. However, many K-12 teachers (like most Americans) are not. Even those who are may not fully understand how science literacy goals relate to instruction. Project 2061's new CD-ROM tool, *Resources for Science Literacy: Professional Development* brings together a variety of resources to help in both regards.

Resources for Science Literacy provides science educators with an understanding of science literacy, what it requires of students, and how teachers can help students achieve it. The wealth of material on the CD-ROM can serve as the cornerstone of a long-term professional development program that will enhance both content knowledge and teaching craft. Teacher educators can use this tool to rethink their teacher preparation and in-service programs; school districts and individual teachers can use it as the basis for professional development workshops or self-guided study.

Regardless of how well they are prepared to teach to science literacy goals, teachers need support as they try new materials, methods, and schedules in their schools. Moreover, they need encouragement and practice in collaborating with colleagues in other grade ranges and other subjects.

With these requirements in mind, Project 2061 has launched an initiative to improve teacher preparation and training of new teachers at two sites—in Maryland and Colorado—and to develop prototypes for improving teacher preparation elsewhere. The initiative is designed to encourage long-term professional development programs where teachers study science literacy goals, relate them to sound principles of instruction, and practice applying them in the analysis and revision of curriculum materials, instructional strategies, and assessments. It also helps tie teacher preparation programs more closely to national K-12 reform initiatives and to in-service programs in the schools.

Aligning curriculum and assessment materials with benchmarks and standards. Designing a K-12 curriculum that will adequately address a particular set of science literacy goals (*Benchmarks*, the science standards, or state frameworks) depends on the availability of a pool of curriculum materials aligned with those goals—preferably with effective instructional strategies and assessments built in.

To help identify such materials and encourage the development of new materials, Project 2061 has produced, with the help of hundreds of K-12 teachers, materials developers, and teacher educators, a reliable procedure for analyzing curriculum materials and assessments. Although the procedure was developed using the learning goals in *Benchmarks* and the science and mathematics standards, subsequent trials indicate that it can also be used with state education frameworks and with learning goals in other subjects—provided they are precise, explicit statements of what knowledge and skills students should acquire and retain. For example, over the past year, Project 2061 has worked closely with the Kentucky Middle Grades Mathematics Teacher Network to adapt the procedure to mathematics using Kentucky's *Mathematics Core Content for Assessment*, the national standards for mathematics, and Project 2061's benchmarks as the criteria for

alignment. (See Figure 1 for an example of how the three sets of learning goals treat a particular mathematical concept at very different levels of specificity.) The project is now working with 32 Kentucky teachers who will use the procedure to examine middle-school mathematics materials and to develop workshops to train teachers throughout the state in analyzing materials.

Resources for Science Literacy: Professional Development

In addition to the full text of *Science for All Americans*, the *Professional Development* CD-ROM includes:

A **science trade books database** describing more than 120 books helpful in explaining for the general reader many areas of science, technology, and mathematics. The database links each book explicitly to sections of *Science for All Americans* so that users can compile a reading list around a particular topic.

Descriptions and analyses of 15 **undergraduate courses** that attempt to foster science literacy; again, links to sections of *Science for All Americans* are explicit.

Detailed **comparisons of *Benchmarks for Science Literacy* to the national standards** in science, mathematics, and the social sciences; these show the overwhelming overlap among the documents and explain the differences, making it easier for educators to use both benchmarks and standards when making decisions about curriculum, instruction, and assessment.

A guide to **cognitive research** on how students understand and learn specific concepts central to science literacy.

A Project 2061 **workshop guide** useful in designing professional-development workshops or tutorials that focus on understanding and using benchmarks and standards to improve curriculum, instruction, and assessment.

