MINNESOTA TIMSS REPORT: DECEMBER 2008

A PRELIMINARY SUMMARY OF RESULTS

TRENDS IN INTERNATIONAL MATHEMATICS AND SCIENCE STUDY

MINNESOTA SCIENCE AND MATH COMPARED INTERNATIONALLY IN TIMSS

The 2007 TIMSS is referred to as the Trends in International Mathematics and Science Study. With more than 60 countries participating and 425,000 students assessed, TIMSS 2007 is still the largest study of student math and science achievement in the world. Fourth and eighth grade students were the focus in 2007 and each participating country sampled approximately 4,000 students in 150 schools.

SciMath^{MN} sponsored Minnesota's 1995 participation as a 'mini-nation' in TIMSS, and was awarded the contract to analyze the 2007 Minnesota TIMSS results, where Minnesota again participated as a mini-nation.

Mini-nation status allows Minnesota to participate as if it were a nation, establishing our ranking among the other participating nations and providing insight into our students' ability to compete on a global scale.

WHERE IS MINNESOTA MATHEMATICS IN 2007?

MINNESOTA'S 2007 TIMSS MATHEMATICS PERFORMANCE

- The 2007 TIMSS U.S. mathematics performance at both grades 4 and 8 improved over 1995.
- In 1995, Minnesota's performance at both grades 4 and 8 was not significantly different from the overall U.S. performance.
- In 2007, like the U.S. overall performance, Minnesota's scores at both grades 4 and 8 improved from 1995 but unlike 1995, Minnesota's 2007 performance is significantly higher than that of the U.S. at both grades 4 and 8.
- At 4th grade, Minnesota students scored about a half of a standard deviation above the TIMSS Scale Average (500) just below the 4 top achieving countries.
- At 8th grade, Minnesota students performed about one-third of a standard deviation above the TIMSS Scale Average (500) but substantially below the top 5 achieving countries.
- The Minnesota 4th grade performance **gain** was among the largest of any of the 16 countries that participated in both the 1995 and 2007 TIMSS ($p < .05$).
- The Minnesota 4th grade **gain**, which was over a third of a standard deviation, was more than three times the gain indicated for the U.S. as a whole.
- At 8th grade, Minnesota's 2007 **gain** over 1995 was substantially less than the 4th grade gain – about one tenth of a standard deviation – which was not statistically significant ($p < .11$).
- A similar pattern of improvement from 1995 to 2007 for both the U.S. as a whole and Minnesota can be noted with the NAEP results.

WHAT HAS HAPPENED SINCE MINNESOTA PARTICIPATED LAST IN 1995?

MORE THAN A DECADE OF ACTION

Minnesota has not stood idle in the twelve intervening years between these tests. A number of significant statewide educational changes have been implemented:

- State standards in mathematics and science were implemented in 1997 and have since been revised twice.
- Rigorous high stakes tests (Minnesota Comprehensive Assessments) have been in place since 1998 in mathematics (and 2008 for science).
- SciMath^{MN} developed Frameworks for teaching mathematics and science (based on Minnesota state standards) that were widely distributed and used throughout Minnesota.
- Standards-based mathematics curriculum increased in use – especially in larger districts, thereby impacting the majority of students in the state.
- Increased classroom time has been allocated in many districts to the tested subjects – especially at the elementary level.
- Graduation requirements in both mathematics and science have significantly increased.
- Algebra will be required for all 8th grade students in the year 2011, and Algebra II will be required of the same cohort of students for graduation in 2015; graduates of 2015 must also complete either chemistry or physics. Many districts have already initiated the change process to prepare students for these requirements.
- SciMath^{MN} shared Minnesota's participation in the 1995 TIMSS with many districts which produced valuable lessons for the districts becoming resources for staff development and decision-making.

CONTEXT FOR MATHEMATICS SCORES

- In 1995, Minnesota performed relatively quite well in science but no different from the mediocre U.S. performance in mathematics.
- At that time, the conjecture as to why Minnesota's science performance was so much better than its performance in mathematics was the existence of a strong informal network in science that essentially functioned as statewide standards for what should be taught and learned.
- In 2007 after having true statewide standards in place since 1997, Minnesota continued to perform quite well in science by international standards.
- The conjecture as to why the state improved so dramatically in 4th grade mathematics is that, unlike 1995, the state has had statewide mathematics standards in place since 1997, which were revised in 2003. Therefore, all four years of the mathematics learning of Minnesota's TIMSS 2007 4th graders were most likely informed by the 2003 standards. It should also be noted that the 2007 TIMSS 4th grade test reflected similar emphases to those in the 2003 standards for 4th grade mathematics.
- The development of the 2003 standards was influenced by the international benchmarking data available through the 1995 TIMSS.
- The existence of these formal mathematics standards are conjectured to function similar to the informal science network in 1995 providing statewide coherence and focus as to what teachers teach and students learn.
- Another consequence of formal state standards and increased use of more robust, standards-based curriculum is that mathematics instruction time at the elementary level for many districts has increased from as little as 30 minutes per day in 1995 to around 60 minutes or more per day in 2007.

- Coincident with the introduction of statewide standards was the introduction of the state accountability assessments (Minnesota Comprehensive Assessments), which tend to focus attention and bring emphasis to the content in the standards.

- One of the goals of standards and accountability assessments is to reduce the variation from one school to another in what teachers teach and emphasize and in what students learn which is what is seen in the 2007 Minnesota TIMSS results.

