TIMSS UNITED STATES

US National Research Center

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TIMSS HIGH SCHOOL RESULTS RELEASED

On February 4, the National Center for Education Statistics released the last report in the Pursuing Excellence series. This publication culminates the process of reporting initial findings from US participation in the Third International Mathematics and Science Study (TIMSS). A process that started with the release of the first report (on Grades 7 and 8) in November of 1996. This report presents findings concerning the standing of US twelfth graders in mathematics and science achievement compared to their peers participating in the TIMSS. Twenty-three countries participated in the assessment of students in high-school, with three studies composing this effort: 1) a study of the general knowledge of mathematics and science attained by all students in the final year of secondary education, 2) a study of achievement in mathematics of students taking advanced coursework in that subject, and 3) a study of achievement in physics of students taking advanced coursework in that subject. Thus, the studies look at the 'yield' of US pre-university education in terms of general mathematics and science knowledge of all twelfth graders. The also look at the specialized knowledge acquired by students that have taken the most demanding coursework available in mathematics and science.

General Knowledge in Mathematics and Science

Four key findings are reported regarding general knowledge in Mathematics and Science:

- US Twelfth graders scored below the international average, and among the lowest of the 21 nations that participated in the assessment of general knowledge. Mean achievement in mathematics general knowledge was significantly higher in 14 nations. In science, 11 nations exhibited significantly higher mean student achievement levels than that of the US (Figures 1 and 2).

- US students exhibited higher mean achievement levels relative to other nations at the eighth grade than at the end of secondary schooling in both mathematics and science education.

- The US was one of three countries for which there was no gender gap in student mean achievement levels in mathematics general knowledge. There was a gender gap in science, as was the case for all TIMSS countries but this gap was smaller for the US than for all other countries in the study.

Figure 1:
Mathematics General Knowledge Achievement

Nations With Average Score Significantly Higher than the US

Nation	Average
(Netherlands)	560
Sweden	552
(Denmark)	547
Switzerland	540
(Iceland)	534
(Norway)	528
(France)	523
New Zealand	522
(Australia)	522
(Canada)	519
(Austria)	518
(Slovenia)	512
(Germany)	495
Hungary	483

Nations With Average Score Not Significantly Higher than the US

Nation	Average
(Italy)	476
(Russian Federation)	471
(Lithuania)	469
Czech Republic	466
(United States)	461

Nations With Average Score Significantly Lower than the US

Nation	Average
(Cyprus)	446
(South Africa)	356

International Average = 500

Figure 2:
Science General Knowledge Achievement

Nations With Average Score Significantly Higher than the US

Nation	Average
Sweden	559
(Netherlands)	558
(Iceland)	549
(Norway)	544
(Canada)	532
New Zealand	529
(Australia)	527
Switzerland	523
(Austria)	520
(Slovenia)	517
(Denmark)	509

International Average = 500

Nations With Average Score Not Significantly Higher than the US

Nation	Average
(Germany)	497
(France)	487
Czech Republic	487
(Russian Federation)	481
(United States)	**480**
(Italy)	475
Hungary	471
(Lithuania)	461

Nations With Average Score Significantly Lower than the US

Nation	Average
(Cyprus)	448
(South Africa)	349

- The US international standing regarding general knowledge was somewhat stronger in science than in mathematics, a pattern similar to findings in the fourth and eighth grade TIMSS assessments.

Achievement of Advanced Students

Key findings reported for advance students are:

- Mean achievement levels in both the subject areas were among the lowest in the TIMSS. Mean achievement of US twelfth graders was not significantly greater than that of any other of the TIMSS countries (see Figures 3 and 4) and it was significantly lower than some .

Figure 3:
Average Advanced Mathematics Performance Of Advanced Mathematics Students in All Countries

Nations With Average Score Significantly Higher than the US

Nation	Average
France	557
(Russian Federation)	542
Switzerland	533
(Austraila)	525
(Denmark)	522
(Cyprus)	518
(Lithuania)	516
Greece	513
Sweden	512
Canada	509
(Slovenia)	475

Nations With Average Score Not Significantly Higher than the US

Nation	Average
(Italy)	474
Czech Republic	469
(Germany)	465
(United States)	442
(Austria)	436

Nations With Average Score Significantly Lower than the U.S.

Nation	Average
NONE	

International Average = 501

Figure 4:
Average Physics Performance Of Advanced Science Students In All Countries

Nations With Average Score Significantly Higher than the US

Nation	Average
Norway	581
Sweden	573
(Russian Federation)	545
(Denmark)	534
(Slovenia)	523
(Germany)	522
(Australia)	518
(Cyprus)	494
(Latvia)	488
Switzerland	488
Greece	486
(Canada)	485
France	466
Czech Republic	451

Nations With Average Score Not Significantly Higher than the US

Nation	Average
(Austria)	435
(United States)	423

Nations With Average Score Significantly Lower than the US

Nation	Average
NONE	

International Average = 501

- This low mean performance level of US advanced students in twelfth grade was true for all content areas in both mathematics and physics.

- Gender gaps exist in both advanced mathematics and physics in the US, with males outperforming females.

- More countries outperformed US students in physics than on advanced mathematics. This differs from the results for general knowledge in mathematics and science, where more countries outperformed the US in mathematics than in science.

For further information, including instructions on ordering a copy of this report, use the link to the National Center for Education Statistics on the US TIMSS web site: http://ustimss.msu.edu.

Written by: Gilbert A. Valverde, Associate Director, US. National Research Center, Michigan State University

STANDARDS DO MATTER

"Statements of mathematics or science 'standards' are more than pieces of paper," according to Dr. William H. Schmidt, discussing Facing the Consequences: Using TIMSS for a Closer Look at US Mathematics and Science Education, a report he recently co-authored.

Mathematics and science standards recently have been a source of debate in many states. The recent contentious adoption of new, controversial mathematics standards in California is a clear example. This debate about standards comes in the middle of current interest in developing regional and national consensus about what each American child should be expected to learn in mathematics and science at each grade level.

If standards were simply bureaucratic or political documents, they might be only pieces of paper. Facing the Consequences suggests that shaping mathematics and science curricula is far from mere bureaucratic paper-shuffling, arguments about words, or simply another arena in which to air political differences.

"Such decisions do matter," Schmidt said. "Our report uses the TIMSS [the Third International Mathematics and Science Study] data to show that standards and the curricula behind them matter to what children learn and know."