The Project 2061 materials-analysis procedure is rigorous, requiring reviewers to study carefully the meaning of selected science and mathematics literacy goals before closely analyzing a material's likely contribution to those specific goals. This rigor is essential. Many available curriculum materials, some of them very popular, do a poor job of promoting learning of specific science literacy goals. SRI International found that textbook publishers, however eager to quote the *NSES* or *Science for All Americans* and to

employ new technological formats, remain unconvinced that they need to change the science content in their materials. With publishers and developers nevertheless making claims about their materials' alignment to national standards or *Benchmarks*, it is important to equip educators with a reliable way to evaluate materials for themselves. Also, by training curriculum developers to use the exacting procedure, Project 2061 hopes to encourage them to effectively address science literacy goals in their materials. The procedure includes sets of explicit criteria against which to examine a material for its match to learning goals and asks for explicit evidence to support any claimed match. This makes the materials-analysis task rigorous and time consuming, but also likely to produce reliable and valid results. Project 2061 is now working with teachers in Kentucky and Philadelphia on ways to streamline the procedure.

In addition to its usefulness in evaluating curriculum materials, several features of the procedure make it a powerful professional development tool for teachers, helping them to change the way they look at curriculum materials.

To make Project 2061's materials-analysis procedure widely available, Project 2061 is now developing *Resources for Science Literacy: Curriculum Evaluation*. This CD-ROM/print tool will include (1) detailed instructions for evaluating curriculum materials and assessments in light of *Benchmarks*, national standards, or other learning goals of comparable specificity; (2) case-study reports illustrating the application of the analysis procedure to a variety of curriculum materials; (3) a utility for relating *Benchmarks* and national standards to state and district learning goals; and (4) an overview of issues related to developing the procedure, as well as discussion of its implications for education.

Designing a curriculum to promote science literacy. Analyzing curriculum materials is one way for educators to get started on implementing science literacy goals. However, a much larger problem looms for educators: How to reconfigure the entire curriculum to meet science literacy goals and still meet local requirements and preferences. Because refocusing the entire curriculum on science literacy goals is such an enormous undertaking, and one worthy of thoughtful design rather than the stop-gaps that prevail in education, Project 2061 has been developing a new print/electronic tool, *Designs for Science Literacy*, to guide educators in their K-12 reform efforts.

How might a school district go about *designing* a curriculum—the entire scope and sequence of subjects and courses across all grades from kindergarten through high school? *Designs for Science Literacy* first explains general design principles and how they can be applied to the curriculum. Then, looking at the science, mathematics, and technology components of the curriculum together and in relation to the entire K-12 curriculum, *Designs* sketches some possibilities, envisioning how a curriculum might be configured from high-quality instructional blocks (of various sizes from units to courses).

Designs also offers some practical suggestions on how to make near-term improvements that will contribute to long-term reform goals. For example, it discusses (1) how school districts can prepare their teachers and curriculum specialists for reform, (2) ways to reduce the core content of the overstuffed curriculum, and (3) ways to enhance

connections across subjects and grades. In doing so, *Designs* addresses the many considerations and constraints that attend curriculum design.

To further aid in the design of new curricula, Project 2061 is also creating the *Atlas of Science Literacy*, a collection of "growth-of-understanding" maps which depict the sequence and interdependence of knowledge and skills that lead to students' achievement of particular science literacy goals. These maps reveal not only earlier- and later-grade benchmarks related to a particular learning goal, but also the connections among benchmarks in different areas of science, mathematics, and technology. The graphic representation can help curriculum designers to see which concepts are essential to understanding other concepts, to place concepts and activities at appropriate grade levels, and to notice when they are out of place. A K-12 curriculum developed with connections among benchmarks in mind will pace and relate subjects and courses better. (See Figure 2 for a sample growth-of-understanding map.)

Building awareness for reform. At hundreds of workshops over the past several years, Project 2061 has been promoting the notion of standards-based reform to a variety of audiences. Introducing teachers to *Science for All Americans* and *Benchmarks for Science Literacy* helps them to explore science literacy and to see the documents as tools useful for planning instruction, rather than "abstract philosophies" with no relevance to their daily work.

Project 2061's workshops range from introductory sessions to longer training institutes. The project offers customized workshops for mathematics and science teachers from all grade levels, and also for teacher educators, materials developers, and others. Depending on the interests of the participants, the workshops focus on understanding learning goals; analyzing, selecting, and revising materials; evaluating curriculum frameworks; or using a particular Project 2061 reform tool. Workshops are being developed for all of Project 2061's new tools to help educators put them to use as quickly and effectively as possible.

