

**U.S. DEPARTMENT OF EDUCATION
NATIONAL MATHEMATICS ADVISORY PANEL MEETING**

MONDAY, NOVEMBER 6, 2006
SUMMARY

The National Mathematics Advisory Panel met in open session at the Schwab Residential Center, Stanford University, East Vidalakis Hall, 680 Serra Street, Stanford, CA 94305-6090, on Monday, November 6, 2006 at 8:15 a.m., Chair Larry R. Faulkner, presiding.

PANEL AND EX-OFFICIO MEMBERS PRESENT:

LARRY R. FAULKNER	Chair
CAMILLA PERSSON BENBOW	Vice Chair
DEBORAH LOEWENBERG BALL	Member
FRANCIS (SKIP) FENNELL	Member
DAVID C. GEARY	Member
RUSSELL M. GERSTEN	Member
NANCY ICHINAGA	Member
TOM LOVELESS	Member
LIPING MA	Member
VALERIE F. REYNA	Member
ROBERT S. SIEGLER	Member
SANDRA STOTSKY	Member
VERN WILLIAMS	Member
HUNG-HSI WU	Member
DANIEL B. BERCH (PRESENT VIA CONFERENCE PHONE)	Ex Officio Member
DIANE JONES (PRESENT VIA CONFERENCE PHONE)	Ex Officio Member
RAYMOND SIMON	Ex Officio Member
GROVER J. (RUSS) WHITEHURST	Ex Officio Member

PANEL AND EX-OFFICIO MEMBERS NOT PRESENT:

A. WAYDE BOYKIN	Member
WILFRIED SCHMID	Member
JAMES H. SIMONS	Member
KATHIE OLSEN	Ex Officio Member

STAFF MEMBERS PRESENT:

TYRRELL FLAWN	Executive Director
IDA EBLINGER KELLEY	
JENNIFER GRABAN	
HOLLY CLARK	
MICHAEL KESTNER	
KENNETH THOMSON	

CALL TO ORDER

Chair Larry R. Faulkner called the November 6, 2006 National Mathematics Advisory Panel meeting to order at 8:15 a.m.

OPEN SESSION-INVITED TESTIMONY

WELCOMING REMARKS: CHAIR LARRY R. FAULKNER

Chair Faulkner began by welcoming everyone to the morning session of the National Mathematics Advisory Panel, specifically members of the public and members of the Panel, to the session. He asked about the need for sign language services, and there was no such need in the audience.

Chair Faulkner thanked Stanford University for hosting the National Math Panel on this occasion, and stated that the location is a continuation of holding panel meetings in places around the country that represent high achievement in education. He acknowledged Debra Stipek, Dean of the Stanford School of Education, and thanked her for her assistance in planning the meeting.

WELCOME FROM STANFORD UNIVERSITY PRESIDENT: PRESIDENT JOHN HENNESSY

Dr. Hennessy welcomed the group to Stanford and commented that they believe the work of the panel is critically important. He noted that half of Stanford's students major in science or engineering topics, and he sees a growing need for mathematics across a variety of disciplines. The country continues to rely on the importation of talent from around the world, and he sees that as a fundamental threat to the nation's ability to continue to lead in science, technology and innovation. He stated that if we are going to continue to be world leaders at a time of increasing competition, we have to do a better job of educating people in our own country and preparing them for careers in science and engineering.

He thinks the problem is one where each part of the pipeline has to make a contribution, and acknowledges that universities have to better educate young people and attract them into science and engineering. High schools also have a responsibility, but it begins with the K-8 experience.

He stated that teachers are absolutely crucial to preparing students. It is vital to think about how to attract, educate and retain good mathematics teachers.

**PRESENTATION ON TRENDS IN MATHEMATICS AND SCIENCE STUDIES (TIMSS):
MICHAEL MARTIN, CO-DIRECTOR OF TIMSS AND PROGRAM IN INTERNATIONAL READING LITERACY STUDY (PIRLS) INTERNATIONAL STUDY CENTER, BOSTON COLLEGE.**

Dr. Michael Martin began with some background on Trends in International Mathematics and Science Study (TIMSS), a test that has been studying student achievement in mathematics and science internationally since 1995. It is conducted every four years, and they are currently working on the 2007 assessment.

Dr. Martin stated that the message from TIMSS 1995 is quite stark. U.S. mathematics performance in relation to the TIMSS scale was just about average overall, and declined as students progress up the grades. Scores are acceptable in fourth grade, about average in eighth grade and then worse in twelfth grade. The scale was developed in the first TIMSS in 1995 to have an average of 500 and a standard deviation of 100.

Dr. Martin went into more detail by stating that in 1995, average achievement of U.S. fourth-graders was just above average with a score of 518, compared to the average of 500. This, for example, was well below the highest-achieving country, Singapore, which had a score of 590. At the eighth grade, the performance was almost average, 492, but somewhat farther behind Singapore, for example, which had a score of 609. At the twelfth grade, there are two different tests including an assessment of mathematics literacy and an advanced mathematics test. The score for the assessment of math literacy for U.S. eighth-graders was below average at 461. The advanced mathematics test, given to about 14 percent of the cohort, was also well below average at 442.

Dr. Martin explained the hypothesis behind the repeat of the test in 1999, which hoped to see an increase in achievement due to the reform efforts concentrated at the earlier grades in the 1980s and early 1990s. TIMSS was given again just to the eighth grade, but the results were disappointing in that eighth-graders, who had been fourth-graders in 1995, were still about average with a score of 502.

Dr. Martin went on to describe TIMSS 2003, where at the eighth grade, students were still just about average at 504. There was improvement from 1995 to 2003, from 492 to 504. At the fourth grade, students were steady with a score of 518.

Compared to other countries, Dr. Martin explained, consistently high-performers in mathematics in TIMSS have been the Asian countries. Singapore, for example, had a score of 605 at the eighth grade and 594 at the fourth grade.

Dr. Martin described another function of TIMSS, which is to keep a record of international benchmarks of the actual mathematics the students know and can do. The TIMSS Advanced International Benchmark is set at a score of 625. Students reaching this benchmark can, for example, apply algebraic concepts and relationships to solve problems. They also can solve simultaneous inter-equations, model simple situations algebraically, and apply measurement and geometry in complex problem situations. TIMSS reports the percentage of students in each country who reach these benchmarks.

Looking at eighth grade in 2003, the highest-achieving country, Singapore, had 44 percent of its students reaching this advanced benchmark. Other countries came in as follows: Chinese Taipei (Taiwan), 38 percent; South Korea, 35 percent; Hong Kong (formerly a country), 35 percent; Japan, 24 percent; and the United States, 7 percent.

Dr. Martin went into some of the possible reasons for this U.S. lag. Japan and the United States are similar in terms of gross national income per capita (GNI), with Singapore and Hong Kong not far behind in terms of available resources. Korea and Chinese Taipei also have comparatively modest per capita GNIs.

The next possible reason for the U.S. lag, Dr. Martin explained, was that each of the high-achieving countries has a national curriculum and highly important high-stakes examinations, which the United States does not.

Dr. Martin further examined the curriculum question. Singapore and Japan have all of the TIMSS mathematics topics in their curriculum, and the United States has about 83 percent. Chinese Taipei has only two-thirds of the topics, and Korea and Hong Kong have only about a half. Therefore, Dr. Martin concluded this does not account for the difference.

Dr. Martin examined curriculum content and what is actually taught. Again, this does not seem to be the easy answer because more than 80 percent of the topics were taught to almost all of the students in Singapore, Chinese Taipei and Korea, a little less in Hong Kong, and then the United States at 80 percent.

The next variable examined by Dr. Martin was teacher preparation. He found that teachers must know mathematics to teach mathematics. In Singapore and Chinese Taipei, more than 80 percent of the students were taught by teachers who have mathematics as their major. In Hong Kong, 63 percent; Japan, 80 percent; Korea, 37 percent; and the United States, just about half.

Other factors examined by Dr. Martin included the following: 1) the perceived levels of teacher preparation, which was high across the board, 2) orderly schools, which led to increased achievement, and 3) attendance, where the United States lags with only 18 percent of students attending schools with high attendance rates. Also reviewed was the amount of time devoted to algebra and geometry. What was notable was that the United States, in comparison to other places, had relatively little emphasis on geometry. This may be partly because many of the other countries already laid the basis for algebra in earlier grades and were able to move on to more challenging content.

Technology and calculator use across the countries showed that in the United States, Hong Kong and Singapore, all students have access to calculators and are permitted to use them. But in Chinese Taipei, Korea and Japan, about a third of the students are not permitted to use calculators and are still able to achieve quite a high level of mathematics performance.

Time on task-learning mathematics shows us that Asian countries seem to spend a higher proportion of time lecturing to students. In the United States, students spend their time working on problems either with teacher guidance or by themselves.

**PRESENTATION ON TIMSS:
JAMES STIGLER, PROFESSOR OF PSYCHOLOGY AT THE UNIVERSITY OF
CALIFORNIA AT LOS ANGELES**

Dr. James Stigler's presentation focused on the TIMSS video studies that have been underway since 1995 and their implications for improving teaching. He began with two assumptions that are critical for the Panel to focus on. First is that the classroom is the final common pathway for improving mathematics education and that teaching is something that can be studied and improved, not something that just has to vary randomly.

Dr. Stigler gave some background on the two large studies where data were collected in 1995 and 1999. The methodology behind these studies was to take national samples of eighth grade mathematics teachers through questionnaires and videotaping a single classroom lesson in each of these classrooms. The study consists of a review of hundreds of hours of video from the TIMSS study countries.

The first TIMSS video study included Germany, Japan, and the United States. The second TIMSS video study included some more high-achieving countries such as Czech Republic, Netherlands, Switzerland, Hong Kong, and some other non-Asian higher-achieving countries.

Dr. Stigler stated that the goals of this research were to first, investigate average teaching through a random sample, as opposed to focusing on top-level teachers. The reason for this is because most students experience average classroom instruction. The second goal was to compare U.S. findings to those of other higher-achieving countries.

Dr. Stigler reviewed the findings with the group, the first of which was that teaching is a cultural activity. The second finding was that there is no single best instructional approach. Teaching was found to be very contextual, where what works best in one country might not work in the other, simply because cultures differ from country to country, and it is very hard to change them.

Within these findings, Dr. Stigler found a key intervening variable when teachers taught the math problems designed to engage students with rich and rigorous mathematical concepts. This is something Dr. Stigler did not necessarily find in the United States. The second video study also found that in the higher-achieving science countries the teachers were able to use laboratory activities as a vehicle for engaging students in science concepts, whereas in the United States the activities often became an end in and of themselves.