For example, the report concludes that the TIMSS data make it clear that US students' achievement at third, fourth, seventh and eighth grade varied for different areas of mathematics and science curricula. The US was average (or even above average for some grades) compared to the other TIMSS countries in the "basics of arithmetic" at all four grade levels. US mathematics textbooks and teachers spent a large part of their time on these "basics" — although these topics were not "basic" or central in other TIMSS countries by the seventh and eighth grades.

In contrast, the results were more mixed in other areas. US third and fourth graders scored above the TIMSS average in several areas of geometry — such as the basics of plane, two-dimensional geometry. However, US seventh and eighth graders scored near the bottom. Why were there such differences, also seen in parts of algebra, physical science and other topics? The report suggests that these achievement patterns likely reflect curriculum differences.

Which countries were among the highest achievers varied for different areas of science and mathematics? With the exception of fourth grade science, US students did not compare well with students in the other TIMSS countries. However, even countries such as Singapore or Japan that were at or near the top in many areas scored below the US in some areas. The mathematics and science curriculum area mattered to how well students from each country achieved compared to the others. Content areas appeared to matter because the patterns of emphasis across areas differed from one country's standards to another contry's standards.

The report also concludes that the US practice of providing different content in science and, especially, mathematics to different kinds of students exaggerated differences in US students' achievement. Such differences are often introduced because many believe that it allows all children to be challenged and to learn more. This practice, called "tracking," is common by eighth grade in US mathematics classrooms.

One result is that different eighth graders in the same school often take different mathematics courses — regular or "general" mathematics, remedial mathematics, enriched mathematics, pre-algebra and algebra. This is true for over 75 percent of the schools US eighth grade mathematics students attend. Tracking before high school is not practiced in most TIMSS countries. The report shows that this practice was related to differences in what US children had a chance to learn and to what they ultimately did learn. Tracking created differences among mathematics classrooms so great that no child could overcome those differences through their own hard work and study. What they could learn was limited by the classes in which they were placed.

A third conclusion of Facing the Consequences is that, on average, US children learned little — or at least differed very little in achievement — between third and fourth grades and between seventh and eighth grades. This was true in both science and mathematics. The report is the first TIMSS report to examine these differences closely.

TIMSS is the largest, most comprehensive study of its kind. Over 40 countries participated by testing over a half million students altogether. Almost 40 mathematics and science areas were tested. US students' gains never placed them in the top 25 percent of TIMSS countries in any area. In fact, the US was the only country that never placed among the top performing countries in achievement differences for any of the mathematics or science content areas for either third to fourth or seventh to eighth grade differences.

Why were the gains so consistently small in all areas tested? These achievement differences were consistent with mathematics and science curricula that tried to cover all areas but emphasized none. Schmidt said, "This is what we have been calling 'mile wide, inch deep curricula."

What do all these conclusions — small gains, achievement that differs by content area, differences between US fourth and eighth graders' achievements, exaggerated differences among US students related to tracking — have in common? They all relate to one of the report's general conclusions, which states, "Curriculum does matter." Differences in what is planned for students to study, what their textbooks provide for them to study, and how their teachers respond to the goals set for them affect what and how much science and mathematics US students learn.

One clear implication of this conclusion is that debates about standards — state, local, or national — are not just about words or political agendas. Official standards specify what children are to study in school. They affect what children in states covered by those standards are likely to have a chance to learn. The decisions behind such standards must be carefully, thoughtfully made if US children are to participate in a technologically-oriented, globally competitive American economy and to become truly literate and informed American citizens. Standards do matter — to Americans, to their children, and to all our futures.

Press Statement released by William Schmidt at the American Association for the Advancement of Science (AAAS) Annual Meeting, Philadelphia, February 12-17, 1998.

Are There Surprises in the TIMSS Twelfth Grade Results?

"There is something surprising about the mathematics and science achievement results for US high school seniors," said Dr. William H. Schmidt in discussing the recently released TIMSS (Third International Mathematics and Science Study) high school seniors' results. "What is surprising is not the profoundly disappointing results but rather failing to realize how predictable those results were given what we already knew. The mathematics and science performance of American high school seniors is neither unexpected nor unimportant."

TIMSS released achievement results comparing general mathematics and science knowledge among typical graduating seniors in several countries. They also released results on more advanced, specialized achievement tests for graduating seniors studying physics or calculus (including Advanced Placement courses in one or both of those areas) and their counterparts in other countries.

TIMSS showed very low results for US students compared to those in the other countries giving the tests, both for general knowledge by average graduating seniors and for advanced performance by seniors studying physics and calculus. A recent report, Facing the Consequences, from the US TIMSS Research Center suggested that these results were certainly to be expected. It pointed out that there was a consistent decline in our relative standing from fourth grade to eighth grade in both mathematics and science. Of the almost 40 topics examined in both mathematics and science, none showed improved standing relative to other TIMSS countries from fourth to eighth grade. Most topics showed a decline over the middle school years.

Schmidt said, "It could hardly be a surprise to find this decline continuing on through high school. As we discussed in Facing the Consequences and in our earlier report, A Splintered Vision, US curricula through eighth grade do not focus on any key topics or give them significantly more attention. Those curricula and our textbooks are highly repetitive and unchallenging in grade after grade of the middle school years. How could they provide a sound foundation on which to build during the high school years?" The middle school curricula in most TIMSS countries cover topics from algebra, geometry, physics and chemistry. For most US students these are first studied, if at all, in high school. Many students (about 15 percent) never study algebra, geometry (about 30 percent), advanced algebra (40 percent), other advanced mathematics (around 80 percent), chemistry (about 45 percent) or physics (almost 75 percent).

Schmidt indicated, "US students frequently opt out of advanced study of mathematics and science in high school or are placed in less demanding courses even if they do continue to take mathematics and science courses. So high school mathematics and science is unlikely to overcome the poor foundation provided during US middle school education and reverse the downward trend in comparative performance for average students."

The US is also selective about who takes what courses, especially in mathematics. We do this even before high school and are essentially unique among TIMSS countries in doing so. As early as middle school, we offer different content to different groups of students. We presumably do this to improve our educational 'efficiency' and increase learning for all students or, at least, for the students in our most demanding courses. It doesn't work. Facing the Consequences used TIMSS results to examine these practices in some detail and found that they did little to help most students learn mathematics. The report also found that this practice contributed to exaggerating achievement differences among US students. The new twelfth grade results make it clear that tracking also fails to provide satisfactory achievement for either average or advanced students.