Reconfiguring the education system. As Project 2061's involvement with professional development for teachers indicates, attempting to reform the K-12 curriculum necessarily takes in other aspects of the education system. To explore the complex interactions of all parts of the education system and their influence on curriculum reform, Project 2061 commissioned a dozen concept papers from expert panels in each area. Summaries of papers and related materials will be released as *Blueprints for Reform On-Line* through Project 2061's World Wide Web site, as well as in book form.

A Growth-of-Understanding Map: **The Seasons**

Derived from AAAS Project 2061's *Benchmarks for Science Literacy*

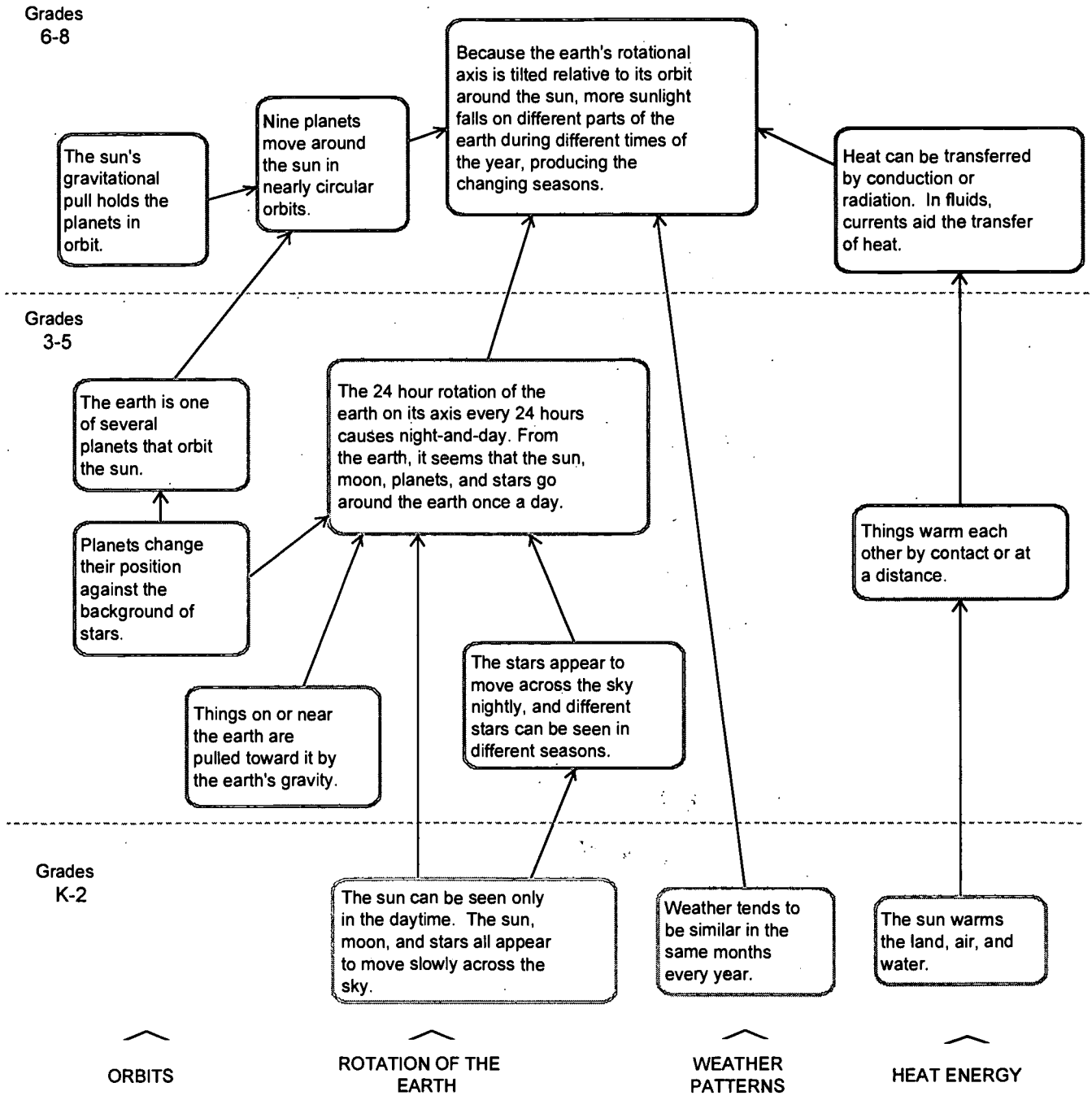


Figure 2. Growth-of-understanding maps graphically depict connections between ideas. They demonstrate how a student might progress from the ideas they encounter in the earliest grades toward learning goals in later grades. This map shows the ideas necessary for understanding the concept of the seasons.

