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Summary of Findings from SSI and Recommendations for NSF's Role with States:

How NSF Can Encourage State Leadership in Improvement of Science and Mathematics Education

December 2000

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Introduction

This report is intended to inform education policymakers, federal officials, educators, and the public about what has been learned concerning state systemic reform of science and math education. The report also outlines a set of recommendations, based on consultation with state leaders, on further federal involvement with states and systemic reform. The Council of Chief State School Officers (CCSSO) has prepared this summary report under grant support from the National Science Foundation (NSF).

NSF has provided leadership and support for systemic reform of K-12 mathematics and science education since 1991. The State Systemic Initiatives (SSI) program was established through cooperative agreements between NSF and states based on proposals submitted by states. Now, after the initial five-year support from NSF, some state reform efforts continue, and other states are pursuing systemic math and science reform through state support. NSF supported a number of research studies and evaluations that have produced findings about the results from the state systemic initiatives.

Research questions

In Spring 2000, CCSSO proposed to NSF a plan for summarizing and reporting key findings and lessons learned from the SSI program. Recognizing that excellent studies had already been completed and published, our goal was not to re-analyze or dispute findings on the implementation and effects of the SSI program. We sought to provide for policymakers and education leaders a summary of the key findings from SSI after a decade of program design, funding, implementation, evaluation, and research. Secondly, we aimed to provide a framework for organizing and integrating further research and analysis of systemic initiatives in science and math. Currently, NSF is supporting ongoing research studies and data analyses that assess the effects of systemic initiatives. We hope this summary report will highlight major findings that cut across existing studies and thus provide a common reference for organizing the findings of successive studies.

Three questions framed our approach to analyzing existing findings and reporting lessons useful for next steps in support of systemic reform of science and math education:

1. How can we define a useful, comprehensive framework for analyzing and reporting on results from statewide systemic reform programs?

2. What evidence is available to assess the extent of change in mathematics and science education as a result of the SSI program?

3. What steps should be taken at the federal and state levels to move forward with systemic reforms and standards-based education based on the knowledge gained from SSI?

Steps in CCSSO Review and Analysis

CCSSO led a multi-step process to develop the summary findings and recommendations provided in this report. From April through October 2000, we completed the following five steps that included input from a variety of people:

1. Review of findings from completed studies, evaluations, and reports on the national SSI program and reports from state SSIs. This review conducted by CCSSO staff resulted in a synthesis of the major findings about SSI, and development of cross-cutting categories of findings.

2. Work with a planning committee to develop a framework for analysis and reporting. CCSSO invited six experts on SSI to meet with the project team to review the compiled findings, and they assisted us in developing a framework for integrating the SSI findings and lessons.

3. Conference on "Findings from the SSI Program." CCSSO convened a conference in June 2000 with researchers, evaluators, and state program leaders from SSI and asked them to review the major research and evaluation findings and to discuss lessons from the states' experience with SSI.

4. Discussion with state leaders on "Implementing Standards-Based Mathematics and Science Education Statewide." In order to gain broader input from state leaders in science and math education, CCSSO held a meeting with representatives from 35 states in September 2000 to develop consensus views on states' needs for moving forward with standards-based education and systemic reforms.

5. Integration of findings and recommendations in a summary report. Project staff updated and revised the findings concerning SSI as they were developed in each of the steps. Draft versions of the report were circulated to all participants and feedback was incorporated in the final report.

The matrix on the following two pages summarizes the results of the CCSSO review and analysis process. The notes in each cell provide summary information. Please refer to the page number listed for a description of what we learned from our review and analysis pertaining to: *Findings from SSI, State Leaders Recommendations, and Implications for New NSF Program with States.*

Matrix Outline of Findings, Recommendations, and Implications for NSF

Findings from SSI Studies (as of 6/00)	**State Leaders Recommendations** (9/00)	**Implications for New NSF Program**
Support for Systemic Reform: • Effective SSIs: Established vision for state program through inclusive collaboration • Used vision statement to develop program goals, design decisions, evaluate progress • Need: Engage public in process (p. 6)	• Initiate state-federal dialogue for defining high quality science and math teaching and learning • Use NSF programs as catalyst for statewide support of reform (p. 14, 17)	• Strengthen state vision for systemic change • Provide national leadership on vision for math-science and strategies for involving stakeholders at local and state levels (p. 21)
Leadership: • Effective state leaders: Credibility, systemic view, combination of qualities, focus on all students • States found leadership needs changed • Leadership training/development provided through SSI (p. 6, 7)	• Provide leadership development on standards-based reforms for next generation–at school, district, state levels • Increase training for states and access expertise concerning leadership role (p. 14, 16)	• Increase capacity and opportunity in systems for teacher leadership • Continue leadership development through leader meetings, workshops • Focus greater attention on systemic leadership in local K-12 education, higher education, state policymakers (p. 21)
Resources/Partnerships: • Effective SSIs: Involved partners from education policy, science-math professions, higher education, business and industry–in key areas of vision, program support, leveraging resources • State education agency important for program planning, coordination of resources, reducing duplication (p. 7, 8)	• Disseminate models for effective partnerships and models for coordination of funds and identifying resources (p. 16)	• Require long-term partnerships that are inclusive of advocate organizations and resource providers –for both systemic planning and support of implementation • Continue to encourage state efforts to link funding sources in public and private sector (p. 21, 23)
Policy/Infrastructure: • Effective SSIs: Experienced stable state leadership and consistent policies • Moved toward aligned standards, curriculum, and assessments • Need: Expand alignment of policies, including student assessments and teacher preparation (p. 8, 9)	• Maintain leadership for standards-based reform • Implement curriculum and materials statewide linked to standards • Continue to align policies with standards • Engage public and higher education on reform of teacher education programs (p. 14, 15)	• Review state programs in relation to standards and identify policy changes needed for standards-based reform • Lead science-math community and higher education in defining quality teaching/teachers • Provide leadership on implementing Glenn Commission and Morella Commission recommendations (p. 23, 24)