That report suggests that tracking is not the only problem with the US approach to mathematics and science education. US science and mathematics curricula cover many topics but without devoting much time to any one topic. This makes it unsurprising that there appeared to be only very small differences in what had been learned by US fourth graders compared to third graders or by eighth graders compared to seventh graders. This was true for all mathematics and science topics examined. Schmidt said, "We have characterized US science and mathematics curricula as 'a mile wide and an inch deep.' We can hardly be surprised to find the achievement gains in all of those topics only an 'inch deep' as well."

The US pattern of consistent small gains contrasts sharply with patterns in other TIMSS countries, where in any single grade there are large gains for some topics and small gains in others. US high school seniors' performance on the TIMSS tests show that this approach of accumulating consistent small gains in the end does not result in overall gains as large as those attained by focusing on some topics for greater gains but changing the focus across the years of schooling. Schmidt suggested, "Surely these results must call into question the entire US approach to mathematics and science curricula across the grades."

What about the US's better students? When asked, Schmidt replied, "For some time now, Americans have comforted themselves when confronted with bad news about their educational system by believing that our better students can compare with similar students in any country in the world. We have preferred not to believe that we were doing a consistently bad job. Instead, many have believed that the problem was all those 'other' students who do poorly in school and who we, unlike other countries, include in international tests. That simply isn't true. TIMSS has burst another myth our best students in mathematics and science are simply not 'world class'. Even the very small percentage of students taking Advanced Placement courses are not among the world's best."

US students have been provided with weak foundations for studying advanced mathematics and science. "Our high school specialists are ill prepared to gain the most from advanced study", Schmidt said. "A few grades of weak specialization in high school does not appear able to overcome the weak foundation we lay in earlier grades."

How mathematics and science is arranged in courses also seems to be part of the problem. Better US students study physics in only one or two courses. This is very different from what the students study in the higher achieving countries where physics study begins during middle school and continues throughout high school. Better US mathematics students during high school years take separate courses in geometry, pre-calculus, etc. In most TIMSS countries, students take a course in mathematics — a course which may include studying parts of advanced algebra, geometry, finite mathematics, and calculus at the same time. They may take such courses for several years.

"What these results for US high school seniors make clear and what we tried to examine closely in Facing the Consequences," Schmidt said, "is that there is no one source of these problems and no one source for their solution. The problem is bigger. It is in our system, not any single part of it. We can waste our time protesting each and every change. We can also waste our time thinking that any one change will solve all our problems. In either case, what we do is waste our time. US mathematics and science education has neither simple villains nor 'magic bullets' to cure our ills. We've failed our tests. Do we want to fail our futures, too?"

Press Statement by William H. Schmidt, U.S. TIMSS National Research Coordinator, Michigan State University

FACING THE CONSEQUENCES: USING TIMSS FOR A CLOSER LOOK AT UNITED STATES MATHEMATICS AND SCIENCE EDUCATION

Dordrecht: Kluwer Academic Publishers, in press

In the United States today we are faced with the consequences of an educational system which is an accretion of many choices and beliefs that have shaped our mathematics and science education. This report presents new analyses to provide a powerful and comprehensive characterization and perspective on the current state of US mathematics and science education based on data from the Third International Mathematics and Science Study (TIMSS). TIMSS is the most extensive and far reaching cross-national comparative study of education ever attempted. It included a comparison of official curricula, textbooks, teacher practices, and student achievements from many countries. (Since not all countries participated in all aspects of the study, the number of participating countries included in any one comparison ranges from 20 to 50.) From this broad ranging comparative evaluation of US mathematics and science education, the authors of the report suggest that two clear facts emerge. The first is that the children in the US receive their mathematics and science education through a fragmented system. Americans have chosen to distribute educational responsibilities so consistently to states and local districts that it is not meaningful to speak of a single US educational system but only of "educational systems." The second fact is that children in the US are not getting the science and mathematics education they deserve. As a consequence of commonly held educational beliefs and an accretion of a myriad of educational choices in many different places, they are not getting the education that would allow them to learn and perform to their greatest potential.

No single belief or choice may be identified as responsible for the current state of US mathematics and science education. In the first part of the report, some of the basic facts about classroom instruction are explored: how much time teachers spend on mathematics and science, what topics are taught and emphasized, as well as how and to whom these topics are taught. Among some of the more surprising results is the fact that the US is above average compared to other TIMSS countries in the number of hours it devotes to mathematics and science instruction (see Figure 1). In addition, in contrast to the practice of many high-scoring countries such as the Czech Republic, France, Hong Kong, Japan, and Korea which offered the same mathematics course to all students, nearly 75 percent of US thirteen-year old students were in schools offering two or more differently titled mathematics classes (see Figure 2). This type of tracking has a long history in the US, based on the belief that it is more efficient to teach students in homogenous groups according to their level of competence. The fact that other TIMSS countries did not track and yet surpassed the US in mean student achievement suggests that this common practice in US mathematics education must be questioned.

Consistent with the hypotheses presented in the earlier publication, *Characterizing Pedagogical Flow*, the TIMSS data found differences in the dominant patterns of instructional practices reported by teachers in different countries. For example, instruction in US eighth-grade mathematics classes was dominated by instructional approaches emphasizing seatwork and review – an approach not strongly represented among the teachers from some countries with high mean achievement. Approaches emphasizing instruction on new material were present in US mathematics lessons to the same or greater extent as in many TIMSS countries but not as much as in Hong Kong, Japan, Korea, and Singapore. Over half of US eighth-grade mathematics classrooms were dominated by review, seatwork, and homework. Since this differed markedly from the pattern in US eighth-grade sci-

Figure 1:

Mathematics Instruction Time in Schools Where All Students Study the Same Mathematics Course.

