A Splintered Vision:

An Investigation of

U.S. Science and Mathematics Education

EXECUTIVE SUMMARY

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THE SPLINTERED VISION: AN OVERVIEW

There is no one at the helm of mathematics and science education in the U.S.; in truth, there is no identifiable helm. No single coherent vision of how to educate today's children dominates U.S. educational practice in either subject, nor is there a single, commonly accepted place to turn to for such visions. Our visions to the extent that they exist at all are multiple.

These splintered visions produce unfocused curricula and textbooks that fail to define clearly what is intended to be taught. They influence teachers to implement diffuse learning goals in their classrooms. They emphasize familiarity with many topics rather than concentrated attention to a few. And they likely lower the academic performance of students who spend years in such a learning environment. Our curricula, textbooks, and teaching all are "a mile wide and an inch deep."

This preoccupation with breadth rather than depth, with quantity rather than quality, probably affects how well U.S. students perform in relation to their counterparts in other countries. It thus determines who are our international "peers" and raises the question of whether these are the peers that we want to have. In today's technologically oriented global society, where knowledge of mathematics and science is important for workers, citizens, and individuals alike, an important question is: What can be done to bring about a more coherent vision and thereby improve mathematics and science education?

Reforms have already been proposed by political, business, educational and other leaders. Extensive efforts are underway to implement these standards, but the implementation process itself is shaped by the prevailing culture of inclusion. Like the developers of curricula and the publishers of textbooks, teachers add reform ideas to their pedagogical quivers without asking what should be taken away.

The study summarized below represents an effort to describe the nature of the diffuse vision of mathematics and science education in the U.S. and to raise questions relevant to policy making.

Purpose of A *Splintered Vision*

A Splintered Vision (written by William Schmidt, Curtis McKnight and Senta Raizen of the U.S. National Research Center for the Third International Mathematics and Science Study and published by Kluwer Academic Publishers) discusses data from the analysis of 491 curriculum guides and 628 textbooks from around the world as part of the recently completed Third International Mathematics and Science Study (TIMSS). It also presents detailed accompanying data on teacher practices in the U.S. and two other countries: Germany and Japan.

The TIMSS is a large-scale, cross-national comparative study of the national educational systems and their outputs in about 50 countries. Researchers examined mathematics and the sciences curricula, instructional practices, and school and social factors, as well as conducting achievement testing of students. They collected data from representative documents that laid out official curricular intentions and plans, analyzed entire mathematics and science textbooks, and searched entire K-12 textbook series for selected "in-depth" topics (subareas within the subject matter.) In six countries TIMSS conducted classroom observations, teacher interviewing, and videotaping.

The TIMSS curriculum and teacher data are extensive and cannot be explored in a single report. The results of analyses of these data are being reported in a series of volumes, three of which are now available.[1]

The present report intends to document and characterize the state of U.S. mathematics and science curricula, textbooks, and teaching practices and place them in a cross-national context. Unfortunately, this study could only provide a snapshot of the "moving target" that is educational practice in the U.S. These data were collected in 1992-93, when the mathematics standards had only existed for three years and the science standards were not finalized.[2] The intervening years have been a time of change for state curriculum standards and textbooks. The TIMSS data on teacher practices discussed here were collected in 1995.

This report is meant to be descriptive and, to a lesser extent, interpretive. It is not a plea for specific reforms. We seek to provide data germane to the ongoing public debate about science and mathematics education policies in the U.S.

Unfocused Curricula

Curricula in both mathematics and science in U.S. schools are unfocused in comparison with those in other countries studied. The lack of curricular focus is more true in mathematics than in science, though physical science guides closely resemble mathematics in their fragmentation. U.S. curricula are unfocused in several respects:

- *Topics Covered*

  Mathematics curricula in the U.S. consistently cover far more topics than is typical in other countries. The number of mathematics topics in the U.S. composite[3] is higher than the 75th percentile internationally in all grades until ninth, when schools typically teach specific courses such as algebra, geometry, etc. In science, the tendency toward inclusion is similar, though less pronounced. The number of science topics in the U.S. composite exceeds the 50th percentile internationally in all but one grade until the tenth, when schools tend to abandon general science approaches for specific courses, such as chemistry and physics.