Blueprints for Reform

Blueprints addresses many questions central to standards-based reform, such as:

Assessment: Do current assessment practices work for or against the kind of learning recommended in *Science for All Americans* (or the science standards)? If against, what will it take to change current approaches?

Business and Industry: In what ways do partnerships between business and education contribute to the attainment of science literacy? Does an emphasis on preparation for work help or hinder the implementation of science literacy goals?

Curriculum Connections: How can connections among the natural sciences, mathematics, and technology be fostered? Between these areas and the arts and humanities?

Equity: Which policies and practices impede the attainment of science literacy by all students, and which foster it? How should "all" be defined?

Family and Community: How are families and communities likely to respond to the recommendations in *Science for All Americans* or the national science standards? Should they (and how can they) help to endorse, support, or implement science literacy goals?

Finance: What are the costs, in terms of money and other resources, of "science literacy for all"?

Higher Education: What changes in admissions standards, if any, will be necessary to support K-12 reforms to promote science literacy? How should undergraduate education build on science literacy goals devised for K-12 education?

Materials and Technology: What new resources are needed for teachers to help students become science literate? How can existing resources be put to better use?

Policy: Do current local, state, and federal education policies help or hinder the realization of science literacy goals? What changes in laws and regulations are needed and possible?

Research: What kinds of research are needed to improve instruction for science literacy? How can relevant findings be disseminated to influence K-12 educational policies, teaching practices, materials, and curriculum design.

School Organization: What will the realization of science literacy goals require of grade structure, teacher collaboration, control of curriculum materials and assessment, and how time and space are organized?

Teacher Preparation: What changes are needed to produce teachers with the knowledge and skills necessary to implement curricula based on science literacy goals?

Kentucky *Core Content for Mathematics Assessment*	National Council for Teachers of Mathematics' *Curriculum and Evaluation Standards for School Mathematics*	AAAS Project 2061's *Benchmarks for Science Literacy*
Algebra/Grade 8/Concept #2 Students should understand functions through pictures, tables, graphs, rules, and algebraic notation.	**Grades 5-8, Standard 8 #2** ...describe and represent relationships with tables, graphs, and rules.	**Ch. 9B, Grades 3-5, #2** Tables and graphs can show how values of one quantity are related to values of another. **Ch. 11C, Grades 3-5, #2** Things change in steady, repetitive, or irregular ways–or sometimes in more than one way at the same time. Often the best way to tell which kinds of change are happening is to make a table or graph of measurements. **Ch. 12D, Grades 6-8, #1** Organize information in simple tables and graphs and identify relationships they reveal.
	Grades 5-8, Standard 8 #4 ...use patterns and functions to represent and solve problems	**Ch. 2A, Grades 3-5, #1** Mathematics is the study of many kinds of patterns, including numbers and shapes and operations on them. Sometimes patterns are studied because they help to explain how the world works or how to solve practical problems, sometimes because they are interesting in themselves. **Ch. 9B, Grades 6-8, #3** Graphs can show a variety of possible relationships between two variables. As one variable increases uniformly, the other may do one of the following: increase or decrease steadily, increase or decrease faster and faster, get closer and closer to some limiting value, reach some intermediate maximum or minimum, alternately increase and decrease indefinitely, increase or decrease in steps, or do something different from any of these.
	Grades 5-8, Standard 9#2 ...represent situations and number patterns with tables, graphs, verbal rules, and equations and explore the interrelationships of these representations.	**Ch. 2A, Grades 3-5, #2** Mathematical ideas can be represented concretely, graphically, and symbolically. **Ch. 11B, Grades 3-5, #2** Geometric figures, number sequences, graphs, diagrams, sketches, number lines, maps, and stories can be used to represent objects, events, and processes in the real world, although such representations can never be exact in every detail
	Grades 5-8, Standard 9#3 ...analyze tables and graphs to identify properties and relationships.	**Ch. 9C, Grades 6-8, #3** Graphs can show a variety of possible relationships between two variables. As one variable increases uniformly, the other may do one of the following: increase or decrease steadily, increase or faster and faster, get closer and closer to some limiting value, reach some intermediate maximum or minimum, alternately increase and decrease indefinitely, increase or decrease in steps, or do something different from any of these. **Ch. 12D, Grades 6-8, #2** Read simple tables and graphs produced by others and describe in words what they show.