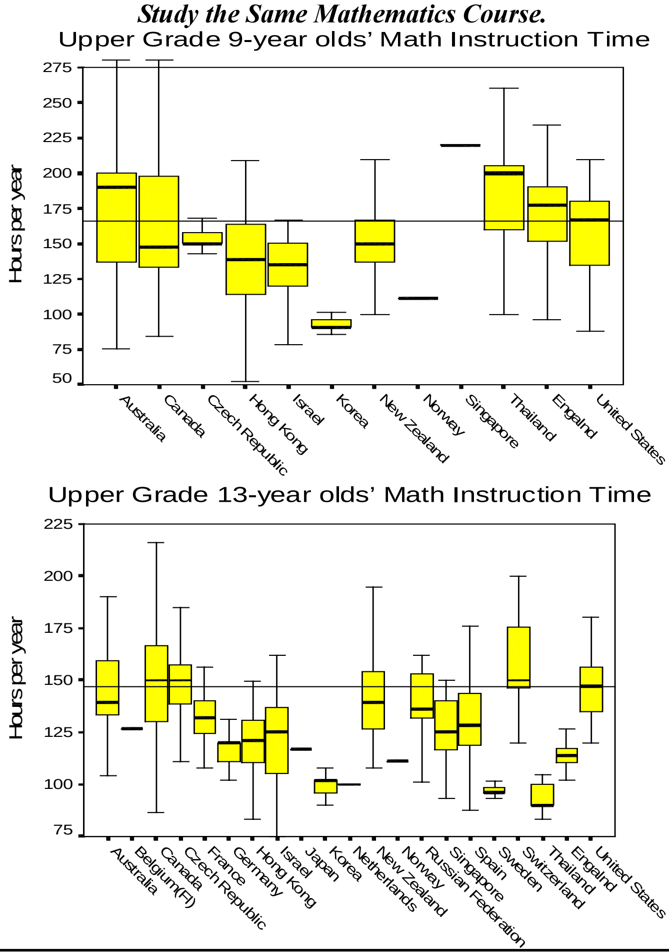
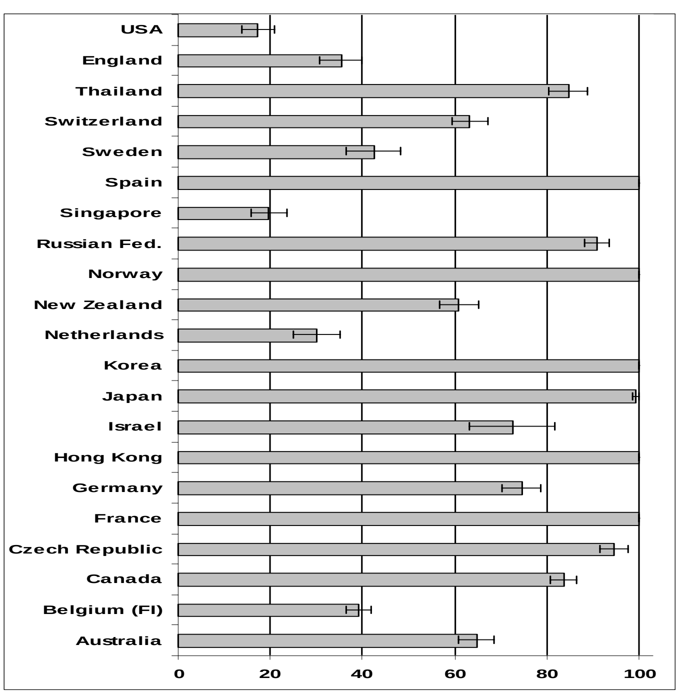


Figure 2:

Percentage of Students in Schools Where All Students Follow the Same Mathematics Course.



ence classrooms, this appears to be a characteristic of how school mathematics was conceived rather than a characteristic US instructional pattern. In many of these US mathematics classrooms, homework was frequently started in class. Only three other countries exhibited this practice in mathematics classes as did Singapore in their science classes.

The oft heard cry of "back to the basics" for US science and mathematics classes stems from the assumption that classrooms in this country have strayed far from their more traditional roots. This is an assumption unsupported by the TIMSS data. Rather, the empirical patterns observed reflect a widespread choice to focus on "basics." This concentration on basics in the US — both in instructional approaches and in curricula (documented more fully in *A Splintered Vision*) — must be questioned given the relatively disappointing and mediocre performance assessing students' learning as measured by the TIMSS tests. US instructional approaches and curricula, both in mathematics and science but especially for mathematics, are less in line with cross national commonalities than are the demanding curricula and classroom practices found in many high-achieving countries.

Students' beliefs and attitudes have the potential to either facilitate or inhibit learning. In this respect, US students did not appear to be especially unmotivated or ill-equipped learners in comparison to their counterparts in other countries. However, US seventh- and eighth-grade students reported studying less but being more optimistic about how well they were doing in mathematics and science than students in many other countries. In addition, a large proportion of these US students reported finding mathematics enjoyable but boring. The unchallenging nature of the curriculum for many and the routinized, undemanding teaching style many encounter may have contributed to this somewhat paradoxical finding. Furthermore, US students believed in the efficacy of hard work in learning mathematics and science more than their counterparts in many other countries.

The second section of the report moves beyond the global single-score reports of achievement to examine the results in greater detail, in ways that are more sensitive to variations in mathematics and science curricula. Contrary to the appearance with these global, single-score results, achievement does relate to differences in curricula. The inability to relate student achievement to educational experiences and curricula is largely a by-product of aggregating and scaling across different topics, contents, and skills. In these more detailed analyses considering more specific content areas of mathematics and science, one of the main findings is that no one country could do it all and do it well. Most countries demonstrated comparatively stronger performance in some specific content areas than in others. For example, Singapore's nine-year-olds, typically the top scorers, scored below those in the US in the area dealing with the geometry of shapes and positions. Australia's students score the highest in this area while ranking eleventh out of fifteen in the area of "rounding and estimating computations. US thirteen-year-olds scored near the bottom of the 22 countries listed in "Physical Changes," with only those in Hong Kong scoring lower, while US students scored second in "Life Cycles and Genetics" with only the students from the Czech Republic scoring higher (see Figure 3).

Examining the pattern of gains countries displayed across these more specific content topics makes the connection between curriculum and achievement even more clear. Countries generally varied more relative to other countries in their gains than in their comparative achievement level. Status, i.e., comparative achievement level, was determined by performance based on accumulated learning over many grades while gains were based on learning within a single grade. If status demonstrated the greater variability, one might suggest that differences were accidents of the measurement process and less likely to reflect anything other than the most marked curricular differences. However, the greater variability for gains (a measure more sensitive to curricular differences) suggests that variance among topics was related primarily to curriculum rather than other factors such as maturation and life experiences. Further evidence of the "mile wide, inch deep" US curriculum may be seen in the US's relatively flat gains profile compared to the notice-

Figure 3:

Science scores for specific content areas for upper grade thirteen-year-olds in selected countries compared to the US mean (national percent correct in each area)

Earth Features	
Czech Republic	*67.1*
Hungary	*67.1*
Korea	*65.3*
Singapore	*64.6*
Belgium (Fl)	61.1
Sweden	60.5
Thailand	59.7
Russian Federation	59.2
Norway	59.2
Japan	59.0
England	58.7
Switzerland	58.2
Netherlands	58.0
Australia	57.5
Germany	57.2
USA	**57.1**
Canada	56.6
Israel	56.1
Spain	55.9
New Zealand	55.9
International	55.4
France	55.1
Hong Kong	54.1