Findings from SSI Studies (as of 6/00)	**State Leaders Recommendations** (9/00)	**Implications for New NSF Program**
Strategic Decisions/Interventions: • Effective SSIs: Focused professional development on standards-based curriculum and materials, content knowledge, active learning • Linked math-science reform to comprehensive school reform models • Need: High school curriculum reform • Need: Improve skills and knowledge of middle grades teachers • Need: Improve programs at transition grades (p. 9, 10)	• Scale up professional development focused on content standards and curriculum • Develop partnerships to improve teacher preparation and support of teachers • Identify alternative models for teacher recruitment, retention, and preparation • Disseminate state models for systemic action • Contrast local and state-level components for systemic reform • Support teachers for action research and improved use of data • Link to state efforts with comprehensive reform and low-performing schools (p. 15, 17)	• Support effective partnership models for enhancing S-M education workforce • Support use of validated, effective professional development models • Maintain systemic K-12, science-math, all students; and encourage focus on under-served areas, e.g., urban, rural • Emphasize intervention at transition points for students, e.g., grades 6, 8, 9, 12. • Suggest links of science-math to broader school reform efforts and improvements linked to state accountability • Encourage research on practice involving teachers (p. 21)
Sustainability: • Effective SSIs: Maintained quality control of programs and interventions • Built on prior reforms • Developed infrastructure for improvement • Leveraged funds from sources (p. 10, 11)	• Encourage multiple resources for support, and consider greater flexibility in NSF support • Provide support to states tied to their systemic models and results (p. 17)	• Request long-term plan and goals from states • Maintain state-matching grants • Encourage linking to other federal programs (p. 21)
Outcomes/Evaluation: • Effects of SSIs: Half the states showed impacts on classroom practice • Achievement gains highest in states with intensive professional development and focus on curriculum and materials • Need: Improve data systems • Need: Develop state assessments adequate to evaluate standards-based instruction (p. 11, 12)	• Design a unified data system for meeting federal reporting and state analysis needs • Improve data systems to evaluate program effects, disaggregate results by student groups and schools • Use data to monitor teacher growth and program impact on teachers • Provide models for developing assessments more aligned to standards • Support models for research/analysis with state programs using state data • Train educators in use of state data (p. 18, 19)	• Require reporting results linked to standards • Support development of aligned student assessments • Merge reporting to NSF with statewide data systems, reduce parallel data systems and reporting • Request state plan for use of own data to improve instruction (p. 22, 23)

I. Summary of Findings from Studies of the SSI Program

A total of 24 states and Puerto Rico participated in the SSI program in the 1990s through cooperative agreements with NSF. States submitted five-year program proposals aimed at advancing systemic change for improvement in science and mathematics education in schools. NSF provided funding for the approved state proposals with each state committing matching funds. NSF staff and contractors reviewed the progress of programs and provided technical support to states.

The SSIs were funded by NSF in three cohorts of states from 1991 through 1993*:

1991 cohort	**1992 cohort**	**1993 cohort**
Connecticut	California	Arkansas
Delaware	Georgia	Colorado
Florida	Kentucky	New Jersey
Louisiana	Maine	New York
Montana	Massachusetts	South Carolina
Nebraska	Michigan	
North Carolina	New Mexico	
Ohio	Puerto Rico	
South Dakota	Texas	
	Vermont	
	Virginia	

(For brief project descriptions, see Education Commission of the States, 1995; NSF, 1998)

From the outset of the SSI program, NSF provided participating states with evaluation and research support. A national evaluation commenced in 1992 under a contract with SRI International, and a number of evaluation reports and papers were published (including Zucker, et al., 1995, 1998; Zucker & Shields, 1998; Corcoran, et al., 1998). Each state designed and implemented its own program evaluation (see Kahle, 1997, 1998a,b, 1999, for reports from one state). An SSI monitoring contract with Abt Associates provided NSF with regular progress updates. NSF awarded a contract to the University of Wisconsin-Madison for the National Institute for Science Education, which has produced in-depth studies and reports on many aspects of SSI and other systemic initiatives supported by NSF (examples include Clune 1997, 1998; Knapp, 1996; Webb, 1999). Finally, NSF supported special research studies on SSI, such as Rand's Mosaic study (Klein et al., 2000).

In the following pages, we summarize some of the major findings from studies of SSIs, and we organize the findings in a framework recommended by the project planning committee and confirmed in the June 2000 SSI Findings Conference.

Support for Systemic Reform

- **Setting a common vision for improving math and science education provided a basis for systemic planning, consistent models and strategies for improvement, and criteria for evaluating progress.**

All participating states were asked to define and develop as part of their SSI proposals a vision for systemic reform in math and science education. The importance of this entry in the framework for findings from the SSI program, beyond the fact that the states were able to develop an SI vision statement, is how the vision was developed and what was included in the development process.

Active Collaboration for Common Vision. Effective systemic improvement requires the development and communication of a common vision. At the SSI Findings Conference in June 2000, state leaders determined that establishing and maintaining the common vision was crucial for advancing systemic improvement in math and science education. In some states, policy-makers, educators, and leaders of educational institutions, the business community, and professional organizations came together in a collaborative process to develop the SSI vision. The vision statement, and the process for developing the statement, produced broad-based participation in the SSI plans, buy-in from organizations, and support for the SSI goals from diverse groups, including teachers, parents, schools districts, and partners such as businesses and higher education and science-related institutions.

Setting Goals and Evaluation. An important function of the common vision for systemic improvement is the evaluation of progress against planned outcomes. With shared understanding of what is expected in math and science education, it is possible to evaluate an initiative over time, and the quality of specific activities and services can be judged in relation to the vision. In several states, the development of state content standards for math and science was the major event related to vision. In other states, the standards became one of the tools for systemic initiatives to carry out the common vision.

Need: Engage the Public. The SRI evaluation (Zucker, et al., 1998) found that most states did not initially focus significant effort on public information or communications about improvement of math and science education. As projects developed, the importance of engaging the public in SSI efforts became more apparent. Public discussion and debate about the goals for improvement in math and science have become more widespread with the implementation of state standards and their links to student assessment and school and student accountability.

Leadership

- **Leadership skills for systemic improvement in math and science were developed through SSI.**

- **Leaders of systemic reforms must have credibility and capacity in order to develop connections with bases of power and support, including partner organizations and policy-makers.**

The initial development of SSIs emphasized official leadership at the top level in participating states, since all state proposals to NSF required submission from governors and chief state school officers.

Changing Leadership Needs. Early leadership for planning and implementation of state initiatives typically involved well-known math and science specialists from universities, colleges or professional organizations. Over time, leadership of the systemic initiatives changed, with many states moving toward leaders with stronger state political links rather than math/science specializations. The SRI evaluation (Zucker, et al., 1998) indicated that across the SI states there was no clear pattern in program results

identifying a particular type of background and experience as being most important for effective state-level leadership.