Dr. Stigler offered the Panel some guidance in terms of improving teaching, including a study called Algebra Learning For All (ALFA), which was funded by the U.S. Department of Education's Institute for Educational Sciences (IES) through a teacher quality grant. It took place in a very low-achieving district in Los Angeles, California, and included random assignment study of approximately 70 teachers. It was intended to assess the effects of a professional development experience on teachers on student learning. Dr. Stigler wanted to know if he could promote change by working with teachers through professional development on how to use and implement rich problems effectively in the classroom.

Dr. Stigler's research found that stable implementation sessions to regularly work on improving their practice are a key to success, especially when working in low-

performing schools. The second finding showed positive effects on student learning as a result of the professional development, based on implementation of rich problems, but only for teachers with enough content knowledge.

The final piece Dr. Stigler covered dealt with some findings about three common strategies for improving teaching. The first was that improving teaching by recruiting different teachers into the profession has the least likelihood of leading to long-term payoff. The second is improving teachers' competencies (or professional development) also does not have long term pay-off because there are always new teachers coming into the profession. The last is improving the knowledge base for teaching over time to develop a knowledge base that is shareable. Therefore, teachers will eventually be using a different kind of practice because it is based on a new and growing knowledge base.

**PRESENTATION ON TIMSS:
GERALD LETENDRE, PROFESSOR OF EDUCATION POLICY STUDIES,
PENNSYLVANIA STATE UNIVERSITY**

Dr. Gerald LeTendre spoke about TIMSS and the professional development of teachers of mathematics. He focused on the training, selection, placement and professional development of math teachers through findings of a case study project developed and organized by Dr. Stevenson, who conducted an ethnographic study of schooling in the United States, Japan and Germany.

These case studies make up a research component for the TIMSS 1995 study that was designed to look at the broader social context of education and educational reform. They provide detailed empirical data on the interaction of instructional practice, teacher work norms and teacher professional development, over the entire course of public schooling in these three nations.

Dr. LeTendre stated that there is no silver bullet. He went on to say, though, that part of the answer is a group of interrelated factors like curriculum, grade levels, subject matter, instruction, national cultures, national standards and preparing teachers. These factors need to be addressed systematically.

Dr. LeTendre's studies showed the importance of focusing on the teachers currently in practice, as those are the ones who will be in place for the next 20 years. He asked the Panel to think about teachers as a conduit where all the curriculum and standards have to come through, in addition to different forms, cultures, work roles, work patterns and workforce problems.

The TIMSS case studies showed a variation between the three countries in terms of instructional periods, the amount of time spent on supervising, and the percentage of time teachers are actually teaching in math. Dr. LeTendre argued that what we need to think about is the teacher workforce, teacher attrition, and distribution of qualified teachers.

Other nations pool teachers at the district or regional level and regularly rotate teachers, which allows for even distribution of teachers of mathematics across a wider range and more professional interaction among teachers.

Classroom management, tracking and dumbing-down for lower levels are also issues that Dr. LeTendre found that need attention.

The TIMSS case studies also show a difference between a professional culture and professional development. Professional culture refers to the idea that teachers themselves see their profession as one of continuous learning. U.S. teachers have a weaker professional culture and one that does not tend to support individual efforts to improve professional knowledge as much as in other nations. Working conditions and the workforce stability appear to block efforts to maximize teacher's potential. We need to systematically consider how to integrate the teachers themselves into the production and dissemination of subject-specific knowledge about how to teach the curriculum.

Dr. LeTendre concluded that we need a more complex analysis of these data at an early stage in policy formation. We need to coordinate reforms not just of curriculum, but also of standards, training, and professional development if we are to achieve long-term change.

PRESENTATION ON TIMSS: QUESTION AND ANSWER PERIOD:

Dr. Deborah Loewenberg Ball asked all three presenters to talk about the themes in their presentations that are perennially discussed and yet never seem to rise to the level of any systematic improvement in this country. These themes are a national or common curriculum, organization of the teacher's day, and investments in professional knowledge and skills.

Dr. Martin responded by stating it is important to know that while these countries have national curricula, they have well-educated teachers who know their mathematics. They know how to teach that curriculum, not just mathematics in general. The students come to school ready to learn. Schools are safe and orderly places, and there are consequences to not learning. It is a system-wide approach.

Dr. Stigler responded that standards are incredibly important for the improvement of teaching. The way standards are constructed in this country is more of a political process. They are not constructed by experts in the domain generally. But the problem is that there is no way to focus teachers on what the most important concepts are. He also stated that there is a lot of emphasis on teachers getting together to improve their practice, but there also needs to be a way to inject outside expertise and knowledge into that process.

Dr. LeTendre responded that the Panel needs to consider a structural approach of not just a national curriculum and national standards, but also reforms that get teachers motivated, open and engaged in the kind of high-level professional development activities seen in some of these countries. This will require some very concentrated and high-quality leadership at the federal level, coordinated with the largest states. It must be knowledge-based, expert, integrated, long-term professional development and not in-service classes.

Dr. Sandra Stotsky asked the presenters about professional development and the ongoing training of teachers. Specifically she asked what one does for pre-service programs and what the state authority can do to make sure that the incoming professional will be adequately prepared before stepping into that first classroom.

Dr. LeTendre answered that there needs to be serious consideration of the basic mathematics courses our teachers are taking. He would like to see courses that take into

account pre-service and professional development, and that leads back to the universities. There is much going on related to changing teacher education and he sees a need for a much more standardized and rigorous curriculum for these teachers. In addition, they need to be intellectually, emotionally and professionally able to survive the rigors of the classroom and to possibly reduce the attrition rate that we see in the first three to five years.

Dr. Stotsky asked if the panelists had implications for pre-service preparation from their data. They did not. Dr. Stotsky also asked Dr. Martin about eighth grade students' poor performance and the relationship to the testing having no stakes attached. Dr. Martin responded that there is no direct evidence of that, but he believes students either know the mathematics or they do not, and they really try to do their best.

Dr. Valerie Reyna asked Dr. Martin if he has ever conducted a multivariate analysis that included all the putative factors he discussed, as well as all the countries, to see which factors emerge that are uniquely and significantly predictive. Dr. Martin responded that there have been many studies on this, but with too many variables, it is hard to see any clear results.

Dr. Tom Loveless asked Dr. Stigler to comment on the results of the original video study, and their support of and connection to the controversial math reforms of the 1990s. Dr. Stigler responded that would not be the conclusion he would draw because in the first study, there was only one high-achieving country and it did not lead to the only way to produce high achievement. The study showed that the math reforms of the 1990s were very hard to compare to Japanese teaching, for example.

Dr. Loveless also asked about the basic math skill education that takes place outside of the school, such as the Juku in Japan. In Japan, two-thirds of eighth-graders attend Juku, a private school that assists students in learning their basic facts. Dr. Loveless hypothesized that successful classrooms can be freed up to pursue problem-solving activities because someone else is taking care of mastering basic skills.

Dr. Stigler agreed and said that his study could never have weighed the importance of various factors for improving student achievement. It was only a snapshot into classroom practice. But, he stated, it is extremely important to recognize that what happens in classrooms is part of an instructional system that includes families and schools outside of schools.

Dr. LeTendre disagreed with Dr. Loveless in that he did not believe schools could offload all the basic math education. He also stated that fifth and sixth grade are the times when participation in cram and remedial schools begins, which needs to be taken into account. When these schools were analyzed, they found that high participation in cram schools or shadow education was associated with more lower-performing countries.

Mr. Vern Williams asked about whether a national curriculum is possible, or if these other countries have national curriculums that are based strictly on content, and not philosophy or politics.

Dr. Stigler responded that a national curriculum should be possible because it is a way for countries to structure what the important learning goals are for students, and then what is the best order and amount of time to focus on different parts of those goals. Dr. Stigler also added that there needs to be a mechanism in place for gathering data about how what curriculum is working and using that data to revise and improve the curriculum over time. Japan gathers a lot of data, and every 10 years they revise the course of study

and the textbooks for a particular grade level. The United States does not collect data relevant to education policy in that sense. New fads tend to take hold. Dr. Martin added that of all of the 60 TIMSS countries, only the United States, Canada and Australia do not have a national curriculum.

Dr. Hung-Hsi Wu asked Dr. LeTendre about his statement that U.S. teachers are better educated than many of their international peers and that they engage in lots of professional development activities. He questioned whether there is evidence about that.

Dr. LeTendre responded that he is optimistic about the education of U.S. teachers because the structures are in place. More teachers have a master's degree than many of the teachers around the world. He admitted we could do better, and wondered whether the structures could be changed to be more effective.

Dr. Wu asked about the ALFA project and the lack of evidence that teacher content knowledge alone produces more student learning. He asked how that measurement was made, what the definition of content knowledge was and how they measured student learning.

Dr. Stigler said he would be happy to share a manuscript paper with more details on that project. They measured teachers' pedagogical content knowledge using the scale developed by Dr. Heather Hill and Dr. Ball. It did not relate to student outcomes. Student outcomes were measured in three ways: 1) high-stakes assessments for California; 2) district quarterly benchmark assessments; and 3) some performance assessments intended to get at the core concepts of focus, which were fractions, ratios and proportions.

Dr. Wu followed up by asking how is it that teachers scored well on that test, yet the students did not learn more.

Dr. Stigler responded that they were looking at how much students gain over the sixth grade with a teacher who had a certain amount of content knowledge. If teachers do not have any content knowledge, professional development focused on pedagogy is lost.

Dr. Robert Siegler asked the presenters about the intervening variable of engagement in rigorous mathematics, and what to do to promote engagement with rigorous mathematical content for more students. Dr. Martin responded that we need to have teachers who can teach mathematics and who know mathematics.

Dr. Stigler said there needs to be a way to communicate what knowing how to teach mathematics means and what it looks like, because it is rare to see that kind of engagement in mathematics concepts. Then he stated that teachers need a stable setting where they can work together on trying to figure out how to achieve that in their classrooms with their students. He offered to share more information about stable settings, but it is basically a time and place where teachers can regularly meet and work 100 percent on improving instruction, as well as learn how to use their time effectively

Dr. LeTendre echoed Dr. Stigler's points, and pointed to the technical notes in Dr. Gair's paper about the issue of teachers securing students' attention less than 50 percent of the time across a wide range of subjects at the high school level.

Dr. Francis "Skip" Fennell asked Dr. Stigler about the engagement factor and what effective teachers do to engage their students. He also asked about what "rigorous" and "rich problems" mean.

Dr. Stigler responded that Dr. Jim Hiebert's presentation later will answer those questions, but one key factor is a teacher who can point out to students the connections between the same mathematical ideas.