Earth Processes	
England	*66.7*
Singapore	*66.7*
Belgium (Fl)	65.4
Netherlands	62.5
Norway	62.3
USA	**60.9**
Russian Federation	60.8
Canada	60.6
Sweden	60.0
Korea	59.0
Japan	58.5
New Zealand	57.3
Czech Republic	57.2
Australia	56.7
Thailand	56.0
Switzerland	56.0
Spain	55.5
France	55.0
Israel	54.7
Germany	53.9
International	53.5
Hong Kong	52.3
Hungary	51.3

Earth in the Universe	
Sweden	*70.7*
Norway	*70.1*
Netherlands	67.5
Czech Republic	66.9
Japan	66.7
Thailand	66.0
Singapore	64.9
Switzerland	64.8
Korea	64.4
USA	**63.3**
Germany	62.8
Spain	62.8
Australia	62.7
Belgium (Fl)	61.8
New Zealand	61.7
Canada	61.2
England	59.0
Hungary	58.5
International	58.2
Hong Kong	58.0
Israel	56.2
Russian Federation	56.9
France	53.2

Diversity & Structure of Living Things	
Japan	*75.9*
Singapore	*74.2*
Hong Kong	*73.4*
Korea	*72.5*
Czech Republic	*72.3*
Netherlands	*71.6*
Thailand	*68.8*
Sweden	67.7
Hungary	67.1
Australia	66.7
Germany	65.7
Russian Federation	65.7
England	64.5
USA	**63.9**
Canada	63.3
Belgium (Fl)	62.9
New Zealand	62.3
Spain	61.3
International	61.3
Switzerland	61.0
Israel	60.4
Norway	59.2
France	58.4

Life Processes & Functions	
Singapore	*72.3*
Japan	*70.4*
Korea	*68.2*
Czech Republic	*63.7*
Thailand	63.0
Belgium (Fl)	62.9
Netherlands	60.7
Hungary	59.9
Russian Federation	59.4
England	59.3
Germany	58.1
USA	**58.0**
Australia	57.4
Canada	57.2
Israel	57.1
Hong Kong	56.3
New Zealand	56.1
Spain	55.9
Sweden	54.9
International	54.5
Switzerland	54.2
Norway	54.2
France	53.8

Life Cycles & Genetics	
Czech Republic	81.8
USA	**81.2**
England	80.4
Netherlands	79.3
Israel	79.0
Belgium (Fl)	78.9
Canada	78.4
Sweden	78.2
Norway	78.1
Korea	75.9
France	75.7
Russian Federation	75.5
Germany	75.5
Switzerland	75.1
Japan	74.8
New Zealand	73.9
Hungary	73.7
Australia	73.0
Spain	71.1
International	70.2
Singapore	68.6
Thailand	67.3
Hong Kong	65.3

Interactions of Living Things	
Korea	*68.8*
Singapore	*65.6*
Japan	*65.0*
Thailand	*64.1*
Hungary	*63.1*
Australia	*62.0*
England	*61.5*
Norway	59.9
Canada	58.2
Czech Republic	57.6
New Zealand	55.9
Netherlands	55.8
USA	**54.3**
Germany	52.9
Belgium (Fl)	52.9
Spain	52.9
Russian Federation	52.3
Sweden	52.1
International	51.0
Israel	50.2
Switzerland	49.8
Hong Kong	46.6
France	44.8

Human Biology & Health	
Singapore	*74.0*
Czech Republic	*71.6*
Netherlands	71.2
Japan	69.4
Belgium (Fl)	69.3
Hungary	68.7
England	68.3
Israel	67.6
Germany	67.6
USA	**66.8**
Thailand	66.5
Australia	66.5
Korea	65.5
Canada	65.3
Sweden	63.9
New Zealand	63.7
Spain	63.2
Russian Federation	63.1
Norway	62.6
Switzerland	61.4
International	61.2
Hong Kong	59.9
France	55.7

Properties & Classification of Matter	
Japan	*66.6*
Singapore	*66.6*
Korea	*65.4*
Czech Republic	*60.4*
Netherlands	*58.3*
Belgium (Fl)	*57.9*
Hungary	*57.3*
Sweden	*57.2*
Hong Kong	*56.4*
Canada	*55.7*
Norway	*54.8*
Australia	*54.7*
England	*54.7*
Germany	54.9
Russian Federation	54.3
New Zealand	53.5
Israel	53.5
France	52.3
International	51.6
Switzerland	51.1
USA	**49.9**
Spain	49.6
Thailand	46.7

Structure of Matter	
Russian Federation	*56.4*
Hungary	*53.9*
Czech Republic	54.2
Singapore	53.2
Spain	51.0
USA	**48.2**
Israel	44.7
Sweden	42.7
Korea	42.1
Japan	41.1
Hong Kong	40.0
International	39.6
Australia	38.7
England	38.1
Canada	37.1
Germany	35.2
New Zealand	34.5
Norway	31.9
Thailand	30.6
Netherlands	30.0
France	29.4
Switzerland	28.6
Belgium (Fl)	27.4

Energy & Physical Processes	
Singapore	*71.2*
Japan	*68.8*
Korea	*67.2*
England	*64.1*
Netherlands	*63.8*
Czech Republic	*62.3*
Belgium (Fl)	*62.2*
Australia	*61.1*
Hungary	60.2
New Zealand	59.9
Canada	59.9
Hong Kong	59.5
Israel	59.5
Germany	59.3
Switzerland	58.7
Russian Federation	58.4
USA	**57.1**
Norway	56.6
Sweden	56.6
International	56.4
Thailand	55.3
Spain	55.2
France	54.6

Physical Changes	
Japan	*66.7*
Singapore	*63.1*
Czech Republic	*62.9*
France	*61.9*
Israel	*61.4*
Sweden	*61.3*
Netherlands	*61.1*
Hungary	*61.0*
Norway	*60.0*
England	*58.9*
Belgium (Fl)	*58.7*
Canada	*58.5*
Korea	*57.3*
Australia	*57.1*
Russian Federation	57.0
Switzerland	54.0
Germany	53.6
Thailand	53.2
Spain	53.1
International	52.8
New Zealand	52.8
USA	**49.1**
Hong Kong	48.8

Chemical Changes	
Singapore	*73.5*
Korea	65.9
Hungary	65.4
Czech Republic	64.2
England	63.7
Japan	63.5
Australia	61.9
Russian Federation	61.8
USA	**61.4**
Germany	60.7
Israel	60.6
Canada	59.6
New Zealand	59.4
Hong Kong	58.2
Spain	58.1
Netherlands	57.6
Sweden	57.1
International	56.5
Belgium (Fl)	55.6
Switzerland	55.4
Norway	53.4
France	52.5
Thailand	50.9