SSI Improved Leadership Skills. An effect of the SSI program, according to lessons reported from experience of state leaders, has been the development of leadership skills for systemic math and science improvement at both state and local levels.

Credibility and Capacity: Key Leadership Qualities. At the June 2000 SSI Findings Conference, we learned that leadership was a critical component for effective SSIs. Conference participants identified two main lessons: a) leaders of systemic reform must have credibility and capacity, and b) effective leaders will have eight key leadership qualities. Leaders of systemic reforms must have credibility and capacity in order to develop connections with bases of power and support, including partner organizations and policy-makers. Where SSIs have been effective, leadership has operated well in two ways: first, SSI leaders became well known across the state in relation to math and science education; and second, they worked effectively at both the policy level and the local educator level.

One pattern evident among SSIs in the 1990s related to change in top, state-level program leadership with successive stages of a systemic plan, i.e., from defining vision to building partnerships to implementation and evaluation. States may have gained experience and learned what kinds of leadership were needed, or the demands of the SI projects and the leadership required may have produced high turnover. The experience of states with systemic initiatives in math and science demonstrated the following as key leadership qualities:

- vision for quality science and math,
- excellent communicator,
- planning ability,
- understanding context,
- consistency in approach, with flexibility,
- systems-based thinking,
- alliance/partnership building,
- commitment to quality teaching for all.

Resources

- **Effective SSIs developed important partnerships with education policymakers, leaders of science and math professions, higher education, and business and industry; these partners were critical for program vision, support for goals, and leveraging resources.**

- **A critical role for states is in the long-range planning of human and fiscal resources needed for systemic change, as well as in the development of shorter-term strategies and leveraging of available funds.**

The NSF request for SSI proposals clearly specified the need for partnerships, and a basic element for all the state programs was collaboration with higher educational institutions, local businesses and industries, and scientific institutions, e.g., museums. Studies of the SSI program found that partnerships were a key ingredient for building support of SSIs and for leveraging fiscal and human resources.

Partnerships Central to Systemic Improvement. The SRI evaluation (Zucker, et al., 1998) and Clune study (1998) found that partnerships were critical for mobilizing support, developing vision, and linking the leadership and organization for systemic change to advocate organizations (e.g., non-profit and professional organizations, business and industry) and established educational institutions (e.g., higher education, K-12 policy-makers, district leaders). They also concluded that effective partnerships were based on a common vision for mathematics and science and common goals for implementation. SSIs typically used advisory boards or councils as a mechanism for major partners to have regular input and participation in a systemic organization

for science and math. Several successful SSIs used the structure of a non-profit advocacy organization to coordinate state partnerships, and others used existing educational institutions.

Effective SSIs Leverage Resources. The evaluation studies found that successful SSIs used resources to build infrastructure and expand capacity for delivering services to schools by developing teacher networks, establishing associations with regional assistance centers, accessing technology systems, and developing criteria for analysis and selection of curriculum materials. SSIs typically selected the providers for working with schools and teachers on improving curriculum and instruction. Based on the vision for change, the SSI could apply established criteria for selecting providers and guiding their work with schools in a manner that provided a consistent message. For example, one state used criteria set by the SSI to select regional providers for professional development services in science and math that were based in non-profit organizations or technical assistance centers in colleges and universities. Another state, through its partnerships, was able to use SSI-established criteria to evaluate all of the existing professional development programs in science and math and then leverage with the provider organizations to move development efforts toward content and approach consistent with the systemic vision.

States Key for Planning, Coordination. A critical role for states is in the long-range planning of human and fiscal resources needed for systemic change, as well as in the development of shorter-term strategies and leveraging of available funds. SSIs demonstrated that state-level planning and coordination is necessary for the various programs, funding sources, and organizations to work cooperatively toward a common vision for math and science improvement.

Policy/Infrastructure

- **Challenging content standards, clearly written, are an important component of systemic improvement, and successful state initiatives ensured that assessments, curriculum, and instruction were aligned with standards.**

- **State policies and consistent policy leadership supported goals for systemic improvement in math and science.**

At the outset of the SSI program in 1991, emphasis was placed on linking systemic reform to policies at the state level. A priority was placed on following state plans for systemic initiatives with changes in state policies that supported math and science, such as higher course requirements, funding for state assessments, increasing the numbers of well-prepared teachers, and improving methods of professional development for teachers.

Development of State Standards. The role and importance of policies in systemic initiatives changed during the 1990s. National professional content standards for math and science education assisted states in their development and adoption of state standards and curriculum frameworks. Federal funding support through Goals 2000 and OERI grants advanced the development of state frameworks and standards. Leadership of governors and other state policy-makers helped push state standards to the forefront of policy issues in education (Zucker, et al., 1995; Blank, et al., 1997).

When the SSI program began, most states did not have state content standards or curriculum frameworks for K-12 science and mathematics. A majority of states had assessment programs in math that focused on basic skills or competencies, while fewer states had assessment programs in science. During the 1990s, states built on the leadership of national professional organizations (NCTM, 1989; AAAS, 1993; NAS/NRC, 1995) to develop their own state standards in math and science. By 1999, all but one state had established content standards (CCSSO, 2000). The SSI contributed to the development, writing, and

dissemination of frameworks and standards (Humphrey, et al., 1997). SSI became a partner in states' efforts to move toward standards-based math and science education.

The SRI evaluation (Zucker, et al., 1998) and Clune study (1998) indicated that SSIs provided key contributions to the development of standards and frameworks, and that services advanced through the SSIs to schools and teachers, such as professional development, benefited from a standards focus. SSIs have had less direct impact on state student assessment programs. Studies of the SSI program note that the lack of alignment between existing assessment instruments and state standards and goals for improving learning through systemic initiatives impedes state and national efforts to evaluate the program's real impact.

Evidence from SSI studies reveals that some success was achieved in state policies supporting systemic reform and higher quality science and math education (Clune, et al., 1997; Massell, 1997). The evidence also indicates that the states' policy shifts toward standards were consistent with goals for the SSI program as set out by NSF.

Alignment of Policies with Standards. The participants at the June 2000 SSI Findings Conference concluded that challenging content standards, clearly written, are an important component of educational improvement and a systemic model. Several studies of state reforms concluded that more successful state initiatives did focus on working to align assessments, curriculum, and instruction with standards (Zucker, et al., 1998; Massell, 1997). The Conference participants agreed that efforts for systemic improvement in math and science needed to be based on standards, and that efforts toward aligning assessments, curriculum and instruction with standards became a key SSI goal.