Dr. Stotsky asked Dr. Stigler about conclusions made regarding TIMSS. In contradiction to what he presented, she had heard that Japanese students worked in groups to problem solve, and teachers would not lecture or explain until the problems were solved. She thought this spoke to a larger problem of dispelling misinformation about TIMSS and wondered whose responsibility it is to correct.

Dr. Stigler was not sure where the responsibility lies, as the findings have been used to argue both sides. It is true, he explained, that the Japanese spent more time on student cooperative group work and students sharing solution methods, but the teachers also spent more time lecturing. The problem is that the United States does not have a vision of instruction that includes both of those things simultaneously, and in Japan they do. Dr. Stigler mentioned that a way to get past the disagreements is to not focus on ideology, but on instruction.

Dr. Wu commented that he remembered in the 1995 video and in the introduction they talked about how Japanese teachers allow the students to discover mathematics they had not been taught. This may be why people seized on that literally. Dr. Stigler responded that a lot of it is about definition of terms.

**PRESENTATION ON THE NATIONAL ASSESSMENT OF EDUCATIONAL PROGRESS (NAEP):
SHARIF SHAKRANI, CO-DIRECTOR OF THE EDUCATION POLICY CENTER, MICHIGAN STATE UNIVERSITY**

Prior to his position at Michigan State, Dr. Sharif Shakrani was the deputy executive director of the National Assessment Governing Board (NAGB) and the director for analysis at the National Center for Education Statistics (NCES), where he worked on the National Assessment for Educational Progress (NAEP).

NAEP, "The Nation's Report Card," Dr. Shakrani explained, is the oldest assessment in the nation and provides information about what students at the elementary, middle and secondary school levels know and can do in mathematics, science, reading, writing and other subject areas. NAEP started in 1969, with the math assessment starting in 1973. It has two assessments: the Long-Term Trend remains the same over time and the main NAEP assessment changes every 10 years or so to reflect new knowledge of the field.

Dr. Shakrani explained that NAEP is administered at the national level through sampling procedures, as well as at the state level and for the largest 10 school districts in the nation. No Child Left Behind requires all states participate in the NAEP assessment in the areas of mathematics and reading in grades four and eight.

NAEP is a standards-based assessment and does not produce any individual results, but instead aggregates results at the national, state and district levels. It also sub-aggregates the results by producing information for students by race, ethnicity, gender, economic conditions and geographic areas across the nation. Results are based on comparisons with a pre-defined set of standards of what students should know and be able to do.

NAGB is composed of 26 members appointed by the U.S. Secretary of Education. To prevent the appearance of a federally mandated curriculum, NAGB has the responsibility of developing what students ought to know and be able to do in the various subject areas at the key grades of four, eight, and twelve, and NCES has the responsibility of translating these skills into an assessment that is administered periodically through a sample of students at those three grade levels.

Dr. Shakrani presented the Long-Term Trend national NAEP results since the beginning of the seventies for students ages 9, 13, and 17. Age 9 is grade four, age 13 is grade eight and age 17 is grade twelve. The results show a slight improvement in mathematics knowledge for students at grades four and eight, but not so at grade twelve.

For the main NAEP test given to the states, grades four and eight show positive results, but not so for grade twelve, which is an area of concern. In fourth grade, the major emphasis is on number properties and operations, but also includes some algebra, data analysis and probability. In grades eight and twelve, the proportion of materials that measure algebra and geometry increases significantly.

Presently, NAGB has made a significant change in the assessment at the grade twelve-level, where the proportion of items that measure algebra have jumped from 25 to 35 percent. This is reflective of what the institutions of higher education tell us students ought to know and be able to do to move efficiently in their postsecondary education.

Dr. Shakrani stated that over the last two years, NAGB has been reviewing the high school level as an area of concern. They found there is a disconnect between the expectations of tests that would allow students to go to postsecondary education, such as the SAT or the ACT, and what colleges and universities expect students to know and be able to do. A significant percentage of students in college end up in remedial algebra courses, based on placement tests. A new assessment at grade twelve that will take effect in 2009 will be reflective of a major change in twelfth grade testing.

Mr. Shakrani spoke about what is being proposed for the twelfth grade. His handouts show this in greater detail, but he explained that this is reflective of discussion with many educators, mathematicians, mathematics educators from across the country, and with states that are working on improving their mathematics program.

Dr. Shakrani shared some sample questions from NAEP, including whether the students understand the idea of adding positive and negative numbers. At grade eight, only 68 percent of the students can answer the items correctly. In grade four, only 23 percent.

Another sample question was to determine what is two-thirds of 15 marbles. This item is administered at both grade twelve and eight. Only 74 percent of twelfth-graders are able to answer this item correctly, and approximately 50 percent of the students at the grade eight are able to answer this item correctly.

When a question of simple division was asked at grade twelve over the past three assessment cycles, results showed no significant shift or any change in the proportion of students who were able to answer the question.

Included in Mr. Shakrani's handouts is a document that shows more examples of what students ought to know and be able to do at different grades. Another study that NAEP conducted is called the Transcript Study, which is from the national sample of students who are tested at the twelfth grade. They looked at the course-taking patterns of these students over the past five years of their education, and what they found was

students who start with rigorous mathematics at the middle school level rather than high school level tend to perform highest on the NAEP. Because they end up taking algebra at the middle school, they take geometry, algebra II, trigonometry, pre-calculus or statistics probability at the high school level. They do extremely well not only on NAEP, but also in other courses as well.

Another important finding Dr. Shakrani shared is that the relationship of course taking to NAEP achievement is also relevant to the ACT and the SAT.

Dr. Shakrani closed by calling attention to mathematics in high schools to improve rigor, and requiring senior year math to reduce the “senioritis” and remedial course taking in post secondary school.

Chair Faulkner reminded Dr. Shakrani that the charge of the Panel is to get students ready for algebra, and not the content of the high school curriculum as a whole.

PRESENTATION ON NATIONAL ASSESSMENT OF EDUCATIONAL PROGRESS (NAEP):

JAMES MILGRAM, PROFESSOR OF MATHEMATICS, EMERITUS, AT STANFORD.

Dr. James Milgram outlined in his presentation the problems with NAEP. The problems he noted were that it is unfocused, it contains errors, and the level of the exam is far below the levels in high-achieving countries. The NAEP is as broad as it is because it has to align with state standards in math, which number around the 40s or 50s in most states.

To explore the errors, the Brookings Institution asked Dr. Milgram, Dr. Roger Howe and Dr. Hyman Bass to review the algebra questions on the NAEP. They found that, of the 41 eighth-grade NAEP algebra problems, eight of them were mathematically incorrect and one was meaningless. About ten of the correct problems were questions about vocabulary, not about mathematics. He provided examples in his presentation of some questions to illustrate his point.

In the fourth grade, there were 22 questions provided. Four were incorrect, four were essentially vocabulary, and they were all a very low level of difficulty. Again, the error rate was 20 percent, which was a very consistent error rate. He again showed in his presentation some examples of problems. The problems showed incorrect assumptions and the prevalence of hidden assumptions. These errors show very little attention to basic operations and essentially none to skills with fractions.

Dr. Milgram reviewed the types of NAEP questions at each grade level to reinforce the low level of expected knowledge he found in the test. He stated that there are very few fraction standards in grade eight and none in grade four. There is one grade eight standard that asks for operations with integers or fractions.

Dr. Milgram went on to ask, when the report card is flawed, what do the grades mean? He sees as a problem a refusal to involve real math experts in test development. A few mathematicians, including the two mathematicians on the Panel, have been members of the NAGB, but were not allowed to access the exams.

Dr. Milgram stated that in foreign countries and in the new Focal Points, there are six basic subjects that are emphasized through grade eight: 1) place value and basic number skills; 2) fractions and decimals; 3) ratios, rates, percents and proportions; 4)

functions and equations; 5) beginning algebra; and 6) geometry. He asked that NAEP be focused in a similar way.

**PRESENTATION ON NATIONAL ASSESSMENT OF EDUCATIONAL
PROGRESS (NAEP):
QUESTION AND ANSWER PERIOD**

Dr. Loveless asked Dr. Shakrani about NAEP being dominated by whole numbers and whether NAEP at eighth grade does a good job of assessing student competency with fractions.

Dr. Shakrani responded that it does assess competency, and feels that for the test to be valid, it must be reflective of what is taught. He also added that it is essential not only to ask procedural knowledge, but also to measure conceptual understanding. Increasing the number of items in this area significantly, in his view, would take away from other essential areas.

Dr. Loveless followed up by asking Dr. Shakrani if he is comfortable with a fractions/whole number split on the eighth grade test of 17 percent fractions and 83 percent whole numbers. Dr. Shakrani replied that he is comfortable when looking at not only the fractions in procedural knowledge, but also at fractions in problem-solving situations. Dr. Loveless then asked if there were any items on the test that strictly assess the ability to compute.

Dr. Shakrani replied yes, and at the fourth grade level, they ask students to be able to add a column of numbers. There are also some conceptual understanding problems, to determine whether the students can understand monetary transactions.

Dr. Loveless followed up by asking if there were any computation of fractions on the test. Dr. Shakrani replied that there are proper fraction computations. Dr. Loveless responded that he has never seen that type of problem. Dr. Shakrani agreed to show Dr. Loveless those problems in private because they are secured items. Dr. Shakrani also added that on the NAGB Web site, www.nagb.org, there is a test specification document that translates the general statements into specific skills and knowledge that help inform the test item writers.

Dr. Wu asked Dr. Shakrani about the commitment of NAEP to increase computational items. From the presentations today, it does not seem that they have been increased. Dr. Shakrani replied that from the 2005 assessment, almost 60 percent of the items released and replaced were replaced with computational items. That is in concert with the agreement made with the Planning and Steering Committee.

Dr. Wu followed up by asking why it took from 2000 to 2005 to make those changes. Dr. Shakrani responded that it takes time from development of the items, to field-testing, to implementation. Dr. Wu asked if they could expect to see more computational fraction items in 2007, and Dr. Shakrani responded yes.

Dr. Loveless then clarified that he had not studied any items that had been developed after 2003.

Dr. Stotsky asked Dr. Shakrani about the lack of mathematicians on the guiding committees of NAEP, and who determines the membership. She also asked where the guidelines come from and how to get content experts to work on the tests. Dr. Shakrani responded that NAGB is responsible for the identification of the people who work on the

Planning and Steering Committee. The Congressional mandate states that the people who develop the assessment must include people in the field, as well as people from the general public. Organizations in the field help to propose a list of mathematicians, mathematics educators, practitioners, users of mathematics and people from the industry. NAGB reviews these names to ensure that they have geographic, ethnic, racial, and gender representation.