- At 8th grade, Minnesota teachers reported a substantial increase in the amount of time devoted to Algebra over what was reported in 1995. For example, in 1995 8th grade teachers reported spending only 11 percent of their instructional time on Algebra but in 2007, 8th grade teachers reported spending over four times as much instructional time on Algebra (48 percent). The TIMSS 8th grade test had a strong focus on Algebra, which is what is most typically targeted for all 13 year-old students around the world.

- Similarly, in 2007, 4th grade teachers reported devoting substantially less time to mathematics topics often covered at higher grades in other countries and more time on number – computation with whole numbers, fractions, decimals, and number patterns – which is the major focus of grade 4 mathematics internationally.

- The amount of instructional time devoted to number at 4th grade in 1995 as reported by teachers was about one-third of the school year. In 2007, the amount of time spent on number topics increased substantially to almost 60 percent.

THE FOLLOWING CHARTS DISPLAY FIRST THE GRADE 4, THEN GRADE 8 MATHEMATICS RESULTS FOR BOTH 1995 AND 2007

1995 Rescaled Mathematics Scores

Grade 4

Nation	Mean
Singapore	590
Korea, Rep. of	581
Japan	567
Hong Kong SAR	557
Netherlands	549
Czech Republic	541
Austria	531
Slovenia	525
Ireland	523
Hungary	521
United States	**518**
Australia	517
Minnesota, US	**516**
Italy	510
Canada	506
Israel	505
Latvia	499
Scotland	493
England	484
Norway	476
Cyprus	475
New Zealand	469
Thailand	467
Greece	463
Iceland	453
Portugal	442
Iran, Islamic Rep. of	387
Kuwait	351

Mean Across All Countries **500**

Significantly Higher than MN
Not Significantly Different from MN
Significantly Lower than MN

**** Please note:**
The Scale Average for all charts (TIMSS rescaled 1995 and TIMSS 2007, both grade 4 and 8) is 500.

2007 Mathematics Scores

Grade 4

Nation	Mean
Hong Kong SAR	607
Singapore	599
Chinese Taipei	576
Japan	568
Minnesota, US	**554**
Kazakhstan	549
Russian Federation	544
England	541
Latvia	537
Netherlands	535
Lithuania	530
United States	**529**
Germany	525
Denmark	523
Australia	516
Hungary	510
Italy	507
Austria	505
Sweden	503
Slovenia	502
Armenia	500
Slovak Republic	496
Scotland	494
New Zealand	492
Czech Republic	486
Norway	473
Ukraine	469
Georgia	438
Iran, Islamic Rep. of	402
Algeria	378
Colombia	355
Morocco	341
El Salvador	330
Tunisia	327
Kuwait	316
Qatar	296
Yemen	224

Mean Across All Countries **473**

1995 Re-scaled Mathematics Scores

Grade 8

Nation	Mean
Singapore	609
Japan	581
Korea, Rep. of	581
Hong Kong SAR	569
Belgium (Flemish)	550
Czech Republic	546
Slovak Republic	534
Switzerland	534
Slovenia	531
France	530
Austria	529
Netherlands	529
Bulgaria	527
Hungary	527
Russian Federation	524
Canada	521
Australia	519
Ireland	519
Minnesota, US	**518**
Belgium (French)	518
Thailand	516
Sweden	513
Israel	513
Germany	502
New Zealand	501
Norway	498
England	498
Denmark	497
Scotland	493
United States	**492**
Italy	491
Latvia	488
Iceland	484
Spain	483
Greece	479
Romania	474
Lithuania	472
Cyprus	468
Portugal	451
Iran, Islamic Rep. of	418
Colombia	360
Kuwait	355
South Africa	278
Mean Across All Countries	**500**

Note: Grade 8 table reflects significant differences based on the standard errors of the original 1995 scores rather than the rescaled scores

Significantly Higher than MN
Not Significantly Different from MN
Significantly Lower than MN

2007 Mathematics Scores

Grade 8

Nation	Mean
Chinese Taipei	598
Korea, Rep. of	597
Singapore	593
Hong Kong SAR	572
Japan	570
Minnesota, US	**532**
Hungary	517
England	513
Russian Federation	512
United States	**508**
Lithuania	506
Czech Republic	504
Slovenia	501
Armenia	499
Australia	496
Sweden	491
Malta	488
Scotland	487
Serbia	486
Italy	480
Malaysia	474
Norway	469
Cyprus	465
Bulgaria	464
Israel	463
Ukraine	462
Romania	461
Bosnia and Herzegovina	456
Lebanon	449
Thailand	441
Turkey	432
Jordan	427
Tunisia	420
Georgia	410
Iran, Islamic Rep. of	403
Bahrain	398
Indonesia	397
Syrian Arab Republic	395
Greece	391
Romania	387
Lithuania	381
Colombia	380
Oman	372
Palestinian Nat'l Auth.	367
Botswana	364
Kuwait	354
El Salvador	340
Saudi Arabia	329
Ghana	309
Qatar	307
Mean Across All Countries	**451**

WHERE WAS MINNESOTA MATHEMATICS IN 1995?

SUMMARY OF MINNESOTA 1995 FOURTH GRADE MATHEMATICS ACHIEVEMENT RESULTS

- In mathematics content areas, Minnesota fourth-graders exceeded the international average in four of the six areas tested (whole numbers; data representation, analysis, and probability; geometry; and patterns, relations, and functions). In the other two areas (fractions and proportionality; and measurement, estimation, and number sense), the Minnesota fourth grade average was lower than the international average.