Consistent State-level Leadership for Policies. According to the Clune study (1998) and the evidence from the SSI Findings Conference, state policies are a critical component of systemic improvement in math and science, and the support of state leaders for goals of systemic improvement is a key factor. States with effective SSIs were found to have consistent state-level leadership that supported SSI goals and related state policies (Clune, 1998). In the states that began to move toward state assessment programs in math and science that were more consistent with their content standards, the goals of SSIs helped contribute toward this policy direction.

Strategic Decisions/Interventions

- **The professional development models in effective SSIs focused on math and science content knowledge and active learning strategies, and the experiences of teachers were typically coherent and sustained.**

Effective SSIs Provided High-Quality Professional Development. Improving the preparation of teachers in math and science content knowledge is a necessary component of systemic reform and a key factor in improving student achievement. The SRI evaluation (Zucker, et al., 1998) found that effective SSIs produced high quality professional development and teacher networks. The professional development models in effective SSIs, commonly via summer institutes, focused on math and science content knowledge and active learning strategies (Corcoran, et al., 1997). The experiences of teachers through these models were typically coherent and sustained.

Design for Professional Development. Effective SSIs focused their professional development for teachers and the teacher networks on math and science curriculum and instruction aligned with standards (Corcoran, et al., 1998; Clune, 1998). Professional development using a validated model does produce effective change in participants, but it is costly and time intensive (Kahle, 1997). According to Clune, the SSIs were able to reach a substantial number of teachers with professional development. Across the

states, a total of 10 percent of math and science teachers were involved in professional development efforts in any one year during the height of the program.

◆ **Mathematics and science reforms linked to whole-school models were effective, and while no one model was judged superior, each needed to be replicable. An important role for SSIs was to maintain quality control in math and science for reform models applied at the local level.**

Linking Math and Science to School Improvement Models. Evaluation studies of SSIs assessed the degree to which states made strategic decisions for use of their resources to build on and leverage existing models for school improvement. One path toward improved outcomes was via the state's existing models and partnership with existing reform efforts (Zucker, et al., 1998; Knapp, 1996). Studies by SRI and Kahle (1997) found that whole-school models were effective, and that while no one model was judged superior, each needed to be replicable. At the Findings Conference, participants noted that an important role for SSIs is to maintain quality control in math and science for reform models applied locally.

Since 1998, evidence of states and districts adopting comprehensive school reform models and schoolwide programs under Title I grants has grown. The U.S. Department of Education has contracted for several national studies of whole-school reforms, which will provide important new evidence. States now use accountability systems to identify low-performing and high-improvement schools, and extra assistance is provided to some schools. These efforts have grown during the period of systemic approaches to math and science reform.

Sustainability

◆ **Key components for sustainability identified during the SSI program are: maintaining quality control, building incrementally on prior reform, leveraging funds, and infrastructure.**

◆ **Crucial elements of long-term systemic improvement remain on the agenda for math and science reform in most states, including assessment systems, policy change, and consensus building on vision for science and math education.**

Systemic Change Requires Long-Term Plan. A conclusion of the SSI Findings Conference was that systemic initiatives and ongoing improvement efforts cannot be viewed as a project, or even a model, but rather as a shared plan, strategy and vision from which states can move toward school improvement and raising student achievement. In that sense, systemic improvement plans need to have a high priority on sustainability.

Key Components for Sustainability. The SRI evaluation (Zucker, et al., 1998) and Clune study (1998) identified the following three components for sustainability from the initial five-year SSI program:

- **Leverage funds.** SRI analyzed the effectiveness of the state programs in linking their efforts to other sources of funding for math and science education, and the data showed that SSIs, in total, leveraged $500 million over the five years of NSF support for 25 states (1998).
- **Build on prior reforms.** SSIs linked their efforts at state and local levels to a variety of math and science reforms, including Eisenhower professional development support, curriculum development and materials projects, and models for teacher preparation and enhancement supported by NSF.
- **Maintain quality control.** An important function of the SSI was reviewing local models for school reform in relation to criteria and principles established for systemic reform, such as links to standards-based curriculum and instruction.

Building Infrastructure. Based on discussions at the SSI Findings Conference, the SSI program allocated resources for expanding capacity and building an infrastructure for reform; and continued systemic change will likewise require continued resource allocation for infrastructure maintenance and expansion. Some states were effective in utilizing the SSI program as an opportunity for long-term improvements. Short-term effects on student achievement can be gained by allocating more program funds directly for services, especially teacher development with new curriculum materials based on state standards.

Reform Takes Time. Other crucial elements of long-term systemic improvement can take longer periods of time to develop and in many states still remain on the agenda for math and science reform, including:

- establishing an assessment system consistent with content standards,
- passing state legislation and policies consistent with systemic improvement goals (e.g., teacher preparation, professional development),
- consensus building with districts, schools, and the public about the vision for math and science education.

Outcomes and Evaluation

- **One-half of the state initiatives had strong positive impacts on classroom practice, as measured by change in instruction toward inquiry-based learning and alignment with state and national standards.**

- **The SRI evaluation concluded that student achievement increased more in states that had implemented intensive and long-term professional development for teachers and schools, and in states that focused on identifying and providing effective curriculum materials.**

- **Lack of alignment between existing assessment instruments and state standards and goals for improving learning impedes state and national efforts to evaluate the program's real impact, and lack of integrated state data systems inhibits efforts to analyze equity issues in program impact.**

Change in Classroom Practices. A major finding of the national SSI evaluation (Zucker, et al., 1998) addressed the effects of SSIs on instructional practices and curriculum content in science and math. The overall summary results indicate that among 22 SSIs with five years of support, one-half of the state initiatives had strong positive impacts on classroom practice, as measured by change in instruction toward inquiry-based learning and alignment with state and national standards. The SRI analysis was based on evidence from site evaluations, case studies, and data and documents compiled by sites. Because the SRI evaluation was able to use a consistent definition of inquiry-based learning and instruction aligned with standards across the 22 sites reviewed, we can have some confidence of change in classroom practices.