- *Repetition*

  In both mathematics and science, topics remained in our composite U.S. curricula for more grades than all but a few other TIMSS countries. The U.S. approach can be characterized as "come early and stay late." In mathematics, the U.S. practice is to add far more topics than other countries do in grades one and two and then repeat these topics until grade seven. In grades nine and 11 the U.S. composite curriculum drops many more topics than other countries. On average, mathematical topics remain in the U. S. composite curriculum for two years longer than the international median. Only five countries have higher average durations. In science, U.S. practice is to introduce new science topics at intervals, especially grades one and five, with little change in the intervening grades. In grades 10 to 12 the U.S. composite curriculum drops many more topics than other countries. Average intended duration is close to the international median in earth sciences and life sciences, but the U.S. average duration in the physical sciences is two years longer than the median and higher than all but seven countries. In mathematics, the tendency to retain topics over many grades may reflect the traditional approach of distributed mastery the idea that mastering pieces of a subject would lead to mastery of a bigger whole. U.S. curricula lack a strategic concept of focusing on a few key goals, linking content together, and setting higher demands on students. This propensity for inclusion extends even to reform proposals. Many reform recommendations simply add to the existing topics (or are implemented by adding to existing content), thereby exacerbating the existing lack of curricular focus.

- *Emphasis*

  U.S. curricula in mathematics and science seek to do something of everything and less of any one thing. Given roughly comparable amounts of instructional time, this topic diversity limits the average amount of time allocated to any one topic. In mathematics, this accumulation may be a product of our model of distributed mastery over the grades. The reasons for the better results in science are less clear but seem related to general science approaches that move from topic to topic.

- *Variations Among States*

  While the core of mathematics topics was broad, it varied little among the states. The number of core science topics was much smaller, and the overlap among state curricula was also small. While students in U.S. states might have studied a number of science topics roughly equal to the international median, the differing curricular intentions of various states are such that students in different states likely studied only a few common topics.

- *Defining the "Basics"*

  Student achievement in mathematics and science in any country is largely shaped by what educational policy makers in that nation regard as "basic" in these subjects and how well they communicate and support those basics. The U.S. mathematics instructional practices defined de facto eighth grade basics of arithmetic, fractions and a relatively small amount of algebra. In Germany, Japan, and internationally, the basics were defined as algebra and geometry. For science, the picture is more complex since U.S. curricula include single area courses, such as physical sciences, life sciences, or earth sciences. These courses defined a more restricted, focused set of basics, but they applied only to the subset of students receiving those particular courses.

Unfocused Textbooks

Textbooks play an important role in making the leap from intentions and plans to classroom activities. They make content available, organize it and set out learning tasks in a form designed to be appealing to students. Without restricting what teachers may choose to do, textbooks drastically affect what U.S. teachers are likely to do under the pressure of daily instruction. The question thus arises: Do U.S. mathematics and science textbooks add guidance and focus to help teachers cope with unfocused curricula? Unfortunately, the answer is "no." The splintered character of mathematics and science curricula in the U.S. is mirrored in the textbooks used by teachers and students. American textbooks are unfocused in several ways:

- *Topics Included*

  The U.S. mathematics and science textbooks include far more topics than was typical internationally at all three grade levels analyzed. In mathematics, U.S. textbooks are far above the 75th percentile of the TIMSS countries in the number of topics covered. For example, U.S. mathematics textbooks designed for fourth and eighth graders cover an average of 30 to 35 topics, while those in Germany and Japan average 20 and 10 respectively for these populations. As a result, typical mathematics textbooks in the U.S. look quite different than those of a nation such as Japan. The typical eighth grade U.S. textbook (non-algebra) is larger and more comprehensive than the average Japanese text, but it contains fewer sequences of extended attention to a particularly important topic. The U.S. textbooks' sequences are also shorter and have more breaks. The lesson by lesson organization of the U.S. book is much less focused than the Japanese book, and there is far more skipping among topics in successive segments. In science, the differences are even greater. At all three population levels, U.S. science textbooks included far more topics than even the 75th percentile internationally. The average U.S. science textbook at the fourth, eighth, and 12th grade has between 50 and 65 topics; by contrast Japan has five to 15 and Germany has just seven topics in its eighth grade science textbooks.