SUMMARY OF MINNESOTA 1995 EIGHTH GRADE MATHEMATICS ACHIEVEMENT RESULTS

The 1995 performance of Minnesota eighth grade students in mathematics and science achievement reflected both strengths and weaknesses.

- Minnesota eighth-graders scored about the international average in mathematics.
- The same students scored well above the international average in science (among the top countries).
- They scored above the U.S. average in all specific content areas but showed the same wide range of individual scores.

Being among the best in the U.S. is not the same as being first in the world.

- Minnesota's consistently strong performance in mathematics and science compared to the rest of the U.S. looks different in an international context.
- Eighth grade mathematics in Minnesota was seventh grade mathematics by international standards in 1995.
- As results on U.S. NAEP testing demonstrated, some Minnesota students--particularly students of color-- lagged far behind their peers in mathematics achievement at the eighth grade, a fact hidden by the single average Minnesota score for mathematics on the TIMSS tests.

SUMMARY OF CONTEXTUAL FACTORS IMPACTING MATHEMATICS IN 1995

- Minnesota mathematics classrooms look a lot like mathematics classrooms in other parts of the United States. Because our teachers are well qualified and our students are largely interested in learning, achievement for Minnesota eighth graders is superior to most other states and the United States average. However, compared to international standards, the achievement of Minnesota students was not outstanding. Here are some findings from the 1995 TIMSS questionnaire data which are related to the achievement results.
- The content of Minnesota eighth grade mathematics courses was less rigorous than that in most other countries.
- Ability grouping or tracking reduced the opportunity for many students to learn rigorous mathematics.
- The content of Minnesota eighth grade mathematics courses was less coherent than the content in most other countries.
- Classroom activities did not reflect learnings from cognitive science and brain research about successful learning experiences. These include the necessity for communication and active engagement by the learners.
- Time spent in class on mathematics and science: Minnesota and U.S. fourth grade teachers spent slightly more time in class per week teaching mathematics and science than their international counterparts. In fact, four of the seven countries which significantly outperformed the U.S. in mathematics at grade four spent less time in class per week than the U.S.
- Class size: The Minnesota average class size at fourth grade (28 students) and the U.S. average

class size (24) were close to the international average (25) in 1995. Of the six countries that outperformed Minnesota in mathematics at fourth grade, four (all Asian) had much larger average class sizes, ranging between 36 and 43 students per class.

- Teaching challenges: Minnesota and U.S. fourth grade teachers, like their counterparts in a majority of the TIMSS countries, most frequently cite "varying academic abilities of students" and a "high student-teacher ratio" as factors that limit how they teach their class. The U.S. is actually below the international average in the percentage of teachers who report that their teaching is limited by these challenges, including classroom discipline.

- In a nutshell, Minnesota showed through it's 1995 science results that our students can successfully compete in a global market, but our approach to teaching mathematics left much to be desired.

WHERE IS MINNESOTA SCIENCE IN 2007?

2007 TIMSS SCIENCE PERFORMANCE:

- In contrast to the performance in mathematics, in science neither the U.S. nor Minnesota demonstrated significantly different performance in 2007 than in 1995.
- In 2007, Minnesota maintained its relatively high level of performance, being outperformed by very few countries at either 4th or 8th grade and significantly outperforming the U.S. at grade 8.

CONTEXT FOR SCIENCE SCORES

- In 1995, Minnesota performed relatively quite well in science but no different from the mediocre U.S. performance in mathematics.
- At that time, the conjecture as to why Minnesota's science performance was so much better than its performance in mathematics was the existence of a strong informal network in science that essentially functioned as statewide standards for what should be taught and learned.
- In 2007 after having true statewide standards in place since 1997, Minnesota continued to perform quite well in science by international standards.
- The development of the 2004 science standards was influenced by the international benchmarking data available through the 1995 TIMSS.
- Coincident with the introduction of statewide standards was the introduction of the state accountability assessments (Minnesota Comprehensive Assessments), which tend to focus attention and bring emphasis to the content in the standards. However, science testing did not start until the spring of 2008.
- One of the goals of standards and accountability assessments is to reduce the variation from one school to another in what teachers teach and emphasize and in what students learn which is what is seen in the 2007 Minnesota TIMSS results.

THE FOLLOWING CHARTS DISPLAY FIRST THE GRADE 4, THEN GRADE 8 SCIENCE RESULTS FOR BOTH 1995 AND 2007

1995 Rescaled Science Scores

Grade 4

Nation	Mean
Korea, Rep. of	576
Minnesota, US	**553**
Japan	553
United States	**542**
Australia	541
Austria	538
Czech Republic	532
Netherlands	530
England	528
Canada	525
Italy	524
Singapore	523
Slovenia	522
Ireland	515
Scotland	514
Hong Kong SAR	508
Hungary	508
New Zealand	505
Norway	504
Latvia	486
Israel	482
Iceland	479
Greece	473
Portugal	452
Cyprus	450
Thailand	450
Iran, Islamic Rep. of	380
Kuwait	360

Mean Across All Countries **500**

Significantly Higher than MN
Not Significantly Different from MN
Significantly Lower than MN