Dr. Fennell asked, relative to the table of specifications for the NAEP, whether the percentage of items within the content cells were the same for both the Long-Term and the main NAEP.

Dr. Shakrani responded that they are different, and on the main NAEP, the percentages change every 10 years and the Long-Term stays the same. In NAEP, as a sample assessment, any one student takes a very small portion of the test, so they can afford to measure a longer list of things that students should know and be able to do. But the proportion and the configuration of the main NAEP versus the Long-Term trend are significantly different.

Dr. Siegler wondered whether the language and the grouping used to describe the goals and skills on the NAEP, as opposed to high-achieving countries, is to blame for the inch-deep, mile-wide kind of criterion. He asked if anyone has tried to maintain comparable categories in these comparisons to get a sense of how different the U.S. practices are from the high-achieving practices on the variability of topics.

Dr. Milgram responded that he will be looking at that question as part of a National Comprehensive Center for Instruction conference next week. He will look at all the research in the high-achieving countries and review it to understand what they are doing.

Dr. Siegler also asked Dr. Milgram about the chart that showed the numbers of math standards in different states, and wondered if anyone had looked at a correlation between progress in these states, or absolute scores in math achievement in these states on the one side and the number of standards specified on the other. He believed if this were an important factor, there ought to be a negative relation between the two.

Dr. Milgram responded that no one had yet looked at that question, but he would caution that there is also the issue of the selection of standards and the overall objective. It is not just the standards in one year. It is the way they build and the way they fit together, and the objectives that are contained in the pattern.

Dr. Wu sensed some discrepancy in Dr. Shakrani's presentation when he was talking about fractions. Dr. Wu said he understood him to say that since they are not taught, they would not be tested, yet he also mentioned that NAEP's size allows it to ask questions on areas that have not been taught.

Dr. Shakrani responded that NAEP both reflects and leads. It includes what is being taught as well as what the mathematics educators and mathematicians say should be taught.

Dr. Wu also said he didn't hear a sense of urgency in posing more questions on computational fractions or fractions, even though it is the weakest area and is essential to learning algebra.

Dr. Shakrani agreed that these are not only the essential skills for algebra, but they are essential skills for any mathematics and there are an appropriate number of these questions that can be on the test.

OPEN SESSION--PUBLIC COMMENT

TAMRA CONRY, MIDDLE SCHOOL MATH TEACHER, REPRESENTING NATIONAL EDUCATION ASSOCIATION

Ms. Tamra Conry commented on behalf of the National Education Association (NEA), an organization that represents 3.2 million educators in public schools and institutes of higher education throughout the country. She stated that a qualified, caring, diverse, and stable workforce in our schools, an NEA priority, requires a pool of well-prepared, highly-skilled candidates for all vacancies and high-quality opportunities for continual improvement and growth for all teachers.

NEA supports federal incentives for qualified individuals to enter the teaching profession and for collaborations between school districts, teacher unions, and institutes of higher education for the development of programs that would facilitate the recruitment and retention of a qualified, diverse group of teacher candidates. The NEA believes that newly hired teachers must receive strong preparation and support in both content and content-specific pedagogy. NEA also believes that professional development should be strongly tied to increasing student achievement.

Ms. Conry stated that strong content knowledge must be connected closely to a variety of teaching strategies and methods of instruction.

The NEA remains opposed to pay systems that directly link teacher compensation to student test scores, as these systems fail to recognize that teaching is not an individual or isolated profession.

MANDY LOWELL, SCHOOL BOARD MEMBER, PALO ALTO UNIFIED

Ms. Mandy Lowell spoke about her district, Palo Alto Unified, where they have teachers who are collaborating in professional communities engaged in developing their own rigorous instruction. This works at the secondary level, but leads to confusion at the elementary level. She asked the Panel to specify the problems students should be able to solve in elementary school and not leave that up to the teachers.

While improving elementary teachers' math knowledge, paying higher salaries to get the best and brightest, and including time for reflection are important, she sees these as long-term and expensive approaches. There also are competing demands in schools from other subject areas.

Ms. Lowell stated that other problems include teacher turnover and addressing those currently in education school instruction. She also has teachers asking if students are ready for algebra in eighth grade and if students in other countries are just more mature or better prepared.

Ms. Lowell asked that the Panel be clear on how to teach, whether it is memorization or a multi-step approach to learning, in addition to addressing the different pace at which all students learn. She asked the Panel to look at research from cognitive psychologists on the importance of over-learning and rehearsal, and effective encoding and reliable retrieval from long-term memory. She asked for the Panel to promote reliable and specific classroom assessments.

Good, explicit textbooks and software are immediately effective strategies that will help our kids now.

While her district is high-achieving, she asked that the Panel not look at it for what works, but instead look at what works in districts where parents are not filling gaps and where kids have less-enriched home lives.

JIM RYAN, TEXTBOOK PRODUCT MANAGER, KEY CURRICULUM PRESS

Mr. Jim Ryan has 10 years of experience in public education, both as a high school math teacher and as an administrator. He also spent seven years in the science, technology, engineering and math (STEM) fields, including as a programmer and analyst for Apple Computer. He now works for Key Curriculum Press, a provider of mathematics instructional tools and technology learning tools.

Mr. Ryan defined the mission of the Panel as, “What do my students need?” He explained that the country's diverse student population needs a broad array of quality instructional materials, and teachers need a variety of instructional approaches at their disposal for their heterogeneous classes. Students need clearly defined standards of success and flexible means by which success can be achieved.

Mr. Ryan explained that more than 90 percent of high school math textbooks used nationally come from only four publishers. They are similar in both content and pedagogy. In 1999 in California, where the textbook selection process has been most restrictive, only three algebra textbooks were approved for eighth grade. On the 2005 NAEP exam, 43 percent of the eighth-graders scored below basic in math and fewer than one in four showed proficient understanding. He questioned the process of providing such similar textbooks year after year when that way of teaching does not seem to work.

Mr. Ryan explained that in addition to curricula flexibility, schools also need to provide teachers with professional development to enable them to understand the content and to use the curriculum wisely. His company, Key Curriculum Press, has found an effective union between curriculum and technology. He stated that critical concepts, more effectively learned with no technological component, must be taught alongside far-reaching concepts only enabled through technology. He called for quality of content and avoiding a myopic view of how mathematics should be presented to students, as well as diverse instructional tools.

MARTHA SCHWARTZ, CO-FOUNDER, MATHEMATICALLY CORRECT

Ms. Martha Schwartz is a former math teacher, geophysicist, educational consultant and parent. She came out of the Parent Vote movement, and called herself a “combatant in the so-called math wars.”

Ms. Schwartz acknowledged the recent report from National Council of Teachers of Mathematics (NCTM), which recently made a very encouraging step in the right direction with the release of its new elementary school *Focal Points*. She thought the national press saw the release as a return to basic skills.

Ms. Schwartz explained that what the math wars are about is mathematical content, what is taught and when. They are also about mathematical pedagogy and how to transfer that content with understanding to students. She said she argued on the basis of

content, on the supposition that it was most important to guarantee what students learned. Because there are many teaching styles that work, specifying content seems to be the place on which to focus.

Focal Points provides agreement on content and measurable goals.

Focusing on pedagogy, she stated that the most popular instructional scheme includes some variant of constructivism. She said its weakness lies in too many interpretations of teaching styles with very little or less emphasis on instruction by the teacher.

She stated that students can also learn through a mix of reading and teacher explanation, with an emphasis on explanation. Highly-unguided and moderately-unguided pedagogies have been pushed relentlessly in recent years by teacher training institutions. The past half-century of empirical research on this issue has provided evidence that minimal guidance during instruction is significantly less effective and efficient than guidance designed to support the cognitive process necessary for learning. She shared in her written remarks some additional data on the issue.

JOHN STALLCUP, CO-FOUNDER, APREMAT USA

Mr. John Stallcup is the initiator and co founder of Apremat USA, which is a Spanish language elementary math program used by about two million children in Latin America today. Apremat USA was formed to bring this free program to Spanish language students in the United States in the first three grades.

Mr. Stallcup told the Panel that he sees a lack of focus, attention and energy on effective early elementary math education in general, and specifically for English language learners. He supported that statement by stating that there is no one person in charge of early elementary math education at the federal or state level and no major public or private grant-making authority that funds early elementary math programs. He also noted that there are no major champions of math like there are in reading. When students are not proficient at math by the third grade, it shows up in the dropout rates in high school.

Mr. Stallcup noted that many proven, well-researched, early elementary math instruction programs are employed around the world by millions. There is nearly universal use of the abacus in China. It enables their 5-year-old students to acquire a number sense and compute large columns of figures easily.

Honduras created an effective, consistently administered, inexpensive, research-based instructional practice for teaching math on the radio. He recommended we look to the Internet to empower math education, as well as educators organizing and integrating online distance learning.

Additional issues noted by Mr. Stallcup were not advancing students on to the next grade without passing the math exam, and changing the way we talk about math. He sees widespread math-phobias and an acceptance of not knowing math, as opposed to the shame of being illiterate. Part of the solution, he feels, is not letting states define proficiency, as in No Child Left Behind (NCLB), and getting parents involved in math instruction. He feels parents should be allowed to see NAEP and TIMSS questions.

He sees television having a role, as well. The availability of high-quality, relevant television programs that either directly or indirectly teach math need to increase.

SHERRY FRASER, DIRECTOR, INTERACTIVE MATHEMATICS PROGRAM

Ms. Sherry Fraser has a degree in mathematics, and 30 years' experience teaching high school. She also has experience developing secondary mathematics curriculum and professional development programs. She has reviewed the transcripts from the Panel meetings, and has based her comments on them.

She is troubled by the focus on the list of mathematical topics that should be included in a curriculum, rather than focusing on teaching and learning. She stated that research has shown lecture and teacher-driven instruction to be largely ineffective. Too many mathematics classes have not prepared students to use mathematics to be real problem-solvers. She concluded that the first, second, and third TIMSS reinforced what we should have already known, that is, we were doing a poor job of educating our youth in mathematics.

Ms. Fraser asked the Panel to recall the last 25 years in math reform, with the NCTM releasing their *Curriculum Evaluation Standards for School Mathematics*. She felt this set of standards had the potential to help the U.S. mathematics educational community begin to address the problems articulated through the 1980s.

She talked about the role of the National Science Foundation (NSF) grants to develop large-scale, multi-grade instructional materials in mathematics to support the realization of the NCTM standards in the classroom. Their focus went beyond memorizing basic skills, to include thinking and reasoning mathematically. She stated that these programs were not the problem, they were the solution. She still feels they show potential for improving school mathematics education. When implemented as intended, research has shown how a different picture of mathematics education can be more effective.