A key outcome measure for evaluating systemic change in mathematics and science education is the degree to which classroom teaching practices and subject content change during the course of the program (see Kahle, 1998a,b, 1999, for examples of use of state data). National standards for science and mathematics, and most state standards, provide goals and rationale for the correlation between method of instruction and student learning of challenging subject matter. Evaluation research on systemic reform for SSI developed a number of valid approaches to measuring change in classroom practices; however, the extent of systematic, representative data collection and analysis on teaching and classroom practices across the participating states was limited, and the analysis was dependent on designs and judgments made by external evaluators.

Improvement in Student Achievement. The SRI evaluation (Zucker, et al., 1998) examined change in each participating state's assessment data over the period of the systemic initiatives. Based on each state's measure of improvement of student learning in participating schools and districts, the SRI evaluation concluded that during the course of the five-year SSI program, student achievement increased more in states that had implemented intensive and long-term professional development for teachers and schools, and in states that focused on identifying and providing effective curriculum materials. On the other hand, states that invested more time and effort in building state infrastructure had less direct evidence of student achievement gains during the five years.

Increased Course Enrollments. Comparable assessments of student achievement across states were not available for SSI. However, state-by-state data on course enrollments in science and mathematics reported by CCSSO (Blank and Langesen, 1999) indicate that SSI states showed greater increases in course-taking in higher-level science and math during the 1990s than non-SSI states.

Need for Alignment. Analysis of improvement in achievement was conducted with state assessment data disaggregated by school and district participation in SSI. Review of state assessments by the SRI national evaluation team (1998) revealed that state assessment instruments were typically not well-aligned with the state standards for math and science. At best, a portion of the standards addressing content areas and expectations for learning were covered by state assessments. The finding that state initiatives supporting intensive professional development in math and science content and curriculum materials had greater impact on achievement indicates that current state assessments, although not consistent with standards, do reveal improvements in math and science learning as projected in program designs. Areas requiring further examination include: how widespread the improvements are within states, the extent of identified change, and the possibility of achieving long-term benefits through focus on infrastructure and organization.

Cross-Cutting Findings

- SSI is the first national program to assert a primary goal of improving achievement of all students in math and science. Basic principles of the SSI program are: a) mathematics and science, b) math and science for all students, and c) systemic change means K-12 (elementary, middle, high school).

- The SSI program moved states toward aligning components of the education system in states; and alignment is a critical step for improvement. Policy change consistent with systemic improvement goals is still required.

- SSI provided leadership development in participating states; and further leadership development toward understanding of systemic improvement will be needed at all levels.

- Systemic improvement for math and science is not a project, but a shared plan, strategy and vision from which states can move toward school improvement and higher student achievement.

- SSI established a vision for math and science education change, clarified goals and needs, and developed systemic models; now, for many states, system-wide implementation is the next step.

II. Recommendations of State Leaders: Implementing Standards-Based Mathematics and Science Education Statewide

In September 2000, the Council of Chief State School Officers convened a two-day Meeting of State Education Leaders to discuss critical issues for implementing standards-based science and mathematics education. The participants, representing 35 states, collaboratively identified important "next steps" for state-federal cooperation toward improving the quality of science and mathematics education in public schools.

As part of CCSSO's effort to summarize and report what is known about systemic reform of math and science education, we sought the views of leaders in all states. Currently, 49 states have content standards for science and mathematics education (CCSSO, 2000). During the 1990s, all of these states developed or revised their standards establishing levels of student knowledge and performance related to K-12 science and math education. Half of the states had an SSI program supported through NSF. Other states worked on implementing standards-based math and science through state support, other federal programs, and other sources.

After a decade of work on developing state standards and experience with systemic initiatives and other reform programs, the states have a strong interest in examining what has been learned, assessing the gains that have been made, and determining directions for next steps. At the September meeting, state education leaders presented their ideas and exchanged views identifying their state's needs for continued improvement in math and science education. They worked together to prepare recommendations for how federal agencies can best support and collaborate with states to move forward with systemic improvement of math and science education.

The meeting agenda included workshops on specific topics related to implementation of state standards, including sessions on Resources and Partnerships, Models for Systemic Improvement, Standards and Assessments, Equity Issues, Intervention in Low-Performing Schools, and Data Quality and Use. Each state was invited to send one representative to the meeting, and travel support was provided by CCSSO through our grant from NSF. The meeting included over 50 participants with representatives from 35 states, as well as staff from NSF, other federal agencies, and professional organizations. The Appendix contains a list of participants.

The following sections outline discussion results from the September Meeting of State Education Leaders. Each section identifies key issues and needs raised by the participants, as well as their recommendations for federal-state collaboration.

Standards and Assessments

- **Support continued development and evolution of standards and related assessments at the state, district, and school levels.**

State leaders identified setting priorities and planning with standards as key issues, as well as identifying the methods known to be most effective for advancing standards in districts and schools. States and districts need to establish priorities and long-range plans to move ahead with standards and assessments. In particular, states need guidance on the role of partnerships and partner organizations for advancing standards and assessments. States also need guidance on implementing standards-based curriculum and materials and evaluation of materials in relation to standards. Priority support should be given to:

- Strategies for advocating with policy-makers for assessments that support standards

- Reliable, valid methods of aligning standards, curriculum and assessments,
- Means for highlighting curriculum and materials that support standards.

- **Support leadership development across the states at district and school levels.**

A key need expressed by state leaders related to leadership development and advocacy for standards-based education. A second identified need related to technical assistance in building and using better student assessments. State leaders recommended that NSF and federal agencies support leadership development across the states at various levels of the systems. A strength of SSI resided in its promotion of leadership development; however, a new generation of leaders are needed who are committed to standards-based math and science improvements in classrooms from teachers of science and math to district supervisors, building and district administrators, and state-level leaders. Leadership development efforts should be targeted to specific audiences. Public information and program management skills should be included in planning for leadership development.

- **Improve coordination between federal agencies and labs, and links to states and districts.**

Strategies are needed to improve the relationship and coordination between federal and state agencies and science and engineering labs, e.g., supported by the Energy Department, and the education research and development labs supported by the Education Department. States need to take a more active role in linking these resources to improvement efforts in districts and schools, as demonstrated in several of the SSIs.

- **Develop state-level research and data analysis regarding standards and assessment.**

States have a wealth of data, but new approaches are needed for the analysis and presentation of the data in a manner that would support and lead standards-based reform. In particular, state leaders need models and assistance for analyzing and using state-level data on achievement, teaching practices, curriculum, and other data that would assist teachers and administrators in improving instruction. Specific needs for improving the use of data include:

- state-level analyses of assessments with data on curriculum and instruction,
- school-level models for evaluating effective practices and using results for scaling up,
- improved dissemination of data, and strategies for school improvement based on data,
- common rubric for making comparisons across states.