**** Please note:**
The Scale Average for all charts (TIMSS rescaled 1995 and TIMSS 2007, both grades 4 and 8) is 500.

2007 Science Scores

Grade 4

Nation	Mean
Singapore	587
Chinese Taipei	557
Hong Kong SAR	554
Minnesota, US	**551**
Japan	548
Russian Federation	546
Latvia	542
England	542
United States	**539**
Hungary	536
Italy	535
Kazakhstan	533
Germany	528
Australia	527
Slovak Republic	526
Austria	526
Sweden	525
Netherlands	523
Slovenia	518
Denmark	517
Czech Republic	515
Lithuania	514
New Zealand	504
Scotland	500
Armenia	484
Norway	477
Ukraine	474
Iran, Islamic Rep. of	436
Georgia	418
Colombia	400
El Salvador	390
Algeria	354
Kuwait	348
Tunisia	318
Morocco	297
Qatar	294
Yemen	197

Mean Across All Countries **476**

1995 Rescaled Science Scores

Grade 8

Nation	Mean
Singapore	580
Czech Republic	555
Japan	554
Korea, Rep. of	546
Bulgaria	545
Minnesota, US	**544**
Netherlands	541
Slovenia	541
Austria	539
Hungary	537
England	533
Belgium (Flemish)	533
Slovak Republic	532
Australia	527
Sweden	523
Russian Federation	523
Ireland	518
Germany	518
Norway	514
Canada	514
United States	**513**
New Zealand	511
Thailand	510
Hong Kong SAR	510
Israel	509
Switzerland	509
Spain	504
Scotland	501
Italy	497
France	488
Greece	486
Iceland	484
Latvia	476
Portugal	473
Denmark	472
Romania	471
Belgium (French)	466
Lithuania	464
Iran, Islamic Rep. of	463
Cyprus	452
Kuwait	415
Colombia	393
South Africa	263
Mean Across All Countries	**500**

Significantly Higher than MN
Not Significantly Different from MN
Significantly Lower than MN

2007 Science Scores

Grade 8

Nation	Mean
Singapore	567
Chinese Taipei	561
Japan	554
Korea, Rep. of	553
England	542
Hungary	539
Czech Republic	539
Minnesota, US	**539**
Slovenia	538
Hong Kong SAR	530
Russian Federation	530
United States	**520**
Lithuania	519
Australia	515
Sweden	511
Scotland	496
Italy	495
Armenia	488
Norway	487
Ukraine	485
Jordan	482
Malaysia	471
Thailand	471
Serbia	470
Bulgaria	470
Israel	468
Bahrain	467
Bosnia and Herzegovina	466
Romania	462
Iran, Islamic Rep. of	459
Malta	457
Turkey	454
Syrian Arab Republic	452
Cyprus	452
Tunisia	445
Indonesia	427
Oman	423
Georgia	421
Kuwait	418
Colombia	417
Lebanon	414
Egypt	408
Algeria	408
Palestinian Nat'l Auth.	404
Saudi Arabia	403
Morocco	402
El Salvador	387
Botswana	355
Qatar	319
Ghana	303
Mean Across All Countries	**466**

WHERE WAS MINNESOTA SCIENCE IN 1995?

THE FOLLOWING FINDINGS FROM THE 1995 TIMSS ANALYSIS ILLUSTRATE THE VALUE OF CURRICULAR FOCUS FOUND IN SCIENCE:

Minnesota did particularly well in science (on TIMSS 1995) primarily because the major factors contributing to success were relatively well aligned.

- Course offerings were consistent statewide (eighth grade science in Minnesota was earth science, the content area we scored highest in), and a majority of teachers used the same or similar textbooks at grade 8.
- There was little tracking in eighth grade science, as compared to eighth grade mathematics.
- Teacher licensing supported the curriculum focus.
- The tradition of inquiry-oriented instruction and the long-standing availability of appropriate materials (kits, etc.) also helped explain Minnesota's strong showing in science.
- The focus and coherence of the components of the system, not any one part of the system in isolation, made the difference in how Minnesota performed as a whole.
- The 1995 international TIMSS results showed that it's not who is taking the test, or how much homework or time on task students have, or length of school day or school year, that makes the biggest difference in student performance.
- The U.S. performance on TIMSS showed the weaknesses of unfocused curriculum and instructional approaches, further complicated by use of diverse and unaligned assessments.
- Minnesota's performance on TIMSS illustrated the power of alignment (as reflected in our science scores) and the problems with lack of focus (as reflected in our mathematics performance).
- Even in science, we still needed to improve – to move beyond traditional approaches and to close the gender gap (and similar performance gaps which may exist for other under-performing groups of students).
- The national standards provided a potentially powerful source of direction and focus for Minnesota mathematics and science, but the danger would be uneven implementation (some districts use the standards, some don't) or burden by addition (adding recommendations from the standards without taking anything away from the existing curriculum).

KEY FINDINGS ACROSS ALL COUNTRIES PARTICIPATING IN THE 2007 TIMSS:

COUNTRIES REACHING AN INTERNATIONAL "ADVANCED" BENCHMARK

- Across both disciplines, Asian countries had the highest percentages of students reaching the Advanced International Benchmark, representing fluency on items involving the most complex topics and reasoning skills.
- In mathematics, remarkable percentages of students reached the Advanced International Benchmark. In particular, at the fourth grade, Singapore and Hong Kong SAR had 41 and 40 percent of their students, respectively, achieving at or above the mark. At the eighth grade, Chinese Taipei, Korea, and Singapore had 40 to 45 percent of their students achieving at or above it. The median percentage of students reaching this Benchmark was 5 percent at the fourth grade and 2 percent at the eighth grade.
- In science, the highest performing countries at the fourth grade -- Singapore and Chinese Taipei -- had 36 and 19 percent of their students, respectively, achieving at or above the Advanced International Benchmark. At the eighth grade, Singapore and Chinese Taipei had 32 and 25 percent of their students, respectively, achieving at or above the Benchmark. The median percentage of students reaching this Benchmark was 7 percent at the fourth grade and 3 percent at the eighth grade.