Forces & Motion	
Czech Republic	*78.1*
Japan	*73.6*
Singapore	*73.4*
Netherlands	*71.2*
Korea	*69.6*
Hong Kong	*69.4*
Switzerland	*68.8*
Hungary	*68.7*
England	*67.6*
Sweden	*67.5*
Australia	*67.2*
Norway	*67.1*
Canada	*66.3*
Germany	66.9
New Zealand	65.6
Belgium (Fl)	65.2
France	63.8
Spain	62.6
Russian Federation	62.1
USA	**61.3**
International	61.2
Israel	54.9
Thailand	56.4

Science, Technology, & Society	
Korea	*74.3*
Hungary	*73.3*
Netherlands	*67.4*
Sweden	*66.9*
Singapore	*66.4*
Belgium (Fl)	*65.2*
New Zealand	*60.4*
Japan	*60.1*
Thailand	*59.2*
England	*57.2*
Hong Kong	54.8
Canada	52.5
Switzerland	52.5
Norway	52.1
Czech Republic	51.9
Australia	51.5
Israel	51.3
International	47.9
USA	**47.5**
Germany	47.3
Spain	44.1
France	42.9
Russian Federation	40.4

Environmental & Resource Issues	
Singapore	*73.12*
Thailand	*70.05*
England	*67.23*
Australia	*64.67*
Netherlands	65.1
Korea	62.7
Japan	61.7
Canada	61.5
New Zealand	61.4
USA	**59.9**
Belgium (Fl)	59.7
Czech Republic	59.1
Spain	58.6
Norway	58.2
Hong Kong	53.3
International	53.0
Sweden	51.8
Israel	51.6
Switzerland	50.3
Germany	50.1
Hungary	49.4
France	48.5
Russian Federation	46.8

Scientific Processes	
Singapore	*74.62*
Korea	*64.2*
Netherlands	65.2
France	62.2
Czech Republic	60.7
Australia	60.6
Japan	60.1
England	60.0
Canada	59.2
USA	**58.9**
Hungary	57.3
Hong Kong	57.2
Belgium (Fl)	56.9
New Zealand	56.7
Thailand	55.3
Germany	53.4
Israel	51.8
Switzerland	53.3
International	53.1
Sweden	52.4
Norway	52.1
Russian Federation	51.2
Spain	49.6

KEY
Significantly Higher
No Sig. Difference
Significantly Lower

able peaks for some topics seen in the gains profiles of nine- and thirteen-year olds in many other countries.

The TIMSS data further demonstrates that the cultural, ethnic, and racial heterogeneity of the US population cannot explain the variability in the mathematics and science results of US nine- and thirteen-year-olds. The patterns in US student achievement suggest that variations in mathematics and science achievement is not simply a matter of natural differences among persons since much of this can be linked to US curricular policies. Neither was the variability in US mathematics achievement particularly noteworthy compared to that in other TIMSS countries. Indeed, several of the high scoring countries such as Korea, Japan, Hong Kong, and the Czech Republic demonstrated more variability in their thirteen-year-olds' mathematics scores than what was found in the US.

The third part of the report summarizes new analyses and integrates them with previous results and conclusions to construct a comprehensive portrait of the structural characteristic of US mathematics and science educational practice. Some of these characteristics include:

- Official US mathematics and science curricula that were typically "a mile wide and an inch deep."
- Mathematics and science instruction in the middle grades that was highly repetitive and progressed little over the demands of earlier grades.
- Some students had access to educational possibilities in mathematics and science that were denied to others.

As much as the report seeks to build a case for the importance of curriculum in strong achievement, it would be a mistake to think that any one thing matters so much that it outweighs all other factors. There is no single factor that alone may solve all the difficulties in US mathematics and science education. Although many such panaceas have been proposed, the bottom line is that there are no magic bullets. Some of the "magic bullets" that are discussed more fully in the report as not supported by the TIMSS data include:

- Assigning more homework to produce greater achievement.
- Getting "back to the basics."
- Devoting more instructional time to mathematics and science.
- Put algebra earlier (e.g., in the eighth grade) or push more content down to earlier grades.
- Centralize curriculum and educational decision making.

The final section of the report includes a frank discussion of the lessons we can learn from TIMSS along with some consideration of the kinds of supplementary research that would be most helpful in understanding and improving US science and mathematics education.

Summary Prepared by Leland S. Cogan, Senior Research Associate, US National Research Center, Michigan State University.

PUBLICATIONS NOW AVAILABLE

Books

U.S. Department of Education. National Center for Education Statistics, Pursuing Excellence: A Study of U.S. Eighth-Grade Mathematics and Science Achievement in International Context, NCES 97-198, by Lois Peak. Washington, D.C.: U.S. Government Printing Office, 1996.

U.S. Department of Education. National Center for Education Statistics, Pursuing Excellence: A Study of U.S. Fourth-Grade Mathematics and Science Achievement in International Context, NCES 97-255. Washington, D.C.: U.S. Government Printing Office, 1998.

U.S. Department of Education. National Center for Education Statistics, Pursuing Excellence: A Study of U.S. Twelfth-Grade Mathematics and Science Achievement in International Context, NCES 98-049. Washington, D.C.: U.S. Government Printing Office, 1998.

Schmidt, William H., Curtis C. McKnight, Gilbert A. Valverde, Richard T. Houang, and David E. Wiley. Many Visions, Many Aims: A Cross-National Investigation of Curricular Intentions in Mathematics - Volume 1. Dordrecht: Kluwer Academic Publishers, 1997.

Schmidt, William H., Et. Al. Many Visions, Many Aims: A Cross-National Investigation of Curricular Intentions in Science - Volume II. Dordrecht: Kluwer Academic Publishers, 1997.

Schmidt, William H., Curtis C. McKnight, Senta A. Raizen, A Splintered Vision: An Investigation of U.S. Science and Mathematics Education - Volume III. Dordrecht: Kluwer Academic Publishers, 1997.

Journal Articles

Schmidt, William H., Pamela M. Jakwerth, Curtis C. McKnight, "Curriculum-Sensitive Assessment: Content Does Make a Difference," International Journal of Educational Research, Fall 1997.

McKnight, Curtis C., and William H. Schmidt, "Facing Facts in US Science and Mathematics Education: Where We Stand, Where We Want to Go," Journal of Science Education and Technology, Fall 1997.

Jakwerth, Pamela M., Leonard J.Bianchi, Curtis C. McKnight, and William H. Schmidt, "Focus in School Science: An International Comparison," GEO Times, Summer 1997.