Figure 1. A comparison of the treatment of related learning goals in state and national documents.

Project 2061's work so far helps in answering some of these and other questions raised in *Blueprints*. Electronic forums and other interactive utilities related to *Blueprints Online* will encourage more extensive debate of issues central to implementing science literacy goals.

Next Steps

At this writing, a national consensus in favor of standards-based reform appears to be growing. For reform to succeed, it is important now for political and education leaders at every level to stay the course. With its commitment to long-term systemic reform of education, the American Association for the Advancement of Science, and Project 2061 in particular, offer the following recommendations to the National Education Goals Panel for ways to bring about some of the changes that will eventually help transform the education system.

- Encourage states and school districts to adopt the widely accepted national benchmarks and standards rather than inventing their own. This will allow educators working at the state and local levels to turn their attention to building understanding and consensus around them and to address other equally important reform tasks. It took three years to create *Science for All Americans*, three additional years to develop *Benchmarks for Science Literacy*, and another three years for *National Science Education Standards*. Thousands of the best scientists and educators were involved and massive resources. Few local communities—even states—are able to replicate such an effort.

- Encourage school districts, state curriculum committees, and others to look to national efforts like AAAS Project 2061 for tools, training, and support. In addition to *Science for All Americans* and *Benchmarks for Science Literacy*, which supply learning goals, Project 2061's tool kit now includes *Resources for Science Literacy: Professional Development* and *Blueprints for Reform Online*. Additional tools—*Resources for Science Literacy: Curriculum Evaluation*, *Designs for Science Literacy*, and the *Atlas for Science Literacy*—should be out within the next year or so. The project also offers workshops and institutes on using science literacy goals to teachers, administrators, teacher educators, policy makers, and others.

- Support and encourage states and school districts in their efforts to align frameworks, local standards, assessments, and textbook-adoption policies with benchmarks and national standards. Draw on Project 2061's workshops to provide intensive training for selection committee members to build their understanding of standards-based reform and their skills in identifying curriculum materials and assessments that will help all students achieve science literacy goals. Allow selection committees adequate time to make thoughtful decisions about curriculum materials.

- Urge publishers and materials developers to create curriculum materials aligned with a specific and coherent set of learning goals, such as those found in Project 2061's *Benchmarks for Science Literacy* and national standards. This will involve educating

publishers and developers about science literacy goals and reform principles, and making it clear that the market demands changes to textbooks, and materials.

- Support the development of valid and reliable procedures for evaluating assessment tools (including high-stakes tests such as state mathematics and science assessments, NAEP, and the forthcoming national test for 8th grade mathematics) for their alignment with national science and mathematics content standards. Findings from evaluations of this sort will also influence and encourage the development of new standards-based assessment items and tasks that can be shared by states and school districts.

- Support states, school districts, private institutions, community organizations, and other entities in their efforts to promote equity in education and ensure high academic achievement of all students.

- Work with Project 2061 to provide teachers with access to long-term professional development that will increase their content knowledge, improve their access to and use of research about teaching and learning, and further their understanding of standards-based reform and how to put it into practice in the classroom. Teachers of science, mathematics, and technology, in particular, need regular opportunities to update their knowledge in these domains and to interact with their scientific and technical colleagues in industry and the research community.