Teacher Preparation

- **Establish a common vision of high quality science and mathematics teaching, and define a professional growth continuum for teachers based on common standards for teacher knowledge and skills.**

State leaders agreed that improving the preparation of teachers in math and science content knowledge is a necessary component of systemic reform and a key factor in improving student achievement. In order for preparation to be improved, states need to engage the participation of higher education, K-12 school leaders, parents, business leaders, and other partners (see report of Glenn Commission, U.S. Department of Education, 2000). Goals for professional growth of teachers should be defined with specific stages, including pre-service and in-service teachers, at 1, 5, and 10 year experience points with a system of benchmarks to track growth. The performance of teacher education institutions should be carefully analyzed and monitored with quantifiable measures to determine how well our systems are able to provide teachers with the level of knowledge and skills they need to teach to standards.

- **Develop or revise state policies on professional development for recertification and use of professional development funds in line with the common vision for quality teachers. States should develop or revise policies on requirements for initial teacher certification based on student content standards.**

An important area for state and federal cooperation is in the formation of standards for teachers, i.e., content and pedagogy that all teachers should know and be able to do. Few states have directly linked standards for student learning in math and science (or other subjects) to state policies regarding recertification requirements, state and local funding for continuing education, or professional development for teachers. In most states, the subject of professional development is elected by the individual teacher, and most time spent in professional development or education for recertification is *not* linked to curriculum or standards.

- **Engage the public and higher education in the urgency for reform of teacher education.**

State leaders maintained that proactive *rather than reactive* steps are needed. Long-term thinking and planning is needed now while the economy is strong. The federal government should lead by gathering stakeholder groups together and involving key leaders of higher education institutions. In teacher education, major retooling of systems and policies for preparation is required. Standards for teacher knowledge and performance should to be established, and teacher preparation programs should be reformed according to these standards. The recommendations of the Glenn Commission support NSF and state leadership and provide an excellent point of departure for reform.

Equity in Standards-Based Math and Science

- **Focus teacher preparation on standards-based science or math, and improve preparation programs to increase teacher skills for instruction with all student groups.**

Inequity exists in the allocation of teachers in science and math, with more poorly prepared teachers assigned to schools with higher concentrations of low-income students and to classes with more low-achieving students. Inequity also exists in the distribution of high-quality professional development aimed toward standards and in the selection of districts and schools for testing standards-based models for math and science education.

National and state leadership should direct the design and implementation of teacher preparation/licensure and teacher professional development towards state and national content standards for science or mathematics education, rather than relying on discipline-based curricula for teachers (e.g., major in biology). Emphasis should be placed on integration and intersection of disciplines, and teachers should be prepared to teach to all groups of students.

- **Develop and advance the use of state data systems that will provide adequate access to data for evaluating the effects of science and math initiatives and analyzing the quality of teachers assigned in classrooms.**

Data systems in states and districts are presently inadequate for measuring and monitoring the impact of math and science reform initiatives in schools and within different groups of students. Existing data systems are similarly inadequate for assessing the quality of teacher preparation, as well as the supply, demand, and allocation of teachers of science and math. State and local data systems should allow educators and policymakers to analyze the following aspects of science and mathematics education:

- changes in curriculum, professional development, and other initiatives in schools,
- effects of specific programs on student performance, with a data capacity to data by at-risk groups of students,

- teacher retention, turnover, preparation, and professional growth,
- general availability and access of data systems to all state and local educators.

Resources and Partnerships

◆ **Build state partnerships that lead toward improving preparation, recruitment, and retention of teachers.**

The Glenn Commission report (U.S. Department of Education, 2000) identifies present and future problems related to the quality of science and math teachers, and underscores the need for new approaches to developing, supporting and retaining quality teachers. NSF should provide resources for states to use partnerships to create a system for alternative methods of recruiting, developing, and retaining math and science teachers. Forming partnerships is a useful strategy for maximizing what is already known about improving teacher quality and for improving existing research, program models, and dissemination methods. Partnerships can increase the drive for better, more complete data on teacher supply and demand, teacher quality, attrition, and training, and recruitment of new teachers. Partnerships can build and support change in math and science teacher preparation and training and can promote productive work among:

- university/college science, mathematics, and education departments,
- state departments of education, including licensure offices and curriculum specialists, professional science and math organizations,
- state math and science coalitions/partnerships,
- business leaders in states.

NSF can have an important leadership and catalytic role in these partnerships.

◆ **Expand NSF support of state partnerships for continued systemic change.**

States need to be made aware of what is known about effective partnerships and methods of collaboration with federal agencies/programs, professional scientific organizations, education leadership, foundations, and business and industry. Effective partnerships take time, often years, to establish. Interpretation of results is an issue, due to the difficulty of establishing attribution that would allow a partnership to take credit for long-term changes in student performance.

If systemic reform is to continue after termination of NSF funding, the establishment of partnerships should be a targeted, fundable goal of NSF programs. Different possible models for building partnerships should be considered, e.g., partnerships led by state agencies vs. partnerships led by non-profit, advocacy organizations. Effective models for partnerships should include business and community leaders, education policymakers, government officials, state and local agencies, and teachers.

Models of Systemic Improvement

◆ **NSF support can serve as a catalyst within states to advance reforms and instructional improvement statewide.**

State leaders recognized a need for strong messages to local educators and policy-makers calling for systemic change and standards-based science and math education. The leaders identified a number of components of science and math education that should be included in models for reform at the school and district levels:

- articulated curriculum,
- resources,
- assessments aligned with standards,
- critical mass of quality teachers,
- professional development linked to standards,
- policies consistent with reforms,
- leadership especially at building level,
- home involvement,
- partners in higher education and community.

◆ **NSF funding model should be systemic, with an emphasis on incentives to states that historically have not been funded. States also need assistance with shaping the state role in initiatives.**

State leaders see the need for models for state action; that is, how to lead initiatives at the state level and build on state experiences of leadership thus far. First, states need a basis for selecting from the various models for whole school comprehensive reforms. Second, evidence is needed regarding approaches to state leadership, including models based on accountability, services delivery through regional intermediary providers, and use of non-profit organizations in leadership and coordination. Third, states need assistance with strategies for partnership building through community and resource providers (e.g., higher education, business), as demonstrated in several existing SSIs.