Ms. Fraser referenced a 2004 National Academy of Sciences study on K-12 math programs. It looked at the evaluation studies for 13 NSF projects and six commercial textbooks. The NSF-funded curriculum projects showed promise. She explained why, even with these promising programs, we still have not seen progress by relating the problem to what happened in California in the late 1990s. A state board member gave the California standards to a group of four mathematicians for input, and they addressed the content only and called for algebra I for all eighth grade students. She stated there is data to show these standards have not improved mathematics education. Most of California's students have had all of their instruction based on these standards since they were almost adopted.

Ms. Fraser urges the panel to look at the California data and make recommendations based on the desire to improve mathematics education for all of our students. She concluded that direct instruction of basic skills does not suffice.

Dr. Loveless asked Ms. Fraser to summarize again the NSF curriculum study. Ms. Fraser stated that her conclusion was that, based on the 147 research studies accepted by that panel, it is quite clear the NSF-funded curriculum projects have promise to improve mathematics education in our country.

Dr. Loveless followed up by asking whether the report went on to say that, however, despite the promise, there was not any real concrete evidence of effectiveness in terms of promoting student achievement.

Ms. Fraser stated that the report showed that when looking at the NSF programs as a whole, there is not enough concrete evidence to say for sure that they are effective. However, study after study shows they are very promising, and with more research, she is sure they would find they are very effective.

Mr. Williams asked whether Ms. Fraser thinks the organization, Mathematically Correct, was the only group that thought there was a problem with the math standards in California before the new ones were adopted. Ms. Fraser responded that there were thousands of people who testified, but she is not sure if there were many people outside of that organization because she was not sure who actually was in it.

Dr. Ball asked, given Ms. Fraser's experience in public discourse on education, whether she has any comments for the Panel about what kind of public education about mathematics education would enable progress in the improvement of mathematics education. Ms. Fraser responded that we all know that students need to know the basic skills--how to add, subtract, multiply, and divide--but that is not enough. She went on to say that they also need to be able to problem-solve, apply their understanding, and understand what they have learned and why they have learned it.

Dr. Frances "Skip" Fennel asked Ms. Fraser to give the Panel a quick profile about other groups of students. Ms. Fraser responded that all of her data came off of California's Web site. Looking at eighth grade and the Hispanic population in California, 46 percent of eighth grade students are Hispanic. By the time they finish high school, less than 10 percent of Hispanic students are proficient in algebra I.

In algebra II, less than 15 percent actually take the course, and less than two percent of them are proficient. That makes less than three percent of Hispanic students proficient in three years of college-prep math.

In eighth grade, eight percent of the population is African American. Less than two percent of those are proficient in algebra I. Less than three percent of African Americans take algebra II, and out of those students, less than one-third of one percent are proficient. Ms. Fraser stated that the data shows the problem is not being solved in California.

Dr. Loveless asked whether the current framework in California can be blamed for those numbers and whether Ms. Fraser had the numbers from the previous framework for comparison. Ms. Fraser stated that she did not have that data. But she does know that the number of students taking geometry has only risen from 17 or 18 percent to 21 percent, so there is not a big shift there. She asked the Panel to look at the California Department of Education Web site under the California standardized testing and reporting for more information about the decrease in achievement.

RICHARD RUSCZYK, CEO, ART OF PROBLEM SOLVING, INC.

Mr. Richard Rusczyk runs a company and a foundation, Art of Problem Solving, which designs materials and programs for eager math students. He works online with many strong math students all over the country, including members of the U.S. Math Team, Clay Jr. Fellows, and winners of the Siemens, Intel and Davidson research competitions.

The students he works with are not just good at math, they also love math. However, whenever he asks a group of his students, "What is your least favorite class at your regular school," by far, the most common answer is math class.

Mr. Rusczyk sees his students spending dozens of hours a week on his site, which is www.artofproblemsolving.com, and in his non-credit classes. He described that the reason for this dichotomy is because the standard math curriculum is not designed for students who like math. It is designed for students who are being forced to learn it.

Mr. Rusczyk said that when even honors classes focus far more on perfecting simple algorithms than on reasoning and problem solving, the best and brightest are turned off from math. These students want to be challenged and do not want to memorize tricks for tests. Teachers also are being taught to hate math. Mr. Rusczyk said the result of taking the fun out of math causes students and teachers to quit. Standards and tests also are taking away interest and incentive from students who want to learn above the minimal level.

To engage the best students, they need flexibility instead of restrictions. Teachers dealing with these eager students need to deliver useful resources, create opportunities, remove obstacles and stay out of the way. The curriculum isn't well designed for eager students, but there are good materials out there for students who really want to challenge themselves. Textbook adoption is difficult for all but large companies, and that squeezes out small publishers who write for the top students.

Technology, Mr. Rusczyk stated, has put them in a position to leverage the ability of the few to the benefit of the many. These eager students will be the ones who will make the advances in science, engineering, technology and medicine. He said we cannot continue to hold them down and chase them out of math.

Dr. Ball asked about sorting students into those who want to learn and those who do not and what the implications are for the responsibility of this Math Panel for all students in this country. Mr. Rusczyk stated that teachers can tell who wants to learn and who does not. But there are some teachers who can get students who are not interested in learning math and turn them on, and that is an extremely important skill for teachers to have. Students also learn not to want to do math from their parents and friends.

Dr. Loveless talked about the implications for the eager students Mr. Rusczyk talked about from the movement in education over the last decade or two towards heterogeneous grouping, and moving away from tracking and ability grouping. Mr. Rusczyk responded that the best thing to do is keep students of all abilities together. They feed off each other. His concern, though, is the mandate in the public schools to bring low-achieving students up and how this takes away from the education of the students at the top. He stated that those eager children can benefit from work outside of the classroom.

Dr. Loveless followed up by asking why surveys are showing the number of students who say they like math are declining. He asked Mr. Rusczyk if he saw a connection to something that happened since 1990 that may explain that. Mr. Rusczyk responded that it would be a guess since that is not his area of specialty, but he would say that when the achievement numbers go down, it reduces the incentive to engage the students who are already above a proficient level.

Vice Chair Benbow asked Mr. Rusczyk what he thought they could do to stimulate students in math and science besides "getting out of the way." Mr. Rusczyk

responded that they need to be shown interesting, challenging problems and encouraged to practice the basic skills. Once they master the basic skills, show them challenging multi-step problems that require multiple areas of mathematics. Mr. Rusczyk cautioned against accelerating a student once they have mastered that grade level's math because they will just be shown more average curriculum at another grade level. They just need deeper problems.

Mr. Williams stated that he often sees parents dealing with children who are bored in school. He tells them to access sites such as the one Mr. Rusczyk is associated with where students can communicate and associate with other bright students. Also, schools may not have teachers who can provide some of the more challenging problems to which he is referring.

STEVE YANG, FOUNDER AND CEO, MATHSCORE.COM

Mr. Steve Yang is a Massachusetts Institute of Technology (MIT) graduate, and founder of a software company called Mathscore.com. He believes the Panel should emphasize a solution that can easily be duplicated across every school within the United States, regardless of teacher talent, access to computer technology and budget. He does not think the proposals to hire staff, train teachers, entertain students, and integrate technology are scalable or will meet the needs of every school in the United States.

He referenced TIMSS findings in Asian countries such as Singapore, China, and Japan, stating that even though they outperform the United States, they have not made any significant adjustments to the way they teach math for well over 100 years.

What they do differently, Mr. Yang stated, is to force a focus on math facts by regularly doing timed tests. By the end of fourth grade, nearly 100 percent of all students in these countries have complete mastery over their multiplication and addition math facts. Kindergartners are exposed to addition, and by second grade, addition math facts are mastered. By the end of fourth grade, students know their multiplication facts. They demonstrate superior critical thinking skills because they have a proper foundation on which to build critical thinking skills.

Mr. Yang stated that according to student usage at Mathscore.com, less than one in five of his fifth-graders has a mastery of multiplication. He offered to share this data after the presentation if there was interest.

Mr. Yang asked the Panel to suggest a mandate on regular timed math tests starting with first-graders. He said there should be a standard on the number of problems, difficulty of the problems and the time allotted at each grade level. This way, regardless of school resources, every teacher in the country can unambiguously adhere to this approach. He also believes knowledge of math facts should be tested on state tests. He believes this solution is measurable, can easily be implemented in every school in the United States and aligns with the NCTM *Focal Points*.

Mr. Yang stated that schools with computers can use technology to teach math. His company, Mathscore.com, provides customizable, printable math facts worksheet generators at no charge. Mathscore.com has seen proven improvement in test scores by users of the system, which validates the approach of starting with math basics before focusing on critical thinking skills.

CHARLES MUNGER, PHYSICIST, CALIFORNIA CURRICULUM DEVELOPMENT AND SUPPLEMENTAL MATERIALS COMMISSION

Dr. Charles Munger is an experimental physicist and a member of California's Curriculum Commission. The Commission advises the California State Board of Education on the curriculum in the state's public schools. He is the past chair of mathematics. He spoke on behalf of himself and not the Commission.

In 1997, California wrote its own standards for what students should know and be able to do in mathematics at each grade level, and in 1999 completed its own guidelines, the Mathematics Framework, for how best to get students to master the mathematics in those standards. The state had its publishers design new and appropriate instructional programs, and the first such instructional program hit school districts in the year 2000.

He explained that norm-referenced tests are administered statewide in grades K through 8 to measure student achievement relative to those standards. After six years, these test show the fraction of students scoring at proficient or above has risen 4 percent each year, compounded now for six consecutive years, a 25 percent gain overall. That four percent annual figure is uniform across all grades kindergarten through eight for students in rural or in urban districts, and across all ethnicities, economic classes, all degrees of learning disabilities and language abilities.

Dr. Munger stated that it looks like California has figured out how students learn and what they can learn, to have seen this kind of uniform, consistent progress. He asked Panel members to visit the California Department of Education Web site and study the California data, standards, framework and instructional materials.

Dr. Russell Gersten asked whether there was evidence of a reduction in the gap between native English speakers and English learners. Dr. Munger stated that there is not a significant reduction in the gap, due to the new standards not addressing the needs of students who already were performing well.

Vice Chair Camilla Benbow inquired about the two presentations on California achievement data and how Dr. Munger calculated the four percent. Dr. Munger responded that the test data can be found in the paper he submitted and on the Web site. He also stated that he is looking at how it increased while other people are looking at the absolute levels.

Dr. Ball questioned Dr. Munger's implication of causality and the problems associated with that, as there have been such a large number of interventions and efforts to improve math education over the last two decades.