Project 2061's focus for more than a decade has been on reforming the science, mathematics, and technology curriculum, and our recommendations reflect that unique perspective. The project's goal of science literacy for all Americans goes far beyond high scores on tests, more hands-on activities for students, or more attractive textbooks, particularly these do not also help to promote science literacy.

Our experience tells us that meaningful, lasting reform takes an uncomfortably long time. The temptation to look for quick fixes and short-term solutions is difficult to resist. But leaders must always look beyond immediate needs, however urgent, to achieve more far-reaching goals. What was true in 1989 when *Science for All Americans* was published remains true today:

> "There are no valid reasons—intellectual, social, or economic—why the United States cannot transform its schools to make scientific literacy possible for all students."

Sources

American Association for the Advancement of Science. (1997). *Resources for science literacy: Professional development*. New York: Oxford University Press.

American Association for the Advancement of Science. (1993). *Benchmarks for science literacy*. New York: Oxford University Press.

American Association for the Advancement of Science. (1989). *Science for all Americans*. New York: Oxford University Press.

Atkin, J. Myron, Bianchini, Julie A., & Holthuis, Nicole I. (1996). *The different worlds of Project 2061*. Paris: Organisation of Economic Cooperation and Development.

Blank, Rolf K. & Pechman, Ellen. M. (1995). *State curriculum frameworks in mathematics and science: How are they changing across the states?* Washington, D.C.: Council of Chief State School Officers.

Suter, Larry E., ed. (1996). *Indicators of science and mathematics education 1995*. Arlington, VA: National Science Foundation, Directorate for Education and Human Resources, Division of Research, Evaluation, and Communication. (NSF 96-52).

National Center for Education Statistics. (1997). *The condition of education 1997*. Washington, D.C.: U.S. Department of Education, Office of Educational Research and Improvement. (NCES 97-388).

National Education Goals Panel. (1996). *The 1996 national education goals report: Building a nation of learners*. Washington, D.C.: Author.

National Education Goals Panel. (1995). *The 1995 national education goals report: Building a nation of learners*. Washington, D.C.: Author.

National Research Council. (1996). *National science education standards*. Washington, D.C.: National Academy Press.

Schmidt, William H., McKnight, Curtis. C., & Raizen, Senta A. (1997). *Splintered vision: An investigation of U.S. mathematics and science education*. Norwel, MA: Kluwer Academic Publishers.

Zucker, Andrew A., Young, Viki M., & Luczak, John. (1996). *Evaluation of the American Association for the Advancement of Science's Project 2061*. Menlo Park, CA: SRI International.

NATIONAL EDUCATION GOALS PANEL STATEMENT RELATED TO STANDARDS

NATIONAL EDUCATION GOALS PANEL
Statement on Voluntary National Education Content Standards adopted November 15, 1993

In 1990, the President and Governors agreed on six national education Goals and committed themselves to a decade of sustained action to meet the Goals. With the Congress, they created the National Education Goals Panel to measure and support the nation's progress toward meeting the Goals.

To meet Goals 3 and 4 (the Student Achievement and Mathematics and Science Goals), a consensus has emerged that as Americans we must agree on our priorities — the results we expect from students in core academic areas. These "content" standards should be rigorous and challenging, and they should reflect high expectations for what students should know and be able to do.

The National Education Goals Panel strongly supports the development of clear, rigorous content standards, and it believes that voluntary national standards are essential to this effort. The Goals Panel believes the following principles must serve as the foundation for these standards:

Voluntary

The Panel will participate only in the establishment of voluntary national content standards that may serve as models and resources for State and local reform efforts.

The Panel would oppose any federal effort to require States and local schools to use such national standards.

Academic

The Panel believes that voluntary national content standards should address only the core academic areas as stated in the National Education Goals.

Voluntary national content standards should not address non-academic areas such as values, beliefs, student attitudes and behaviors.

World-Class

The Panel will endorse only those national content standards which, though uniquely American, are at least as challenging and rigorous as the academic expectations for students in other countries in the world.

Voluntary national content standards must not be compromised or watered down for any reason. The Panel believes that our focus should be on helping each student reach higher levels of academic achievement.

Bottom-Up Development

National and State content standards must be developed through a consensus building process that involves educators, parents and community leaders from schools and neighborhoods across the country.