◆ **Provide flexibility in funding approaches to sustain reform.**

NSF programs should be sufficiently flexible to allow alignment with state-based education initiatives. Programs should be flexible to: a) provide assistance at different levels of a systemic reform initiative, and b) permit "power sharing" between existing state and NSF drivers of systemic reform.

◆ **Link math and science initiatives to broader comprehensive reforms.**

One strategy suggested by state leaders is to allocate funds and assistance to grades with *transition points in schools,* e.g., 8 to 9, 12 to 13. The intended outcomes would be to reduce the attrition level of students in transition and to increase the number of students who complete a math/science standards-based education.

A second strategy is to support collaboratives involving K-12 state departments of education, boards, and regents including vocational, community, technical, and four-year institutions. The focus of collaborative work would be on curricula that are standards-based, especially relationship between quality math-science programs and reading-writing programs. Other foci of the collaboratives could be on coherence of reform approaches and policies, instructional practices, methods of assessment, and state and local high-stakes tests and accountability systems.

◆ **Focus on intervention with low-performing schools.**

State leaders acknowledged the danger of losing emphasis on high standards as larger numbers of students fail to meet them and identified the need to assess the effectiveness of math/science programs as they affect low-achieving students. States need to focus on identifying and assisting low-performing schools with a methodology that is researched and state-specific.

States can establish recognition programs for schools that raise student achievement in math and science with priority on awards for progress with low-achieving students and low-performing schools. Recognition programs should aim to raise student achievement in math and science quantitatively and qualitatively, and states should take the lead in dissemination and reproduction of successful models for low-achieving students with a school-wide approach.

Data Use

- **Develop funding and policy support for a unified, coordinated, and web-based federal and state data collection system that is user-friendly.**

Current state information systems are designed and used primarily for accountability reporting, state level decisions, federal reporting, and aggregating data from schools and classrooms to state level. Data are not accessible at different levels of systems in most states, and data reports are usually not formatted and presented in ways that are useful or understandable to educators, administrators, business leaders, or policymakers. Systemic change can be advanced by connecting schools, specialists, teachers, and researchers through data systems. Support is needed for improving current methods of collecting, analyzing, and formatting data for reports, with a special focus on advancing instructional uses of data, as well as uses for policy-makers.

- **Assist teams of teachers and other educators to better understand and use data.**

Training should focus on improving knowledge of teams in these areas:

- presenting data with a goal to increase applications of data for instruction,
- understanding and application of appropriate statistics and reporting,
- writing test items, developing rubrics, and developing alternative forms of assessment,
- helping teachers analyze student work, disaggregate data, and answer "what does the data tell me?"

- **Establish consensus criteria for determining improvement in student achievement.**

Educators and the public have difficulty in sorting out meaningful improvement in learning from simple changes in test scores. Criteria for determining improvement across different kinds of tests, items, and content areas could be made understandable and easier to apply for all users of educational data.

- **Develop reliable measures and methods of evaluating change in classroom instruction, curriculum, and teacher content knowledge.**

State leaders want tools for evaluating standards implementation in schools, including:

- improved methods of student assessment,
- measures of classroom practices and enacted curriculum,
- reliable, comparable measures of professional development and impact on teaching.

- **Improve data to estimate teacher supply, demand, and quality.**

States need improved data to make informed policy decisions about the next generation of teachers. Currently, many states do not have adequate data or methods for addressing the supply and demand of qualified teachers of mathematics and science. Data should allow states to determine the adequacy of supply of certified elementary teachers vs. supply of qualified teachers of K-6 mathematics and science, in addition to the usual focus on qualified teachers of secondary math-science teachers. Finally, states need to make specific estimates of teacher-leaving rates, demand for middle and high school teachers, and numbers of graduates and new teachers entering the teaching force.

III. Implications for New NSF Program with States

Support for Systemic Reform: States and districts need to more clearly and thoroughly establish and communicate the goals for mathematics and science education in schools, the significance of changes in curriculum content and teaching practices, and the envisioned expectations for all students. The vision for science/math and its understanding by the public need to be more common to all of the stakeholders in K-12 math and science education.

Leadership: A result of the SSI program was leadership training within states in many aspects of systemic reform. For these leadership skills to be maximized, consistency in approach to math and science education needs to be maintained within the states. In addition, continuing leadership development is needed in these and other areas addressed by SSIs: professional development based on SSI models, selection and use of standards-based curriculum materials, and assessment development that is aligned with standards. Part of the SSI leadership development was achieved through cooperative meetings and activities of state leaders, and part through training and assistance by NSF and contractor organizations. A new generation of leaders and new levels of leadership are needed for continued expansion of systemic reforms.

Resources/Partnerships: To achieve further progress on systemic improvement in math and science education, states and federal agencies must decide how the lessons about partnerships and merging of resources can be applied toward more broad-based, statewide implementation. States suggested a number of components of systemic improvement that can be advanced through partnerships.

Policy/Infrastructure: States have only begun to define policies that align standards to the high school curriculum and course content in math and science. Also, most states have not yet made a strong policy connection between state content standards for student learning and the knowledge and skills teachers should be required to have in order to teach those standards.

Almost all states confer great flexibility to teachers and districts in meeting recertification requirements and in using state funds for professional development and in-service education. A major area of intervention through the SSI program was in professional development models, and states have demonstrated that certain models produce results for changing practices of teachers. The support of state policies in the area of professional development has yet to be achieved.

Strategic Decisions/Interventions: Across the participating states, each SSI tested a model for intervening with teachers, schools, or districts to improve teaching in math and science. While the models differed and results varied, these states now have evidence of and experience with an approach for working with schools and teachers that reflects state goals for improvement. We know from evaluations that the more effective SSIs focused their intervention designs on content knowledge of teachers and their use of active learning strategies.

States are still struggling with approaches to implementation of standards and would benefit from building on the record of effectiveness demonstrated by the SSI program in the support and leadership for intervention, such as professional development. Further support from the federal level should build on the evidence and models developed through the SSI program.

NSF resources can provide incentives to states for systemic change. NSF support can also provide leverage and incentives for state improvements with standards-assessment alignment, data systems, professional development, and other areas by providing flexibility to add new staff and leadership, improving training for current staff, providing time and organizational resources to focus efforts, and increasing expertise through collaboration and coordination.