Valverde, Gilbert A., and William H. Schmidt. “Refocusing U.S. Math and Science Education.” Issues in Science and Technology, Winter 1997-98, 60-66.

Cogan, Leland. S., and William H. Schmidt, (in press). An Examination of Instructional Practices in Six Countries. In G. Kaiser, E. Luna, & I. Huntley (Eds.), International Comparisons in Mathematics: The State of the Art. Falmer Press.

McKnight, Curtis C., and Gilbert A. Valverde. Explaining TIMSS Mathematics Achievement: A Preliminary Survey. In G. Kaiser, E. Luna, & I. Huntley (Eds.), International Comparisons in Mathematics: The State of the Art. Falmer Press.

Newspaper

Schmidt. William.H., and Curtis C. McKnight. "U.S. Students Can Raise Test Scores - If We Adapt." Boston Globe, Focus Section, March 15, 1998.

WORK IN PROGRESS

Greater Expectations: Learning from Other Countries in the Quest for World Class Standards in Mathematics and Science Education

Great hopes are pinned on the formulation of new and demanding standards in school subjects despite the tremendous controversy often besetting the process of their definition (the political battles over mathematics standards in the state of California a recent example), and despite the pessimism of influential thinkers in the field of education. Much of the discussion surrounding educational standards currently is international in character. Increasingly, curriculum experts, professional associations and policy-makers have become concerned with how standards defined in this country compare to those in other countries. This reflects the fact that, despite the efforts of a number of high-profile revisionists that discount such notions a ‘mythology’ many hold that school children in the US do not exhibit high levels of educational achievement - and that their peers in many other nations do.

TIMSS has contributed substantial data to support this position. Results from this study suggest that the situation regarding what school children learn in the US is disheartening. Our school children are not at all positioned to reach the high expectations set for them by our state governors and the President. They are not likely to be “first in the world” by the end of this century in either science or mathematics. Our national goal, as stated in the Goals 2000: Educate America Act is stated in terms of comparing education in this country against other countries. Our goal is to lead all other nations in the achievement of our pupils in mathematics and science. Many of the most important interest groups in education - including state governors, the business community, the federal government, professional associations of educators and many others - speak today of ‘World-Class Standards’. But what precisely are ‘World-Class’ standards? What expectations do, for example, high-achieving countries have regarding essential knowledge and skills that children must acquire in order to meet the expectations held for them by the educational system? The purpose of work currently underway at the US TIMSS Center is to begin the exploration of this question using the data base created by TIMSS for the analysis of intended curricula. The question addressed is twofold: What are the expectations held by the educational systems of countries performing among the best in the world, and how do expectations in the United States compare to the expectations of this select group of countries? This work is a continuation of the curriculum benchmarking studies being conducted by TIMSS researchers in the United States. Here we will report our work benchmarking the intended curriculum in the United States against those of high-achieving TIMSS countries. We hope that this effort will aid curriculum specialists, mathematics and science education specialists, and others in the standards movement.

Summary by Gilbert Valverde, Associate Director, U.S. National Research Center, Michigan State University.

Diverse Expectations: Chaotic Variation in US Eighth Grade Mathematics

Extensive public discussion is currently focused on what mathematics should be taught to US students and when it should be taught. An analysis of course titles in US grade eight schools participating in TIMSS and what is taught in these courses revealed a wide spectrum of intentions and expectations. Course titles frequently held little if any indication about the intended curricular focus. The most prevalent course title by far was simply “math” or “mathematics” but many others incorporated the notion of tracking students according to ability with such titles as “average mathematics”, “gifted” or “high” mathematics, “LD mathematics”, and “remedial mathematics” among others.

From course titles and student tracking information five main types of mathematics courses were identified: remedial, regular, enriched or accelerated, pre-algebra, and algebra. The textbooks used in these courses were categorized on the basis of their titles and content profiles into three types: regular, pre-algebra, and algebra. Regular and pre-algebra textbooks were employed in all five types of eight grade mathematics courses and algebra texts were being used in all but remedial type courses. Teachers’ emphasis of specific topics did vary both as a function of the type of course being taught and the type of textbook being used. Clearly substantial variation existed in opportunities students had to learn various mathematics topics in their classes.

Schools attended by low SES students were more likely to have offered remedial and regular courses and less likely to have had pre-algebra and algebra courses than other schools. Nonetheless, the great variation in the type of mathematics courses offered and the content focus of these courses was not substantially related to schools' size and location, nor students' ethnicity and socioeconomic status. Rather, this implicit tracking of students into different types of mathematics courses occurred within, as well as, across schools yielding further evidence of the splintered vision that exists in the US about what eighth grade students should learn in mathematics. This chaotic variation undermines the expectations of the public - particularly the business community - that holds the expectation that children will learn specific mathematics and seriously jeopardizes a quantitatively literate society and a technologically prepared work force.

Summary prepared by Leland S. Cogan, Senior Research Associate, U.S. National Research Center, Michigan State University.

Curriculum Sensitive Assessment: Content Does Make a Difference

The recent results emerging from the Third International Mathematics and Science Study (TIMSS) raise anew- important issues about assessment designed for achievement comparisons. With TIMSS, as with prior achievement- research, considerable popular and policy attention has been paid to the relative standing (or ranking) of participating countries. Typically these rankings have been in terms of either their total scores - for TIMSS, on the mathematics and science achievement tests or, at best, a few reported broad- area sub-scores. This article explores the use of rankings and total-test scores in large-scale comparative studies and some of the issues related to them. It examines their value as a basis for policy decisions and educational research. It uses TIMSS data to explore the effect of aggregating data on assessments' sensitivity to curricular differences. The article focuses on issues of assessments designed to compare student achievement in broad academic subjects (e.g., mathematics, science, and reading) in order to reach conclusions on the effectiveness of participating educational systems.

This article argues that student performance in mathematics and science is inherently multi-dimensional and that variations in performance most likely are closely related to differences in educational experiences. It also tries to show that highly aggregated scores of broadly sampled domains are inherently misleading and mask fundamental, educationally relevant diversities at more curricular specific levels. Without thoughtful interpretation and careful respect for their limitations, the masking from such highly aggregated scores may well lead to incorrect conclusions about the irrelevance of curricular specifics and may misguide educational policy. The article also provides a few recommendations about the appropriate use of achievement comparisons based on large-scale, especially cross-national, testing.

Summary by Pamela Jakwerth, Senior Research Associate, formerly with Michigan State University, currently with American Institutes for Research in Palo Alto.