TRENDS IN ACHIEVEMENT

- At the eighth grade, the pattern was less pronounced. Although close to a dozen countries showed improvements, like Korea, Slovenia, Lithuania, and the United States, most countries either showed little change or declined.
- At the fourth grade, in both mathematics and science, more countries showed improvement in 2007 than declines. Steady improvement since the first TIMSS in 1995 was shown by high-achieving Hong Kong SAR and Singapore, medium-achieving countries such as England, the United States, and Slovenia, and lower-achieving countries.

ACHIEVEMENT BY GENDER

- At the fourth grade, the differences in achievement between boys and girls were negligible in approximately half the countries in both mathematics and science. In the remaining countries, girls had higher achievement in about half and boys had higher achievement in the other half.
- At the eighth grade, the differences in achievement between boys and girls were negligible in about one third of the countries. In the remaining countries, girls had higher achievement than boys in more countries, especially in mathematics.

HOME ENVIRONMENT

- Across both subject areas and grade levels, students who reported speaking the language of the test at home had higher average achievement.
- At the eighth grade, higher levels of parents' education and the presence of books, computers and Internet access in the home were associated with higher average mathematics and science achievement.

STUDENT ATTITUDES

- At both grades and in both subject areas, students with more positive attitudes toward these subjects, who reported a higher level of self-confidence in learning mathematics and science, and placed a higher value on them as important to future success, also had higher achievement.

SCHOOL ENVIRONMENT AND CURRICULUM

Across both subjects and grade levels, on average:

- At both fourth and eighth grades, achievement was highest where principals and teachers had a positive view of the school climate, including high levels of teacher job satisfaction, high expectations for student achievement and parental support.
- Achievement was highest among students attending schools with more than 90 percent of

students having the language of the test as their native language.

- Achievement was higher among students who attended schools that reported few attendance problems, few shortages or inadequacies in resources.
- There was a positive association between achievement and students' perception of being safe in school.
- Most countries reported having a national curriculum, and that preparation in how to teach it was part of pre-service education.

TEACHER PREPARATION

- In both subjects, at both the fourth and eighth grades, the majority of students were taught mathematics by teachers in their 30s and 40s. Although about one fourth of the students internationally were taught by teachers 50 or older, relatively few students were taught by teachers younger than 30.
- Supplying schools with teachers well prepared to teach mathematics and science appears to be an increasing problem, especially at the fourth grade. At the eighth grade, most teachers had studied mathematics or science and reported feeling very well prepared to teach the topics in the TIMSS assessment. In contrast, teachers at the fourth grade reported little specific training or specialized education, especially in science. Just half the students had teachers who reported feeling very well prepared to teach the TIMSS science topics.

TIMSS: MORE THAN JUST A TEST…

The 1995 Third International Mathematics and Science Study (TIMSS) was the largest, most thorough international study of mathematics and science education ever conducted; 41 countries, including the U.S., participated in student testing and surveys of school practices. It retains this status in the 2007 testing.

TIMSS provides comparative assessments of student outcomes, instructional practices, curricula, and cultural context. In 1995, TIMSS assessed nearly 34,000 U.S. students in grades 3-4, 7-8 and 12, including the more than 5000 students who participated in the Minnesota comparison.

The 1995 TIMSS, for example, included five main components:

1. Curriculum analyses
2. Achievement tests
3. Questionnaire surveys of students, teachers, and administrators
4. Case studies of subjects in the United States, Germany, and Japan; the working environment and training of teachers; methods for dealing with differences in ability; and the role of school in adolescents' lives, and
5. A video study of classroom lessons in the United States, Germany, and Japan.

The 2007 achievement tests included both multiple choice and free response items in the following areas:

Mathematics

- Grade 4: Number, Geometric Shapes and Measures, Data Display
- Grade 8: Number, Algebra, Geometry, Data and Chance

Science

- Grade 4: Life Science, Physical Science, Earth Science
- Grade 8: Biology, Chemistry, Physics, Earth Science

Both the mathematics and science assessment frameworks also have a cognitive dimension—Knowing, Applying, and Reasoning. To enable reporting by cognitive domains, these also were revised for TIMSS 2007 to sharpen the distinction among categories.

IS TIMSS REALLY A FAIR COMPARISON BETWEEN PARTICIPATING COUNTRIES?

The question of fairness and comparability frequently arises during discussions of international testing. The following points are made by Patrick Gonzales in: *Pursuing Excellence: Comparisons of International Eighth-Grade Mathematics and Science Achievement from a US Perspective, 1995 and 1999* (2001, NCES).
TIMSS is not a comparison of "other nations' best students to our nations' average students". The International Study Center at Boston College controls the process of quality-control measures and among those controls are the following:

- The grades assessed in participating nations are selected based on student age: grade 8 for example, in the US and most nations is the grade containing the largest proportion of 13 year-old students (the targeted age).
- National and school samples are rigorously reviewed for bias and international comparability.
- Participating countries or states must test a representative sample of all of their students. In 1995, for example, at least 95% of the age cohort was required to be available for the testing sample at grades 4 and 8 (no more than 5% of students could be excluded).
- A professional translation agency verifies the accuracy of translated materials. Materials are prepared first in English and then translated.
- Project coordinators in each country are thoroughly trained and monitored.
- Quality-control staff conducts site visits of each participating nation.
- Scaling of scores allows valid comparison over the years.
- Some items are not released, but are re-used to assist in scaling of scores between years.