- *Emphasis*

  The propensity of U.S. curricula to do something of everything but little of any one thing is mirrored in textbooks. The few most emphasized topics account for less content than is the case internationally. Among the fourth grade mathematics textbooks investigated, the five topics receiving the most textbook space accounted on average for about 60 percent of space in the U.S. textbooks but over 85 percent of textbook space internationally. At the eighth grade level, the five most emphasized topics in non-algebra U.S. textbooks accounted for less than 50 percent of textbook space compared to an international average of about 75 percent. An exception are U.S. eighth grade algebra books which were highly focused, the five most emphasized topics accounting for 100 percent of the books. Among the U.S. fourth grade science textbooks investigated, the five topics receiving the most attention accounted for an average of just over 25 percent of total space in U.S. textbooks compared to an average of 70 to 75 percent internationally. Among the U.S. eighth grade science textbooks investigated, the five most emphasized topics in more general science texts accounted for about 50 percent of textbook space compared to an international average of about 60 percent. In contrast, U.S. eighth grade science books oriented to a single area were highly focused, with the five most emphasized topics accounting for more of the textbooks than was true in the international average.

- *Difficulty*

  U.S. eighth grade science textbooks emphasized understanding and using routine procedures, which represent the less complex, more easily taught expectations for student performance. This emphasis was typical of what was done internationally. It is not, however, typical of the diverse and more demanding performances called for in current U.S. science education reform documents. Most U.S. schools and teachers make selective use of textbook contents and rarely, if ever, cover all of a textbook's content. Publishers can reasonably expect that those who adopt and buy a particular textbook will feel free to use only the contents that suit their purposes. Unfortunately, the result is large textbooks covering many topics but comparatively shallowly. Even in the largest textbooks, space is still limited. It is impossible for textbooks so inclusive to help compensate for unfocused official curricula. Thus, our analysis shows that U.S. textbooks support and extend the lack of focus seen in those official curricula.

How Teachers Deal with the Splintered Vision

Teachers in the U.S. are sent into their classrooms with a mandate to implement inclusive, fragmented curricula and armed with textbooks that embody the same "breadth rather than depth" approach. How do they handle such a situation? Not surprisingly, the instructional decisions made by U.S. teachers mirror the inclusive approach of the tools they are given. U.S. teachers handle the splintered vision they get in several ways:

- *Topics Covered*

  U.S. mathematics and science teachers typically report teaching more topics than their counterparts in other countries, including Germany and Japan. This is true for science teachers even when using a single area textbook such as physical science, life science, or earth science.

- *Emphasis*

  Since instructional time for science or math within a school year is limited, the data show that teaching more topics means that teachers spend little time on most topics. U.S. eighth grade mathematics teachers indicated that they taught at least a few class periods on all but one topic area included in the teacher survey's questionnaire. They devoted 20 or more periods of in-depth instruction to only one topic area, fractions and decimals. However, in Germany and Japan many other topic areas received this more extensive coverage. According to the survey, the five topic areas covered most extensively by U.S. eighth grade mathematics teachers accounted for less than half of their year's instructional periods. In contrast, the five most extensively covered Japanese eighth grade topic areas accounted for almost 75 percent of the year's instructional periods. U.S. eighth grade science teachers also indicated that they would devote at least some class time to every topic area surveyed. None was omitted completely and no topic was marked to receive more than 13 class periods of attention by eighth grade physical and general science teachers. Additional topic areas received more extensive coverage in Germany and Japan. On average U.S. eighth grade general science teachers' most extensively covered topics accounted for only about 40 percent of their instructional periods, but this percentage was also lower for science in Germany and Japan (about 50 to 60 percent).

- *Number of Activities*

  U.S. teachers engage in more teaching activities per lesson than their counterparts in other countries. More than 60 percent of U.S. eighth grade mathematics and science teachers reported using six or more activities in a typical class. In Germany only 25 percent reported using six or more activities, and even fewer reported doing so in Japan.

Is This The Best Our Teachers Can Do?

U.S. mathematics and science teachers work hard and often face demanding workplaces. Our data show that they are scheduled to work about 30 periods each week, which is more than teachers in Germany (just over 20 periods) and Japan (fewer than 20). These teachers rarely have the luxury of being idealists. Unfocused curricula and inclusive textbooks set few boundaries for instructional decisions and appear to require a little bit of everything. It is easier for real teachers making real decisions in the real workplaces of U.S. schools to settle for the first alternative that seems good enough rather than search for the best possible instruction. They try to cover as much as they can rather than teach just a little. In a word, they "satisfice" The data shows that U.S. mathematics and science teachers are aware of and believe in more effective, complex teaching styles than they practice. They often have information that would help them do their work more effectively. Their beliefs suggest that they might choose to organize instruction differently under circumstances less consumed by the need for coverage. Effective teachers should not be unusual, nor should effectiveness require extraordinary efforts and dedication by teachers. The reality, however, is that U.S. teachers are placed in situations in which they cannot do their best. We have yet to unleash the effectiveness of U.S. teachers. It seems likely that fundamental changes are needed in teacher knowledge, working conditions, curricula quality, student expectations, and textbook content.