Dr. Munger stated that California is lucky to have a lot of data to work with and can look at computations for vast numbers of students. He agreed that causality is a problem, but he stated he would be willing to listen to someone who could point to another profound statewide change that would explain these data. He asked the Panel to look at California as an experiment of very large scale, which seems to have some positive net outcomes that provide a point of comparison.

Dr. Siegler asked about California's NAEP test results and whether these scores have also increased. Dr. Munger did not know how California scored on those tests.

Dr. Stotsky asked if there was a connection with teacher education specifically since the standards came about and the curriculum frameworks were produced. Dr. Munger responded that teacher training would be a factor in rising achievement as

California has always had consistent efforts in teacher preparation and they would be trained to use the standards properly. He is not aware, though, if funding was increased to do so.

OPEN SESSION - INVITED TESTIMONY

PRESENTATION ON INSTRUCTIONAL TECHNOLOGY AND CALCULATORS:

MARK SCHNEIDERMAN, DIRECTOR OF EDUCATIONAL POLICY, SOFTWARE AND INFORMATION INDUSTRY ASSOCIATION (SIIA)

Mr. Mark Schneiderman outlined what, how and why technologies are being used today in mathematics education, to set the stage for the other panelists who will demonstrate and discuss the related research. SIIA member companies depend on the nation's schools for a skilled, high-tech workforce. Their concern is with the inadequate performance of students in science, technology, engineering and mathematics. SIIA members develop and deliver educational software, digital curricula, and related technologies and services for use in education.

Mr. Schneiderman stated what is driving the use of technology today in education is that educators recognize that their traditional methods and materials may not be working as well with digital age students. In addition, NCLB accountability has raised awareness about the performance gaps of many of our students. As a result, educators are looking to individualize instruction through differentiated methods, media and time-on-task, and they need tools to address these different student needs.

Mr. Schneiderman said that another driver is the need to provide access to quality curriculum, courses and instructors for all students regardless of traditional barriers of geography, mobility, language or disability. According to a recent survey of the 2,500 largest school districts, over 75 percent of district superintendents agree or strongly agree with the premise that ubiquitous technology can allow teachers to spend substantially more one-on-one time with each student.

Mr. Schneiderman referenced the U.S. Department of Education's 2004 report, *Toward A New Golden Age in American Education*, that stated meeting NCLB's vision and goals will require not only a rethinking and realignment of the industrial age factory model of education, but also a rethinking of the tools available to support such change. From the back office to the classroom, schools of the information age will need to effectively employ technology to meet the needs of all students, parents, teachers and administrators.

Mr. Schneiderman explained that beyond the hardware involved which provides a platform, there are two main categories of curriculum and instruction and teacher-instructional supports.

Technology use in teacher-instructional supports includes computer-based assessment, observation tools, professional development, instructional management systems and communication tools, among many others. The technologies provide real-time assessments of student learning and provide ongoing feedback. Technology use in professional development includes online learning, where teachers can access courses regardless of time or place; email and Web sites, which create virtual professional

communities; and instructional management systems, which provide educators with a single platform by which to manage disparate elements of the curriculum, content, assessment or professional development.

Mr. Schneiderman explained that the curriculum and instruction category of technology use is divided into three areas of: 1) courseware and digital content; 2) technology-mediated distance learning; and 3) learning tools. Courseware content integrates various degrees of information and pedagogy. They address declarative, procedural and conceptual knowledge, and the interaction of all of them. Categories include tutorial skill building and practice, problem solving, simulation, educational games and other areas.

He asked that the Panel consider that their recommendations may not make it into textbooks for many years, while they can rapidly make their way into electronic materials. Technology also can incorporate any number of cognitive and pedagogical learning theories, as well as the diverse needs of students.

Technology use in learning tools helps us gather, organize and present information. They can include simulation tools such as calculators and graphing calculators. They are often reserved for students once they have mastered skills, but can also be used to assist students in gaining that knowledge. Technology mediated distance learning also helps students by providing access to courses and online tutoring.

Mr. Schneiderman then outlined several research considerations. Years of research provide sound theoretical bases for technology's impact on teaching and learning, and many examples of promising impact, but he realizes that research is ongoing and more work is needed. He gave four areas of consideration: 1) is the technology being accurately implemented with an appropriate infrastructure; 2) what is the relationship between the learning theory and the technology value that are being used together; and 3) what are the outcome measures of the technology use.

Specifically, Mr. Schneiderman asked that the panel look at 1) the research on technology; 2) the value technology provides in terms of differentiated instruction and engaging the learner; 3) various methods for examining that research; and 4) engaging in the public/private partnerships needed to advance this research.

RICHARD SCHAAR, EXECUTIVE ADVISOR TO THE OFFICE OF EDUCATION POLICY OF THE EDUCATIONAL AND PRODUCTIVITY SOLUTIONS (E&PS) DIVISION, TEXAS INSTRUMENTS, INC.

Mr. Richard Schaar covered Texas Instruments' (TI) approach to improving students' mathematical knowledge. He began with the history of the company where in 1986, they were visited in Dallas by two mathematics professors and they discussed the twenty-year decline in SAT math scores. The first ten years were demographics. The second ten years were achievement. They asked these people to see if TI could do something about the issue. This began its involvement in developing products, materials and training with the help of leading educators and mathematicians, most of whom were aligned with NCTM standards. In 1990, TI shipped their first graphing calculator for pre-calculus, the TI 81. It was an immediate best seller and had impact far beyond what they had anticipated. They are currently shipping about four million graphing calculators a

year. They are required in nine states, and permitted, with other various forms, in 28 other states for use in algebra and above.

The benefit of calculators, Mr. Schaar explained, is the power of visualization. Students could visualize mathematics more accurately than they could previously with just pencil and paper. It literally turned mathematics into an experimental science, allowing for different learning styles and other approaches.

Mr. Schaar explained that their work had two fundamental principles of: 1) the augmented product, such as the training materials and the professional development; and 2) integration into the curriculum and instruction, which required it to be appropriate to the instructional need.

Mr. Schaar then explained when the problems arose. The questions were: Did a calculator's presence cause students to not learn basic number facts, and did its presence allow students to solve more complex problems leading to deeper understanding? In addition, because students could do decimals in the way they could on a calculator, did the calculator's use prevent students from learning fraction arithmetic?

TI began to analyze these questions. Fundamentally, Mr. Schaar explained, they have discovered that many teachers did not use the elementary products in appropriate ways even though they had proper professional development available for this. TI had trained over 100,000 teachers in this period, but had a great deal of difficulty getting to a sufficient number of elementary teachers.

To solve this problem, Mr. Schaar said that TI focused on the need for appropriate use and integration into the curriculum and instruction. They did this work during the early math wars, and used the *Finding Common Ground* report to give them guidance. They agreed that the solution would have to include: 1) basic skills with numbers; 2) reasoning about precisely defined objects and concepts; and 3) formulating and solving problems. The *Finding Common Ground* work found that there was an additional research agenda that needed to be formulated to match the work in that report.

Mr. Schaar then explained the necessary systematic interventions, which include leadership, parents, administrators, teachers and math coordinators. It also included professional development that leads to improved achievement, and integrated curriculum and assessments.

Mr. Schaar mentioned an example of a school district outside of Dallas, Richardson Independent School District, where TI and other experts looked at the achievement gap in middle school mathematics. They went in using an integrated approach, and conducted surveys and performed analysis of what was going on using University of Michigan materials. They found that of the students who failed the Texas test in 2005, one-third passed in 2006. The teachers' mathematical knowledge and the growth of this knowledge was positively correlated with the results of their students. In this case, they used TI-Navigator that allows for instant assessment, and a graphing calculator, the TI-73, which is designed for pre-algebra and algebra readiness.

**PRESENTATION ON INSTRUCTIONAL TECHNOLOGY AND
CALCULATORS:
DENIS NEWMAN, PRESIDENT, EMPIRICAL EDUCATION, INC.**

Mr. Denis Newman is the president of Empirical Education, which is an independent Palo Alto-based research company. Its mission is to improve school decision making by providing scientific evidence. They conduct studies for TI including a meta-analytic summary of experimental data and what they call a What Works Clearinghouse-style review. They looked at the research from the past 20 years that had a comparison group or some kind of comparison from which they could derive a difference between students using and not using the technology.

Mr. Newman described a two year randomized experiment in two California districts of professional development and implementation. The results will be ready later this winter.

Mr. Newman talked about a review they conducted that found 13 studies meeting standards they set. Many of those were typically very small scale. They were looking at the integration of graphing calculators, algebra and geometry into specific curricula or teaching approaches. A meta-analysis showed a small number of studies that actually addressed that particular context.

The strongest impact found was a test of the University of Chicago math curriculum looking at professional development, the implementation, the curriculum integration and technology. There is a study underway that involves 33 teachers and about 1200 students in two California districts that were randomized by teachers. One district received the training from Texas Instruments. The others did not.

Study results showed that the introduction of a wireless technology called Navigator in some of the classrooms made a fundamental change in how the teacher was able to get the entire group of students to focus on a problem. The meta-analysis is just a starting point and TI would like to see randomized control trials large enough to look at teacher characteristics, impacts and demographics.

PRESENTATION ON INSTRUCTIONAL TECHNOLOGY AND CALCULATORS:

STEVE RITTER, CHIEF PRODUCT ARCHITECT AT CARNEGIE LEARNING, THE COGNITIVE TUTOR COMPANY

Dr. Steve Ritter explained that The Cognitive Tutor Company offers full curriculum through textbooks, software and teacher training. The model they offer is that students spend 60 percent of their time three days a week in the classroom doing textbook guided activities. The other two days a week the students use the program's software.

Dr. Ritter explained the four basic components of applying research to curriculum development and improvement: 1) a solid theoretical background in learning science; 2) clearly applying that theoretical background in the product; 3) evaluations; and 4) methodology for improving over time.

The theoretical background they have adopted is based on ACT-R, which has been the primary focus of Dr. John Anderson's work and was developed to explain basic facts, learning memory and performance. The aspect of it that is relevant for mathematics education is that complex knowledge is composed of simple cognitive skills, so the more a student practices individual skills, the more efficient those skills will be.

One technique they have used to try to understand how students think about problem solving is eye tracking. Dr. Ritter showed an example in his presentation of a

student's eye movements when trying to solve a word problem. The high-level lessons from this research are that if one wants to understand what a student is learning from the experience of solving that problem, one must understand how the student proceeds through that problem. He stressed the importance of thinking about math education from the student's point of view.