CONCLUSIONS: WHAT CAN MINNESOTA LEARN FROM TIMSS 1995 AND 2007?

- TIMSS shows that student learning is strongly influenced by what's taught and how it's taught; this is born out in the apparent differences between math and science achievement in the 1995 Minnesota TIMSS scores.

- The strong TIMSS performance of countries with system-wide standards and highly focused curriculum and instruction affirms the potential value of Minnesota's Standards for focusing curriculum and instruction statewide.

- Although mathematics and science teachers in Minnesota are generally better prepared to teach than their U.S. colleagues on average, the conditions they teach under and their opportunities for professional development and peer support have only recently received strong support through initiatives such as the legislatively-funded Teacher Academies and district efforts to focus on mathematics and science support for staff.

- The TIMSS results must be understood in the context of full range of reports (both grade levels tested) and in comparison with other measures of assessment (such as the U.S. NAEP mathematics and science tests) which provide a more detailed look at the diversity of student achievement in Minnesota schools.

UNFINISHED WORK FROM 1995:

Teachers' work lives do not exhibit characteristics of other professional communities; they work in isolation, without benefit of feedback or advice from peers.

Minnesota teachers, like those throughout the United States in 1995, taught an average of 30 hours a week compared to teachers in other countries, who taught an average of 20 hours a week. There is comparatively less time to interact with other educators.

- Three-fourths of Minnesota eighth grade mathematics teachers had never visited another teacher's class; more than half had never had another teacher visit their class.

- Three-fourths of Minnesota eighth grade mathematics teachers rarely or never conferred with another teacher or curriculum specialist in planning a lesson.

- Only two out of five Minnesota eighth grade mathematics teachers met with other teachers to discuss mathematics at least once a month. More than two out of five did this twice a year or less often.

Conclusion:
Minnesota eighth grade mathematics teachers are well prepared, qualified and are successful in meeting the expectations of the public and the educational community. Nevertheless, in order to make the changes which will help students become more successful in our global economy, those expectations will have to change and teachers will need long term support and carefully planned opportunities for ongoing, focused and sustained professional development. This will include support for:

- learning new content,
- establishing collaborative learning communities with colleagues,
- implementing new instructional materials which are more rigorous, focused and coherent, and
- using a broader range of effective instructional strategies.

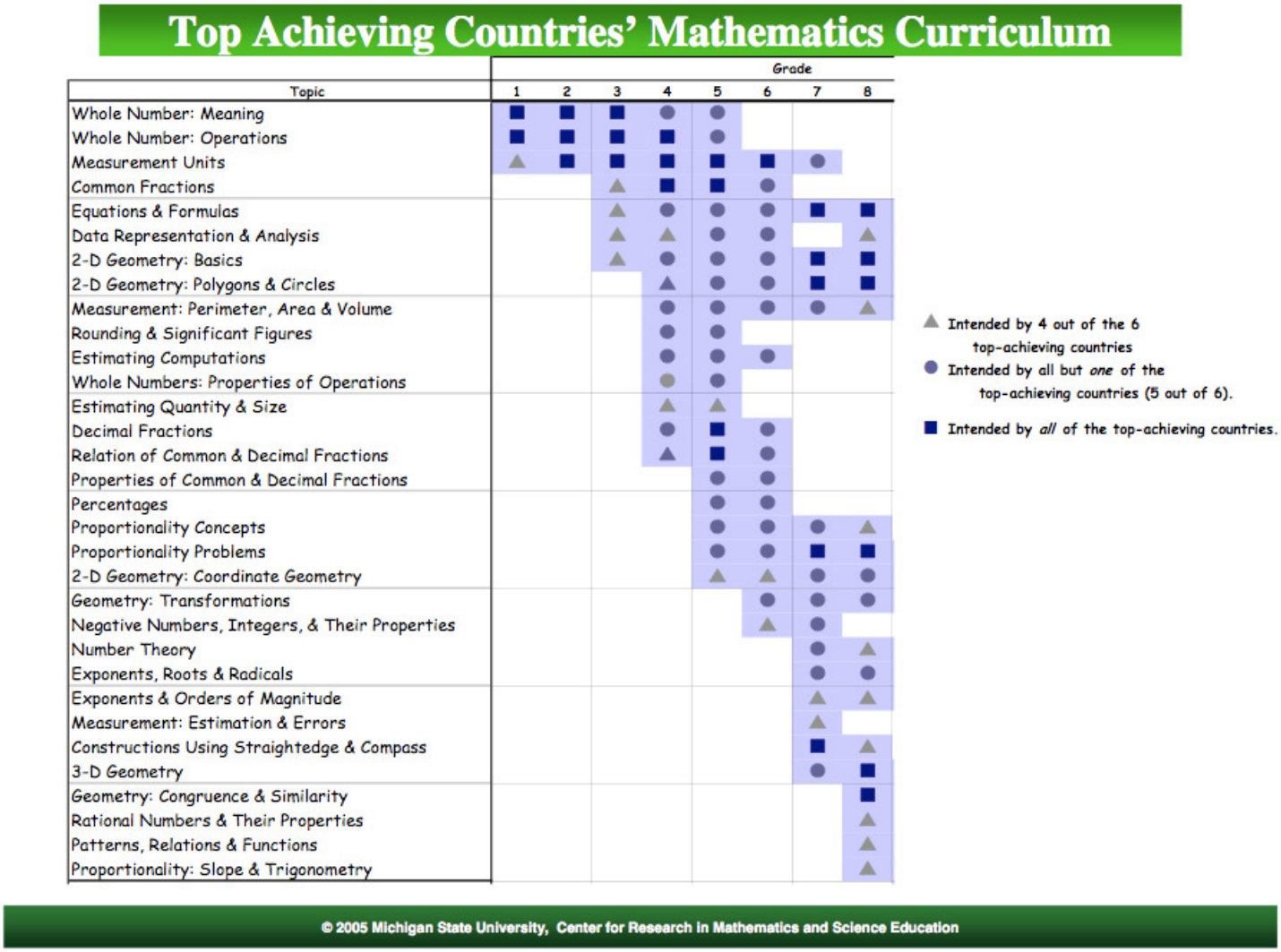
Minnesota's work to date in improving mathematics and science achievement has produced positive results. However, the work is not done. The other nations participating in TIMSS are continuously seeking improvements and so must Minnesota and the United States.