What Can We Expect from U.S. Students?

In mathematics, we have a highly fragmented curriculum, textbooks that are a "mile wide and an inch deep," and teachers who cover many topics but none extensively. We make low demands on students and have a more limited conception of "the basics" than the international norm. It seems highly likely that U.S. student achievement in mathematics will be below international averages. Our science curriculum is less fragmented. Science achievement seems likely to be closer to international averages, but still not what we desire and certainly below some, if not most, of our economic peers. U.S. students' achievements the yield of our aggregate national education "system" in mathematics and the sciences are likely to be disappointing and many of the reasons are not under students' control. We must make substantial changes if we are to compete and to produce a quantitatively and scientifically literate workforce and citizenry.

How Has Our Vision Become So Splintered?

Culture affects education, even in supposedly fixed disciplines such as mathematics and science. Countries differ in the priorities they give to these disciplines, in the way they organize instruction and the value they ascribe to academic success. The qualitative differences found in mathematics and science instruction across France, Japan, Spain, Switzerland, Norway and the U.S. suggest that strong cultural components, even national ideologies, are at work in the teaching of these subjects. The current state of our nation's composite visions guiding mathematics and science education are clearly shaped by cultural forces particular to the U.S., starting with the nation's decentralized approach to education.

- *A System With Many Actors*

  Education in the U.S. always has been guided by agencies and organizations local, state, and national, official and unofficial that take their share of responsibility for education. There are many actors, including states, schools, commercial publishers, national associations, test publishers, teachers, and the federal government. While the independence of these groups is essential to education in the U.S., the result is a composite of sometimes corresponding, sometimes conflicting separate visions. The conversations that cumulatively shape the national visions of mathematics and science education in the U.S. appear to be held in the tower of Babel. Our earlier statement that there was "no one helm" for mathematics and science education should not be taken as implying that there should be either a single helm or a single helmsman. At its best, our system of distributed educational responsibility allows local preferences and community needs to help determine what occurs in local schools. It also provides laboratories to test, implement, and replicate new approaches. At its worst, our system requires that we seek consensus on needed changes site by site. Given the cultural context in which mathematics and science education is carried out in the U.S., a decentralized system with many actors s inevitable. We hope the splintering is not.

- *A Diverse Market for Curricula and Textbooks*

  U.S. textbook publishers face varied, often conflicting, demands for what should be in mathematics and science textbooks. Official mathematics and science curricula vary widely among states and districts. Over 35 states have textbook adoption policies, but in many states districts are free to choose any textbook. Textbook publishers are understandably eager to produce products that will appeal to as many markets as possible. The results are large textbooks that embrace virtually all suggestions offered by the various actors. They include something for everyone. If a clear, coherent vision of what is important existed and was shared by virtually all textbook publishers, it is likely that the resulting materials could soon lead to wide official adoption reflecting that coherent vision.

- *Standardized Tests*

  The cacophony of conflicting demands seen in curricula and textbooks is exacerbated by pressures to provide for successful student performance on common standardized tests. These include state assessments and the National Assessment of Educational Progress (NAEP) tests as well as commercially produced and locally mandated standardized tests. Despite a seeming sameness about most standardized tests, there are differences in content emphases and student performance demands. These differences are sufficient to constitute yet another set of demands to try to reconcile.

- *Mass Production and Mass Education*

  U.S. education has been influenced profoundly by a deeply seated American ideology springing from our national experience with the power of industrial and assembly line production. This ideology revolves around the idea of producing uniform, interchangeable parts that can be assembled into desired wholes. Translated into education, such thinking views school mathematics and science as partitioned into many topics that form the building blocks of curricula. As a result, our students may grasp the pieces but not the whole. We have applied the term incremental assembly to this ideology and believe that it may well keep the U.S. from finding other, more coherent and powerful ways to think about and organize curricula. This is unfortunate. Henry Ford, presumably, did not try to make all models simultaneously on the same assembly line. The lack of focus in U.S. mathematics and science education also has roots in behavioral psychology, which has pushed education in the direction of behavioral objectives and programmed instruction. This notion may help explain our curricula of many small topics, frequent low demands, and interchangeable pieces of learning to be assembled later.

The Impact of Reform

In the U.S. today we live in a climate of reform and talk of reform. Professional organizations concerned with mathematics and science education issue platform documents setting out agendas, benchmarks and "standards." These powerful, demanding, and insightful calls for reform offer coherent visions of what might be done to make major improvements in their targeted educational practices. What has been their impact on mathematics and science education?