Dr. Ritter explained that there is a real disconnect between the student's common sense and correct understanding of math, and what is being taught in the math classroom. To remedy this, Cognitive Tutor creates math problems that help students reason numerically using their real-world understanding of how change happens and then use induction to get to the mathematical expression.

As the situations and equations get more complicated, Cognitive Tutor still guides students to go directly from the word problem to the expression, so that they will work on the expression first and then use the expression to do calculations to solve problems.

Dr. Ritter described the first evaluation they did of the curriculum, which was recognized by the What Works Clearinghouse as matching evidence standards of a randomized control trial. This was done in Moore, Oklahoma, where teachers' classes were randomly assigned to either use Cognitive Tutor or the curriculum they were currently using. The dependent measures included the Educational Testing Service (ETS) Algebra I end-of-course exam, course grades and student attitudes towards mathematics (both their confidence in mathematics and their belief that mathematics is useful outside of the classroom). On all those measures, the Cognitive Tutor students outscored those in traditional classes.

Dr. Ritter said that another study looked at Miami-Dade 2002-2003 Florida Comprehensive Assessment Test (FCAT) scores with and without the use of Cognitive Tutor. Again, Cognitive Tutor students outscored the traditional students. The advantage was magnified for special education students. Dr. Ritter believes that is because the program offers individualized instruction. It also is effective with students with limited English proficiency.

Dr. Ritter reviewed their methodology for improvement. Tests show in real time where improvements are needed. Students and teachers do not have to wait for the final exam. He reviewed in his presentation some additional research on how students learn over time. When looking at student performance in terms of individual skills, one should see an increase in percent of correct answers or a decrease in error rate. He concluded by giving a demonstration of what the Cognitive Tutor program looks like.

PRESENTATION ON INSTRUCTIONAL TECHNOLOGY AND CALCULATORS:

MATTHEW PETERSON, CO-FOUNDER AND SENIOR INSTITUTE SCIENTIST AND CHIEF TECHNICAL OFFICER, THE MIND INSTITUTE

Dr. Mathew Peterson is from the MIND Institute, which is a nonprofit organization committed to improving math education. The Institute developed a program called ST Math. The ST stands for Spatial Temporal/ Space and Time. ST Math is a kindergarten through fifth grade and middle school supplemental math program with a textbook. All of the software is aligned to the California state standards. There is a minimal reliance on language proficiency.

Dr. Peterson gave a demonstration of the program, which showed no words, numbers or symbols at the very beginning. As a student moves forward with the game, some fractions are introduced, and then symbols later on. There was no expectation that deep mathematical understanding would occur just from the interaction on the computer. The explanation behind what they do is the responsibility of the teacher.

Controlled studies in 2002, 2003 and 2004 in California schools of more than 5,000 students in grades two, three and four showed that students' scores on the California Standards Test (CST) shifted towards proficient and advanced levels when they had the supplemental program. These studies probed how much students got through the lessons, how many lessons they actually were exposed to, and whether the experiences directly contributed to their increased scores on the CST. ST Math software also provides real-time reports of student progress via the internet to aid the teacher in individualizing and differentiating instruction. Common sticking points for students emerged from the studies, one of which was when there were distractions created by the designs of the game. They removed characteristics that were too much like video games that slowed students down.

Dr. Peterson explained that they use small pre-tests and post-tests to help with research and development of the games. They make changes in the program when students do not test well. When they see positive test results, they use a control study. When positive results come out of that research, they release the software on a broader scale.

Dr. Peterson sees from the research that students have difficulties with number lines or showing where a number fits in among other numbers. He also has seen that long division is an extremely important skill for understanding rational numbers. And by the end of fourth grade and fifth grade, students need to learn decimals.

Dr. Peterson described their longitudinal study, which looked at the percentage of students in the proficient or advanced math level on the CST. The study looked at students from Madison Elementary, which is 98 percent Hispanic English language learners. Percentages went up as students progressed through the grades. This group of students who used the program was the highest performing group of students in the entire district at every category, which included ratio, performance, percents, operations with fractions, and algebra functions.

PRESENTATION ON INSTRUCTIONAL TECHNOLOGY AND CALCULATORS:

BARBARA MEANS, CO-DIRECTOR OF THE CENTER FOR TECHNOLOGY AND LEARNING, STANFORD RESEARCH INSTITUTE (SRI)

Dr. Means spoke about her experience at the Center for Technology and Learning (CTL) in studying a variety of supports for learning that are provided by technology, and trying to point out some of the challenges to both conducting and interpreting results from research on the effectiveness of technology-supported interventions.

She stated that there are a large number of different ways in which technology can be used in various contexts, so it is hard to answer whether technology in education works or not. There are hundreds of studies looking at early computer-assisted instruction or integrated learning systems. They typically were designed to cover the

whole year's curriculum or multiple grades' curriculum, tutoring on math concepts, a practice environment, immediate feedback and an instructional management system for the teacher. On average, studies show a modest positive effect from these studies. But there is a range reported in the various meta-analyses and many of the individual studies have confidence intervals that include zero.

Dr. Means stated that technology's effects tend to be smaller in studies that have the same teacher of both the treatment and the control classroom. Effects tend to be greater if the researcher or the teacher designed the outcome measure rather than if the outcome measure was a standardized test. Effects also tend to be greater if the study were short term rather than long term. She said there are many limitations of the individual studies that go into many of these meta-analyses, and different analysts have different criteria by which they eliminate studies because of issues of methodological quality. Dr. Means hopes to build a base where there are stronger studies going into this kind of meta-analysis.

Dr. Means described a 1998 survey of teachers who reported that the most useful kind of applications are interactions with geometric constructions. She looked at studies using these constructions. However, the studies are typically small, and there are methodological weaknesses in them, so the research base is not there. Dr. Means then spoke about newer applications and she illustrated the work of Dr. Miguel Nussbaum in Chile and the United Kingdom. The study used wireless personal digital assistants (PDAs) to ask students to match a graphic representation to a numerical representation of fractions and decimals. Students worked in groups to arrive at an answer and then sent it to the teacher. The teacher incorporated frequent formative assessment where he or she received a real time representation of which problems are difficult.

Dr. Means talked about the importance of not only looking at the effect of technology but also the effect of a complex instructional intervention. She used the instructional triangle from Drs. David Cohen and Deborah Loewenberg Ball to look at the instruction emerging from interactions between teachers and their knowledge, students and what they bring to the situation, and the instructional materials. Many of these applications are supplemental; rarely are they the core curriculum. Often the teacher is expected to provide the conceptual knowledge that goes with the technology.

As other presenters had mentioned, Dr. Means pointed out there is no silver bullet. She added that implementing technology does not guarantee the desired effect because there is much variation across classrooms and schools. Technology needs to be implemented well and matched to the instructional content, language and representation of mathematics.

Dr. Means gave an overview of one last application, named SimCalc, which is a curriculum software and professional development around specific topics of rate, accumulation, proportionality and linearity. These topics run through pre-algebra, algebra and calculus. Dr. Jim Kaput, a mathematician, created the application and the accompanying Math World software. She gave a demonstration in her presentation of the application. Research on the effectiveness of SimCalc started back in 1994 and focused on the need for professional development.

Another study to test effectiveness of SimCalc was done by Dr. Jeremy Roschelle, in collaboration with the University of Texas Austin's Dana Center. It included 94 classrooms for a scaling study. The researchers recruited teachers in eight regions of

Texas, including some very rural regions, and poor and Hispanic schools. All of the teachers received professional development from the Dana Center on the topics that are covered in SimCalc. The treatment teachers received professional development on how to implement the software with their kids.

The findings showed positive effects when there was alignment between assessment, professional development and teaching. This is central to SimCalc and grade seven Texas standards. But there were problems with testing effectiveness when the Texas state test was used, as opposed to a test designed by the researchers. A test designed with the study in mind is best to find accurate results. Dr. Means recommended that studies develop a demonstrably valid, reliable assessment that has had external review and that matches the assessments to what the target of the intervention is.

Dr. Means closed by recommending that research needs to focus less on the presence or absence of technology, and more on the instructional content and pedagogy. Research needs to look at the way the intervention is really being used and not just as it was intended. She also called for attention to high quality instructionally relevant assessments and well-designed studies large enough to look at interactions between practices and effects.

PRESENTATION ON INSTRUCTIONAL TECHNOLOGY AND CALCULATORS: QUESTION AND ANSWER PERIOD

Dr. Stotsky asked whether anyone who just presented had thought about approaching the pre-service teachers to help them use technology in their future classroom to see a multiplier effect.

Dr. Schaar said he has had a great deal of difficulty working in pre-service, particularly in the elementary area. He feels this is because elementary teachers have so many different subjects they are learning today, yet they are asked to be mathematics specialists by either doing research or special training. Dr. Fennell added that there is an active affiliate of NCTM called the Association of Mathematics Teacher Educators largely made up of those who provide pre-service teacher education background for teachers. They have materials for this purpose.

Dr. Fennell also observed that pre-service candidates come to their classes with a much better understanding about the computer and how it could be used because they have essentially been raised on it. They then are looked at to help the teachers who have been there for 20 years.

Mr. Schneiderman added that there was a U.S. Department of Education program called, Preparing Tomorrow's Teachers to Use Technology, which provided information about creating partnerships between local schools and pre-service programs. There is still data available on the program, although its funding was cut. He also referred back to the comment that new teachers can use technology because they grew up with it, but he sees the opposite. He feels the veteran teachers who are more comfortable with their teaching tasks and content feel more comfortable experimenting with the technology.

Dr. Loveless asked whether there were controls, codes or standards on the research on the industries' products. He said he was skeptical of positive findings on the industries products.

Mr. Schneiderman said SIIA put together a guide for their members around conducting research on their products, but it does not have strict protocols. He is not sure they are in place or developed throughout education in general. He also sees a problem with funding. Companies are investing in product development and evaluation research, but they need funding from other sources, such as government and foundations. This would provide the protocols and models to develop more research. When a company receives negative findings, the product goes back into product development. There are problems with releasing all results because the products are constantly being revised, especially Web-based products.

Dr. Newman added that IES has raised the bar and has set a number of standards very clearly as to the requirements for this kind of research to have proper causal impact. There is nothing like the Food and Drug Administration that requires these things to be done prior to marketing, and so that is how a publisher can throw things out on the market without any testing. He added that the school districts or the states are initiating the research because it is in their interest to purchase effective products.

In Dr. Newman's contracts with vendors, the agreement is that they will publish findings unless the vendor declares it to be a formative state prior to their publication. They will not put something out that is about a product that is no longer available because it has been fixed.