As the U.S. Department of Education observed about the international results, *"TIMSS is not an answer book, but a mirror through which we can see our own education system in international perspective."* Careful study of the unique data available in the Minnesota TIMSS results will assist educators, parents, the business community, and policy-makers in implementing the Minnesota Standards and achieving the vision of mathematics and scientific literacy for all students.

A KEY LESSON LEARNED FROM THE 1995 AND 1999 TIMSS

THE ABILITY TO FOCUS IS ESSENTIAL

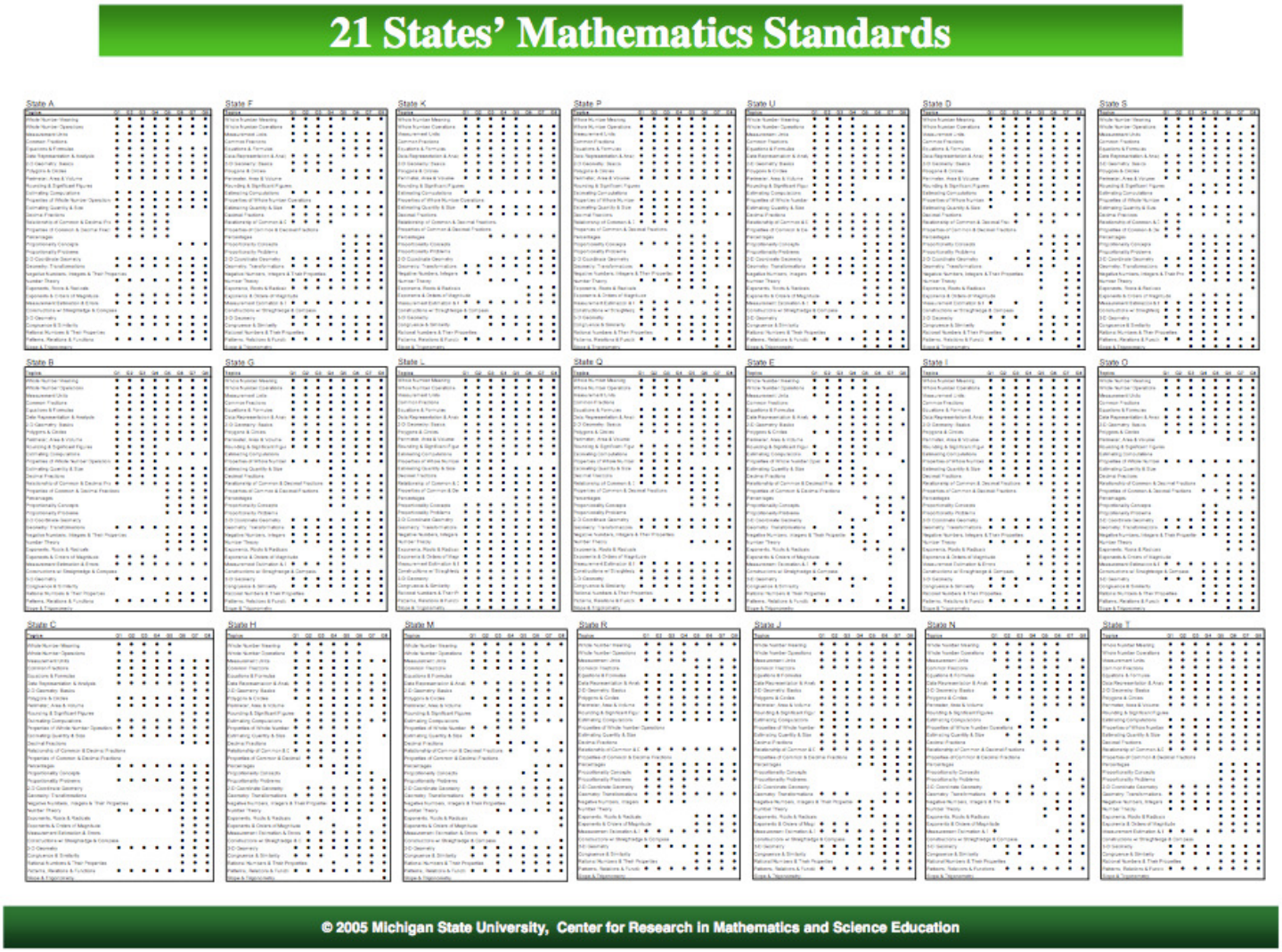
The following table illustrates the concentration or focus on mathematics topics at grades 1-8 for the top performing countries on TIMSS. World-class standards emulate this pattern, and the National Council of Teachers of Mathematics (NCTM) developed and released Focal Points in the fall of 2006; a set of standards that clearly identified and narrowed the focus of math topics for grades K-8 in the US. Minnesota's revision of mathematics standards in 2007 used Focal Points as one of the guiding resources to move towards this vision.