- *Awareness of Reforms*

  As late as two years ago, state mathematics and science curriculum guides, plans, and statements of intentions still called for coverage of far more topics than most other countries did and, far more than would be indicated by current reform agendas in mathematics and science education. The same can be said of textbooks. U.S. mathematics and science teachers are generally aware of these reforms. More than 75 percent of U.S. mathematics teachers indicated familiarity with the NCTM Standards. Fewer U.S. science teachers indicated similar familiarity with the corresponding science frameworks, but those were released five years after the mathematics report. These data suggest that more time alone will not be enough. Failure to create widespread change in teaching practice does not appear to be due to lack of information.

- *An Unfocused Reform*

  U.S. mathematics and science educators approach reform in the same inclusive style as they deal with traditional content they add its recommendations but do not take away. This is clearly contrary to the recommendations of the NCTM Standards. Textbooks have been affected to some extent by mathematics education reform recommendations, but in a similar inclusive manner. As a result, students cannot focus on or be successful in either the old or new curricula. This development is troubling because the reform agendas typically are coupled with more demanding, time-consuming and complex performance expectations that require paying careful attention to a smaller number of strategic topics. Adding more topics will not help. The impact of science reform recommendations remains untested as yet. Reform documents themselves often emerge from compromise among professionals, and this compromise may prevent them from stating a single vision. Even when a reasonably coherent voice emerges for reform for example, the NCTM Standards in math education and the National Research Council's National Science

Education Standards our organizational context causes it to be heard as simply one more voice in a "babel" of competing voices. This "babel" becomes so overwhelming that it is hard for official actors to separate "signal" from "noise" or to prioritize the voices to which they will listen. In such a systemic context, splintered visions are likely to remain splintered.

- *The Need for Time*

  The lack of success reform measures have had to date does not imply that they have been futile. Rather, they imply that reform may take considerable time. Slow progress is certainly no reflection on the quality or power of mathematics and science reform efforts that have yet to be as effectual as their supporters wish in this climate. Certainly it would be drastically wrong to conclude, based on these "early returns," that these reforms have failed. Rather, it seems more appropriate to be amazed at their current successes.

Who Are Our Curricular Peers?

If we take seriously that the proportions of curricula, as set forth in state guidelines and textbooks, set bounds on what is broadly achieved by those taught, we should identify those countries that set similar bounds to their students' achievement. In grade eight mathematics, the U.S. composite curriculum as represented by textbooks is most like those of Australia, New Zealand, Canada, Italy, Belgium (French language system), Thailand, Norway, Hong Kong, Ireland, and Iceland. In grade eight science our curriculum is most like that of New Zealand, Iceland, Greece, Bulgaria and the Peoples' Republic of China.

Are These the Peers We Want?

While the curriculum of any country is interesting and has some important features, we must ask if these are the countries with whom we are and will be trying to compete. As a nation we desire to empower and inform our citizenry comparably as well as to effectively compete economically with other developed countries. We want attainments similar to the European Union, to the APAC countries (especially Japan and the "young tigers" of Korea, Singapore, etc.), and, most definitely, with the other G-7 countries. When we find ourselves most similar to countries other than those with whom we seek to be peers, we have reason for deep concern. In matters of what is basic in teaching children mathematics and science, we are not peers with the composite of other TIMSS countries. We as a nation must be concerned.

What is Necessary for Reform to Succeed?

The U.S. vision of mathematics and science is splintered. We are not where we want to be. We must change. But the required change is fundamental and deeply structural. There are no single answers or instant solutions. Most nations do not share similarly splintered visions in mathematics and science education. Theirs are more coherent. While central guiding visions do not alone guarantee student achievement, they contribute to optimal attainments. These shared visions are insufficient to ensure desired achievements, but they seem necessary starting points. The U.S. has a decentralized educational system in which the component organizations do not always work towards common goals, nor do they always aim at producing important combined results. Formal mechanisms of coordination either by regulation or rewards for selected behaviors have proven politically sensitive and are in limited use. Given such a culture of education, how can a focused vision be achieved? Several principles would seem to be at work:

- *Effective Reform Will Necessarily Be Systemic*

  Information- and motivation-based reforms and improvement policies alone will not bring fundamental improvements. Any serious attempt at change in U.S. science and mathematics education must be deeply structural. The fundamental problem is not a conglomeration of individual problems. Any effective reform in this context will necessarily be systemic affecting several parts at once. Not every systemic reform automatically will address the core of our problems. Appropriate structural reform must pursue focused and meaningful goals. We may not be able to do everything and do any of it well. Instead, it appears we must make choices regarding which goals are more important and how many goals we can effectively pursue.