An Examination of Instructional Practices in Six Countries

This chapter presents conclusions a multi-national research team reached after conducting observations in the mathematics and science classrooms of nine- and thirteen-year old students that informed the development of the survey instruments used in the Third International Mathematics and Science Study. The research team employed an iterative, discourse methodology in analyzing the classroom observations made in each of the participating countries: France, Japan, Norway, Spain, Switzerland, and the United States. A consensus emerged there appeared to be typical patterns of instructional and learning activities in each country's set of observations. These typical patterns appeared to result from the interaction of curriculum and pedagogy. The group coined the term Characteristic Pedagogical Flow (CPF) to refer to these typical patterns and is presented as an extended hypothesis for further investigation and elucidation. Differences in mathematics lessons from the six countries illustrate the key aspects of the CPF concept. A brief description of the CPF for each country's mathematics lessons is presented. The origin of this concept is explained, illustrated, and situated within the context of the larger conceptual model of educational opportunities.

Cogan, Leland S., & William H. Schmidt, (in press). G. Kaiser, E. Luna, & I. Huntley (Eds.), International Comparisons in Mathematics: The State of the Art, : Falmer Press.

FUTURE TIMSS PRESENTATIONS

William Schmidt, director of the U.S. National Research Center and other TIMSS researchers will present findings from the Third International Mathematics and Science Study at several national meetings in the near future. If you will be attending any of these meetings, please plan to attend.

AMERICAN EDUCATIONAL RESEARCH ASSOCIATION (AERA), SAN DIEGO

April 13,
12:00 - 1:55 PM - Session 1.25 the Quixotic Quest: Is Being First in the World a Useful Goal? Marriott Hotel, Room: Cardiff (South Tower, Level 3).

April 15,
8:15 AM - 9:45 AM - Session 21.02 (Symposium: Performance Assessment in the Third International Mathematics and Science Study: Results and Implications); Marriott Hall 2.

10:35 - 12:05, Session 23.66, The Relationship of Curriculum to Achievement: Initial Results from the Third International Mathematics and Science Study (TIMSS), Marriott, San Diego C, North Tower, Lobby Level.

10:30 AM -12:05 PM, Session 23.36, Reforming Math and Science Education: Do State Education Agencies Matter? Hyatt, Cunningham A, 4th Floor.

April 16,
8:15-10:15 AM - L2 (NCME), Comparability
Issues in International Assessment: Content Does Make a Difference Variability, Convention Center, Room 5B, Upper Level.

12:25-1:55 PM - Session 37.03, Educational Opportunity and Achievement in the United States: Summative Report from the Third International Mathematics and Science Study, Marriott Hall 3, North Tower, Lobby Level.

April 17,
10:35-12:05pm - session 48.38, Using TIMSS to Characterize Instructional Practices of US Teachers, Hyatt, Manchester, 2nd floor.

April 30-Mathematics and Science Centers Network, Adrian, MI

MAY
- **1-** Wisconsin Mathematics Council, Green Lake Conference, Oshkosh
- **1-** Michigan MAA - Kalamazoo
- **6-** Glendale Unified School District, California
- **7-** California Parent Teachers Association, San Diego
- **11-** Central Coast Mathematics Project, San Luis Obispo
- **11-** Department of Education, Bismarck, ND
- **12-** Santa Barbara County Education Office
- **14-** South Eastern Regional Vision for Education, Eisenhower Consortia, Atlanta
- **21-** Achieving Schools Seminar, Orange County
- **22-** East San Gabriel Valley ED Consortium
- **29-** Shaping the Future of Undergraduate Science, Mathematics, Engineering and Technology Education Conference, University of Nebraska, Lincoln

JUNE
- **4-** Maryland Business Roundtable for Education, Baltimore
- **9-** Stockton Unified School District
- **15-17-** Conference on Science and Mathematics Education, Lisbon, Portugal
- **23-** Arkansas Association for Supervision and Curriculum Development Conference, Hot Springs
- **23-** Capital Area Institute for Mathematics and Science, Harrisburg, PA.
- **24-** Mid-Atlantic Eisenhower Consortium TIMSS Conference, Philadelphia
- **25-** School-to-Career Summer Institute, San Diego

JULY
- **3-6-** International Conference on the Teaching of Mathematics, Samos Island, Greece

AUGUST
- **4-** Summer Conference on Renewal for Rigor and Relevance in Learning, Southgate, MI
- **5-7-** The University of Chicago School Mathematics Project, Fourth International Conference, Chicago
- **13-** Los Angeles Systemic Initiative
- **14-16-** Martha Holden Jennings Foundation and Ohio Department of Education, Cleveland
- **20-** Crystal Lake, IL

SEPTEMBER
- **20-25-** Gordon Research Conference on International Science Education, Oxford, England

OCTOBER
- **23-** Educational Records Bureau, NYC
- **25-** Math/Science Collaborative Network Connection, Pittsburgh

NOVEMBER
- **2-** Capital Area Math/Science Alliance, Harrisburg, PA
- **6-** California Mathematics Council, Southern Section Conference, Palm Springs
- **19-** California Research Association, San Diego
- **24-** Pennsylvania ASCD Conference, Hershey

NATIONAL RESEARCH COORDINATING COMMITTEE

Dr. Pascal Forgione, Jr., Commissioner of Education Statistics, National Center for Education Statistics; **Dr. Eugene Owen**, National Center for Education Statistics; **Dr. Larry Suter**, Office of Studies and Program Assessment, National Science Foundation. The committee is chaired by **Dr. William Schmidt**, Michigan State University.

We want to hear from our readers, so if you have questions, want additional information about a topic addressed in the newsletter or the study in general, please feel free to contact us. You can write or call Gilbert Valverde, Associate Director - TIMSS, 457 Erickson Hall, Michigan State University, East Lansing, Michigan 48824-1034, telephone 517-353-7755, fax 517-432-1727, or E-Mail, valverde@pilot.msu.edu.

We also are available to make presentations to professional groups or associations who might be interested in being introduced to TIMSS or receiving updates on the project. If your organization is interested in hearing more about TIMSS and would like a representative from our office to present to your group, please contact the National Research Center at Michigan State University.

If you or someone you know did not receive this newsletter directly, but would like to be on our mailing list, please send your name and address along with your request to Marlene Green, 455 Erickson Hall, Michigan State University, East Lansing, Michigan 48824-1034, telephone 517-353-7755, fax 517-432-1727, or E-Mail: marlene@pilot.msu.edu.

Visit our web site:

URL: http://ustimss.msu.edu/

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TIMSS