1995: A MILE WIDE AND AN INCH DEEP…

In the 1995 TIMSS testing, Minnesota, along with most of the United States, was operating under a different set of assumptions than the top TIMSS countries in selecting mathematics topics. As can be observed from the following table, the common belief was that "every topic must be addressed every year". This produced a curriculum that has been described as "a mile wide and an inch deep". It has become apparent that this curricular approach created significant redundancy and allowed few students to reach mastery before moving on – requiring topics to be reviewed in each of the subsequent years.

The topics in the following charts are too small to be able to read, but it is only necessary to observe the distribution pattern of the dots in each state's chart to ascertain the lack of focus by grade in each state.



Science in 1995, on the other hand, through informal statewide agreement, had a much narrower set of focus topics at each grade level in Minnesota, which likely contributed to the relatively higher science scores in 1995. The introduction of state standards for Minnesota and the subsequent revisions have moved Minnesota mathematics and science to a much clearer and more narrow focus at each grade level; much more in line with the approach used by the top performing nations in TIMSS.

RECOMMENDATIONS FOR CHANGE IN POLICY AND PRACTICE:

Based on Minnesota's performance in the 1995 and 2007 TIMSS, SciMath^{MN} recommends the following actions for improving science and mathematics education in Minnesota:

RECOMMENDATIONS FOR IMPROVEMENTS IN WHAT WE TEACH:

- Use the national mathematics and science education standards to guide further development of Minnesota Standards (in mathematics and science).

- Revise the Minnesota K-12 mathematics and science Curriculum Frameworks to align with the new standards and assist districts in focusing their curriculum and instruction.

RECOMMENDATIONS FOR IMPROVEMENTS IN HOW WE TEACH:

- Emphasize tighter focus in district curricula and greater rigor, as well as real-world applications, in teaching to Minnesota's Standards.

- Fund, plan and implement a coordinated and coherent statewide professional development program to orient teacher training around implementing the standards. For example, expand and extend the Math/Science Teacher Academies begun in 2008-2009 which are reaching about 1000 teachers.

- Align teacher licensure and teacher education programs to support effective implementation of the Minnesota Standards and their call for inquiry-based teaching and learning.

RECOMMENDATIONS FOR IMPROVEMENTS IN HOW WE MEASURE:

- Align statewide testing with the Minnesota Standards and include more demanding items on the statewide tests - in particular items focusing on reasoning, inquiry, communication and problem solving.

- Align the schedule of MCA test revision with the schedule of standards revision so that Minnesota schools are tested on the same standards that are being taught.
- Analyze curriculum, instruction, and assessment practices to insure that all students, particularly those who have been under-served in mathematics and science education previously, receive adequate opportunity to learn.

- Provide funding and incentives for local alignment with statewide standards and assessment. Create and implement a statewide continuous improvement plan.

NEXT STEPS IN THE 2007 MINNESOTA TIMSS ANALYSIS:

Minnesota TIMSS data holds insight into potential solutions to issues that have come to light as a result of this and other educational assessments. Examples of questions taken from Gonzales, *Pursuing Excellence* (2001) warranting further investigation include:

- Why do Minnesota and US students' performance relative to the international average tend to decrease as grade levels increase?

- In what ways has the educational context for mathematics and science changed in Minnesota between 1995 and 2007? What further changes would be recommended?

- In what areas have underperforming groups of students made progress? What are promising practices to further reduce the achievement gap?

- What educational policies (national, state or local) have influenced achievement gains for Minnesota students?

- What policies and/or practices have been instituted in nations that experience significant increases or decreases in achievement?

With additional time, analysis of the strands or sub-topics of the assessment will take place, as well as investigation of the academic performance of specific populations of students and analysis of the questionnaire data from both students and teachers.
Focus groups will be assembled in February of 2009 to develop the exact questions for further analysis. Release of that analysis is expected in summer 2009.

FOR FURTHER INFORMATION ABOUT TIMSS…

For U.S. TIMSS Information:

- NCES U.S. TIMSS Website http://www.ed.gov/NCES/timss
- Boston College TIMSS Website http://timss.bc.edu/
- Michigan State University U.S. 1995 TIMSS Website http://ustimss.msu.edu

For Minnesota TIMSS Information:

- Call SciMath[MN] at 612-209-1739
- E-mail info@scimathmn.org
- Visit the SciMath[MN] website at www.scimathmn.org
- Summer 2008: Release of complete Minnesota TIMSS Report (expanded version of this preliminary summary) by SciMath[MN].

ABOUT SCIMATH[MN]…

Founded in 1993, SciMath[MN] is a partnership among business, education and state government pursuing statewide improvement in the teaching and learning of K-12 mathematics, science and technology education based on the national mathematics, science and technology education standards. SciMath[MN]'s mission is to increase the educational achievement and participation of all Minnesota students in science and mathematics to help them meet the complex challenges of their future.

To contact SciMath[MN]: Phone 612-209-1739; E-mail info@scimathmn.org: http://www.scimathmn.org

SciMath^{MN} gratefully acknowledges the generous support of the Minnesota Legislature, the Minnesota Department of Education, Michigan State University (under the leadership of William H Schmidt) and the following Minnesota businesses and organizations in ensuring the 2007 TIMSS participation, as well as the 2008-2009 analysis and informational events.