For these voluntary national education standards to be useful, they must be relevant to each community using them. The Panel has no intention of developing content standards on its own and would oppose any standards that were not developed through a broad-based, participatory process.

Useful and Adaptable

In order to improve instruction and learning in the classroom, the national standards must be clearly stated and free of jargon. In addition, they must allow local educators the flexibility to design their own curriculum plans within the broad outlines of the standards. The number of standards should be limited, so they are feasible for teachers, parents and students to use, and represent the most important knowledge, skills and understandings we expect students to learn.

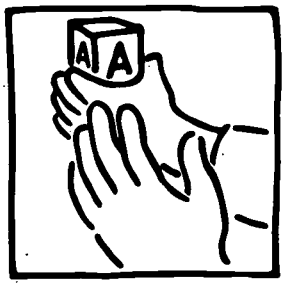
Voluntary national content standards will not be a "national curriculum" but, rather, provide a broad outline of the kind of knowledge and skills necessary "for responsible citizenship, further learning, and productive employment in our modern economy." (Goal 3)

The establishment of national voluntary standards is an effort that has received strong support from the business community, Republican and Democrat Presidents, local educators and citizens from across the country.

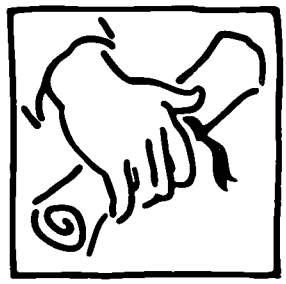
We believe that, if treated with care and wisdom, these expectations of what students should know and be able to do, will empower parents in every community in the nation to demand more of themselves, their children, their schools, and their government.

☆ U. S. GOVERNMENT PRINTING OFFICE: 1997-520-989/90209

NATIONAL EDUCATION GOALS



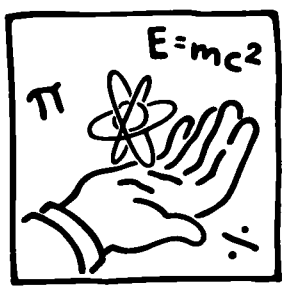
Ready to Learn



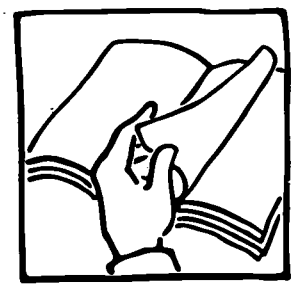
School Completion

Student Achievement
and Citizenship

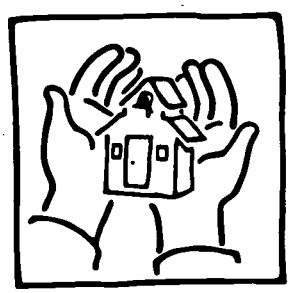
Teacher Education and
Professional Development



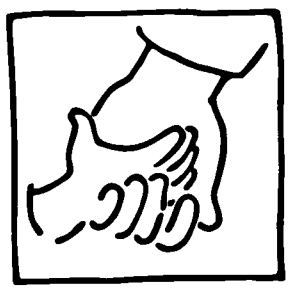
Mathematics and Science



Adult Literacy
and Lifelong Learning



Safe, Disciplined,
and Drug-Free Schools



Parental Participation

NATIONAL EDUCATION GOALS PANEL
1255 — 22nd Street, N.W., Suite 502
Washington, D.C. 20037
(202) 724-0015 FAX (202) 632-0957
http://www.negp.gov
E-mail: NEGP@goalline.org

EA 031115

U.S. Department of Education
Office of Educational Research and Improvement (OERI)
National Library of Education (NLE)
Educational Resources Information Center (ERIC)

NOTICE

Reproduction Basis

☐ This document is covered by a signed "Reproduction Release (Blanket)" form (on file within the ERIC system), encompassing all or classes of documents from its source organization and, therefore, does not require a "Specific Document" Release form.

☑ This document is Federally-funded, or carries its own permission to reproduce, or is otherwise in the public domain and, therefore, may be reproduced by ERIC without a signed Reproduction Release form (either "Specific Document" or "Blanket").