Sustainability: Long-term systemic change is likely to require concentrated resources for building infrastructure, partnerships, and policy change. The tension within the SSI program concerning results vs. long-term development is similar to the tension existing in schools and districts that must meet state accountability goals for improved student scores on assessments. Continued federal support to states for math and science education is likely to include accountability measures focused on outcomes. This outcomes focus needs to be balanced with support for systems building that can ensure continued support for standards-based initiatives in math and science—without equating standards-driven change with the drive for immediate results.

Outcomes/Evaluation: Under the SSI program, each state developed different models for systemic reform and different plans for evaluation of the initiative. NSF subsequently defined six "drivers" for systemic change, which included emphasis on tracking change in student achievement based on assessments consistent with standards for math and science. NSF also required consistent data from systemic initiative sites (states, urban, rural) with the purpose of monitoring and evaluating improvement.

Many states now have accountability systems based on state assessments and other outcomes measures that evaluate progress for each school and district. Many states have data systems with the capacity for linking achievement and other outcomes to a variety of demographic, teacher, and curriculum variables. In new NSF-supported programs, it is likely that many states could meet the reporting requirements with their state data systems, thus reducing duplication of data collection and special reporting systems. The goal of new NSF programs should be to link evaluation of science and math initiatives to state information systems. These systems should include the capacity for disaggregating data by student characteristics and school characteristics.

Another implication from the SSI findings is the need for state assessments in mathematics and science that are more closely aligned with content standards for math and science. States leading systemic change in math and science will need to incorporate a "continuous improvement" model with participating schools, and they will need to look to their data systems to establish a basis for assessing progress by specific student groups and schools, for identifying problems, and for planning further actions.

Suggestions for Facilitating State Proposals and Planning: Dissemination and technical assistance should be provided to states for access to lessons gained from SSIs and other systemic initiatives and tools developed during the past decade through NSF and other federal support for standards-based math-science programs, research and evaluation, including:

- alternate methods of math and science assessment, especially performance assessment;
- evaluation tools, including classroom instruction analysis (e.g., Horizon Research), surveys of enacted curriculum to analyze classroom practices and content (e.g., CCSSO/WCER);
- methods of aligning standards and assessments (e.g., TIMSS/Achieve, Norman Webb/CCSSO analysis procedures, Council for Basic Education (CBE) standards/benchmarks analysis);
- case study evaluation models (e.g., SRI, CPRE);
- data-driven curriculum improvement and models for professional development (e.g., TERC Alliance for Math-Science Reform);
- comprehensive database design for quantitative and qualitative data analysis and utilization (e.g., Systemic Research, Inc.).

In addition, states need assistance in proposal development and writing that incorporate models of systemic improvement.

NSF should collaborate with other federal agencies in the planning and review of programs aimed at improving mathematics, science, and technology education. Federal agencies should act collectively to ensure that they approach systemic reform systemically. NSF should promote greater cross-agency participation in the review of overall programs and of specific proposals related to the systemic improvement of mathematics, science, and technology education.

NSF should increase the participation of business and policy leaders in the review of systemic reform proposals. Research on systemic reform indicates that significant and lasting improvement requires establishment of partnerships that blend the knowledge and support of education, business, and policy leaders. Representatives of these three constituencies should be involved in the proposal review/analysis in order to ensure reform success.

Summary of Implications for NSF Role with States

State leaders recommended that NSF act as a continuing and long-term "surface catalyst" for advancing reforms and improvements statewide. The model for funding support from NSF should be systemic in that all state education systems should be given opportunity to link their efforts with the goals of NSF. At this time, emphasis should be placed on those states that historically have not had support from NSF.

NSF can provide leadership and models for states in the area of alignment of key system components with standards, primarily student assessment programs, curriculum materials, teacher preparation, and evaluation. Flexibility should be maintained in support of different state-based approaches to reform and improvement of instruction. NSF's role should be sufficiently flexible to allow states to focus on different levels of their systems for initiatives and to permit existing state "drivers" of systemic reform to merge with NSF drivers.

Considering that many states are involved in comprehensive K-12 education reforms covering core academic subjects, math and science reform initiatives should be framed within these larger models. For example, some states are focusing on overall educational programs and outcomes for students at the transition points in systems, including grades 8 to 9 and high school graduation to postsecondary education. Many states are also working on improving collaboration of programs related to content standards among state departments of education (for K-12 education), higher education boards, vocational education, and community and technical college systems.

Several priorities for NSF programs are indicated by this review and summary report:

- **Advance the agenda of the National Commission on Mathematics and Science Teaching for the 21st Century.**

The Glenn Commission report (U.S. Department of Education, 2000) provides an important set of priorities for improving the quality of mathematics and science education based on the current needs of schools, districts, and states.

- **Promote building of state partnerships that will continue systemic change over time.**

Models showing effective coordination of federal, state and private funding and use of resources for math and science education improvement need to be made available to states. States can then build on current

evidence about the critical role of partnerships in the vision for systemic math and science education improvement, leadership development, decisions on program interventions, changing policies, and evaluating progress.

- **Focus on advancing equity in math and science education through greater supply of qualified teachers and improved allocation of qualified teachers among districts, schools, and classrooms.**

States should be encouraged to advance state policies emphasizing incentives and subsidies to improve the numbers and preparation quality of mathematics and science teachers. State policies and plans to improve teacher preparation (pre-service and professional development) need to be systemic and coordinated with partner organizations in education, scientific professions, and business and industry. States should support efforts for using educational technology to improve access to quality math and science teaching.

- **Continue support for state development of linked standards, assessments, and accountability.**

NSF should remain focused on leadership development in standards-based math and science and linking improvement efforts to standards. States need specific assistance with use of state-level data for research and analysis to demonstrate extent of progress, identify and disseminate effective models, and plan and target efforts for scaling up.

- **Emphasize use of data for state policy-making and educational decisions.**

State and federal leadership and collaboration should move toward a unified, web-based data system that is user-friendly, with emphasis on data applications for educators at all levels and for long-range policy decisions such as teacher quality and supply. Both NSF and states need access to data on students, teachers, achievement, curriculum, and programs that can be readily analyzed and disaggregated. Data need to be applied in evaluating effects of initiatives over time, and data should drive decisions on priorities for improvement in math and science.

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Appendix

Findings from the SSI Program: Conference on Integrating Results from Research and Evaluation Studies, June 22-23, 2000
Washington, DC

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Implementing Standards-Based Mathematics and Science in Schools Statewide: What is Needed?

Meeting of State Education Leaders, September 18-19, 2000
Alexandria, VA

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