- Effective Reform Must Respect Cultural Context

  Whatever actions are taken must be appropriate to our educational federalism and our context of shared educational responsibility. When discussion suggests the need for more powerful and coherent guiding visions, they must be sought in processes that will achieve wide consensus necessary for change in our context. A corollary is that we may learn from other countries but we cannot emulate their centrally administered changes. Any reform in the U.S. must seek visions that can achieve broad consensus.

Conclusion

The U.S. needs powerful mathematics and science education because they:

- Provide a strong basis for our democracy by helping create a literate and informed citizenry;

- Help each individual to grow, develop, reach his or her individual potential, and become more autonomous and empowered; and

- Provide a sound basis for continuing national prosperity in a competitive, information-driven, technological, and changing international arena.

Perhaps we do not need a central focus for our curricula and teaching. Perhaps the value of diversity outweighs the value of focus. Perhaps our de facto emphasis on breadth will prove more effective overall than other countries' strategies of focusing on strategic topics. That is a matter for further empirical evidence and public discussion.

Both conventional wisdom and a considerable body of research, however, suggest that focus and selection are needed in situations in which too much is included to be covered well. The impact of these unfocused curricula and textbooks in mathematics and science likely includes lower "yields" from mathematics and science education in the U.S. Focus would seem to be a necessary but not a sufficient condition for high student attainments.

What kinds of mathematics and science education do we, as a nation, want for our children? While this is a central question for public debate, it seems likely that we want educations that:

- Are more focused, especially on powerful, central ideas and capacities;
- Provide more depth in at least some areas, so that the content has a better chance to be meaningful, organized, linked firmly to children's other ideas, and to produce insight and intuition rather than rote performance; and
- Provide rigorous, powerful, and meaningful content that is likely to produce learning that lasts and not just learning that suffices for the demands of schooling.

Questions to Ask

The authors of this report do not represent any official or policy-making group. Our job has been to design relevant research, analyze its results carefully, and report them objectively. Because of who we are, we do not feel it appropriate to make specific recommendations. We can, however, at least ask questions questions that our results lead us to believe important for those who do set policy.

Most of these questions are not original with us, although their form here has been influenced by the data we investigated. In fact, some efforts are currently underway to address these questions, including the National Science Foundation's State Systemic Initiatives and the recently convened executive committee of the National Governors' Association in conjunction with business leaders. Those efforts may include answers to several pressing questions raised by these findings:

- How can we focus our mathematics and science curricula and textbooks around an intellectually coherent vision?
- How can we raise expectations and demands on our students?
- How can we help our teachers to do the best they can in teaching mathematics and science to our students?
- How can we find a better model for curriculum and instruction?
- How can we develop a new vision of what is basic and important?

Certainly these are not the only questions that must be asked and answered on the way to the revolution or, if one prefers, to a fruitful evolution in mathematics and science education. We have not touched on whole domains of issues for example, concerns for equity in educational opportunity because we did not want a report on the "splintered vision" of our children's education to be itself unfocused. Others must join in seeking answers to the questions raised here and the others we did not raise. Our data can help.

Presently, however, our story is simple. The U.S. vision of mathematics and science education is splintered. We are not where we want to be. We must change.

WORKS CITED

[1]The first, Characterizing Pedagogical Flow, discusses curriculum data in mathematics and science along with classroom observations and teacher interviews in six TIMSS countries. The second and third, Many Visions, Many Aims: A Cross-National Investigation of Curricular Intentions in School Mathematics and Many Visions, Many Aims: A Cross-National Investigation of Curricular Intentions in Science Education, are reports that present data on the full set of almost 50 TIMSS countries.

[2] At that time the National Council of Teacher of Mathematics (NCTM) Standards (for mathematics education) had only existed for about three years. The American Association for the Advancement of Science's (AAAS) Benchmarks (for science and mathematics literacy) had been released only in preliminary form. The National Academy of Science's National Research Council's Science Education Standards had yet to be fully formulated or released. Therefore this report cannot offer any conclusions about these reforms.

[3]Because the U.S. does not have a national curriculum we aggregated states to find a representative average.

Other reports related to the Third International Mathematics and Science Study (TIMSS) are available at the following site:

http://www.ed.gov/NCES/timss/index.html