Dr. Wu asked about the capability of assessment of educational technology beyond the type of feedback described so far. Dr. Ritter said that it can assess more complex skills and each step in the process. But the limits of the technology are shown in assessing an explanation because of the language barrier. Dr. Wu then asked if technology could assess whether someone knows how to decompose that complex skill into several single skills. Dr. Ritter responded that the technology to do that is close. Language understanding is perpetually ten years off.

Dr. Schaar followed up to say that we are not there yet, but the technology can give instantaneous feedback after each step in the problem solving process. Dr. Peterson added that it is important to check in on the progress of a student to make sure they understand mathematically what is going on behind the work, even if they seem to understand it. He said that they have not figured out how to do that with technology.

Dr. Wu asked whether the limitations of technology should be shared with teachers to control their expectations of it. Mr. Schneiderman added that teachers used to see technology as a threat to their jobs, but no longer. He agrees that education about technology needs to happen, but he does not want to see those concerns get in the way of the expanded use of technology.

Dr. Siegler asked about students who are having difficulties learning, and whether they might also have problems learning to use the technology and then fall further behind. Dr. Peterson responded that students who do the best in the program actually make the most mistakes. Dr. Newman added that it depends on the technology and the design of it, but it would be a good research question. That issue makes teacher preparation even more important.

Dr. Ball asked if the presenters have seen anything in their work that specifies the kinds of mathematical knowledge, domains or skills that are particularly supportable with different technological tools. She also asked if they have done any validation work about what students are thinking and doing when they do this work. Dr. Peterson responded

that they did look at that by asking the students about their work once they completed it. He found they made a lot of progress through that interaction. Dr. Means said the SimCalc assessments included cognitive, think-aloud probing of how the students interact with the items to ensure the assessment was tapping the concepts and skills they were designed to.

Dr. Schaar responded to the first question that they assign specialists to each grade to fine tune the curriculum within the instructional needs of that particular area.

**PRESENTATION ON RESEARCH AND INSTRUCTIONAL PRACTICES:
THOMAS GOOD, PROFESSOR AND HEAD OF EDUCATIONAL
PSYCHOLOGY, THE UNIVERSITY OF ARIZONA**

Dr. Good explained that reform efforts have historically been focused on a small range of ideas that prevent any meaningful reform. He said that many reforms were put in place without the proper data showing effectiveness. The numerous reforms and quick succession between them has left teachers with the belief that the next new reform will soon pass, as well.

Dr. Good explained that he is an educational psychologist who has spent many hours observing math teaching in K-12, especially in grades three through five. He has come to believe that good mathematics instruction varies in terms of curriculum goals, the pedagogical skills of teachers, and the mathematical knowledge of teachers and students. He said that different instructional formats can provide effective learning environments and students can learn from other students, as well as their teachers. He stated that the quality of the teaching format is vastly more important than the format. This is supported by considerable research evidence. Reform efforts promoting one type of format suggest the opposite, that the format is more important. He recommended that the Panel offer a coordinated set of recommendations that affect instruction, evaluation, technology, learning and various issues to avoid mistakes from the past.

Dr. Good recalled the Sputnik crisis that led to a radical reform in math and science with the aim of keeping our country militarily strong. Abstract set theory was introduced. He lists in the appendix of his written testimony names of people who were vocal during this time period. One idea from that time was to ask for evidence and research in terms of the use of reform.

Dr. Good described the reforms of the 1960s that focused on more individualized instruction. Technologies were identified that would recognize how students learned at different rates. In less than a decade, humanistic, open education was introduced so that students would not be isolated learners but they would be part of a community. The open school movement provided students with choices to make them become committed to their learning. That movement faded fast. *A Nation At Risk* was released in 1983 and called for more adult control, structure and content. It compared the United States with Germany, Japan and elsewhere. This reform movement called for more instruction in core academic subjects, longer school days, longer school years and more homework, among other recommendations.

Dr. Good did not feel these reforms addressed the complex issues because they were not sets of coordinated reforms, but instead tried to be revolutionary. These reforms were not based on evidence. These efforts failed because they focused on discrete

concerns, such as curriculum or teaching format. He asked that the Panel remember there is no single variable or any set of variables that have any independent effect on student learning. The usefulness of the variable depends upon both the quality and how it fits into a learning system.

Dr. Good spoke about improving instruction, with a focus on third and fifth grade where many students seem to get lost. He sees the most important predictor of learning or opportunity to learn as the time needed to learn. It is critical to allocate enough time to teach math, yet he has found that the proper amount of time is not provided.

Dr. Good reported that there is evidence to suggest the elementary school curriculum has become a literacy curriculum. A national study found that time spent on mathematics instruction in grades three, four and five was less than the time spent in transition between subjects. Dr. Robert Pianta and his colleagues at National Institutes of Child Health and Human Development in 2004 released a study that examined what took place in a single day in 780 third grade classrooms sampled from about 250 school districts. He found that more than half the time available was spent on literacy instruction. The ratio of time committed to other activities were mathematics, 0.29; transitions, 0.24; science, 0.06; technology, 0.03; and free time, 0.008.

Another study of grade three shared by Dr. Good showed that of 2,736 ten-minute intervals, 587 were devoted to math and 1,642 to literacy, which is a 3-to-1 ratio. He added that as much as an additional 50 percent of math instruction time is lost to announcements, housekeeping and other issues. Time issues continue to get worse as more ambitious math content is added.

Looking at the normative curriculum, Dr. Good shared data from a 2005 national NICHD study of third grade classes and a 2003 study of first grade classrooms that revealed the focus of instruction in most classes was basic skill instruction. The ratio of basic skill instruction to analysis and inference opportunities was roughly 11 to 1.

Dr. Good added that McCaslin, et al. found that the focus in grades three to five was on basic skill instruction. Another study showed students were virtually never asked to engage in tasks that involved higher-order thinking and reasoning. Rather, students were three times more likely to engage in tasks involving basic facts and skills. The McCaslin study also found that students did not make observable decisions in classrooms largely because they did not have the opportunity to do so. In his research, Dr. Good found that students were allowed in only four percent of observations to make any choices. Choices, when allowed, were in procedural areas rather than in opportunities for autonomy. He indicated that if time allowed, he would discuss the potential value of increasing students' contingent choice and argue that earned contingent choice differs markedly from the do-as-you-please choice opportunities associated with the open classroom movement of the 1970s.

Research by Dr. Douglas Grouse and Dr. Good addressed making math more meaningful to increase student learning. This National Institute of Education supported research became known as the Missouri Math Project (MMP). The research assessed the degree of teacher effects on student learning. After establishing a strong correlational link between teaching practices and student achievement, the researchers looked at whether these practices and beliefs can be taught to other teachers in ways that improve students' achievement in comparison to students in matched control groups. They found that the treatment had an important impact on student achievement.

Dr. Good's treatment was based upon earlier findings that showed the ratio of time spent on meaning and developing the meaning of the content should be greater than time spent on practice. They hoped if they could increase the time that teachers and students spent discussing the meaning of the math, they would see some improvement. Others have implemented MMP and have reported positive impact on student achievement in other experimental studies. Some have adjusted the treatment for successful application in other settings.

Teacher educators' view of what normative practice should look like differed from Dr. Good's findings because they felt the treatment was insensitive to teachers and students' beliefs.

Dr. Good closed by stating that what constitutes quality teaching remains under debate, but there are many opportunities for teachers to use formats that involve student-to-student learning, interactions and long-term project work. He stated that students are social beings and the way they think can be more powerfully accessed through their social experiences than through abstract, intellectual experiences.

PRESENTATION ON RESEARCH AND INSTRUCTIONAL PRACTICES: QUESTION AND ANSWER PERIOD

Dr. Gersten asked if Dr. Good still sees his work as relevant since it was 30 years ago. Dr. Good replied that he would change the treatment to treat the student as more of a social learner, but whole class instruction is still relevant. He stated that we know more now about the important role of the teacher. Dr. Gersten followed up by asking Dr. Good to verify that research has found that teachers who spent time developing, discussing meaning and asking questions of students had higher achievement. Dr. Good verified that, but said another cause could be the immediacy and importance of feedback.

Dr. Siegler asked about everyone's assertion that not one factor matters, yet there is research that points to individual factors. Dr. Good replied that he is talking about teaching basic skills versus teaching problem solving. There are many variables within that which can change. It is more about the quality of the format. Dr. Siegler added that if science is going to contribute, they will have to produce generalizations that people cannot totally contextualize. They have to pick some variables if they expect to make some changes. Dr. Good agreed, and stated that it is important to use research to guide reforms, which has not generally happened in past major reforms.

PRESENTATION ON RESEARCH AND INSTRUCTIONAL PRACTICES: JAMES HIEBERT, ROBERT J. BARKLEY PROFESSOR OF EDUCATION AT THE UNIVERSITY OF DELAWARE

Dr. James Hiebert began by stating that teaching matters in terms of providing learning opportunities for students, and that it depends on the learning goals. He stated that while there is no single fix, there are some features that are more important than others that can be found in the research. Dr. Hiebert classified teaching as the ways teachers and students interact about the content during classroom lessons. He cautioned against the thinking that teaching and teachers are the same thing.

Dr. Hiebert stated that teaching has changed little in this country over time, yet the qualifications of teachers have changed substantially. The way we have been interacting with mathematics in the classroom has remained surprisingly stable. He stated that it is very hard to isolate what kinds of teaching methods make a difference because it is extremely difficult to isolate particular features. But, he stated, it appears that different features are more effective for some learning goals than for others.

Dr. Hiebert focused on the goal of helping students make sense of mathematics to attempt to identify a few features. One feature is that students need to see the way in which facts, procedures, representations and ideas are connected mathematically. This can be done by identifying particular topics, ideas and representations that can be related in a meaningful way in the classroom or by looking at common pedagogical structures in the classroom. The second feature Dr. Hiebert described was to allow students to do some of the important mathematical work. This can be done by having teachers present students with challenging problems that are just beyond the level of familiarity of students. Teachers threaten this type of learning by jumping in too quickly to provide the solution.

Dr. Hiebert's research shows these features provide effects in many different styles of teaching. The TIMSS video study addresses the way in which these two features operate in math classrooms internationally. One of the early findings in the study is that students in all countries spend their time in mathematics class solving math problems. He classified the problems as: 1) stating concepts; 2) using procedures; and 3) making connections. Using procedures and making connections are most relevant here. He then went through some specific findings from TIMSS that showed teachers are using these problems in different ways.

Dr. Hiebert explained that other countries have an emphasis on implementing making connections problems, where the United States does not. Teaching is deeply embedded in culture and is hard to change. He stated that most teachers learn how to teach by being students in classrooms and watching their teachers. They also are influenced by their peers, even if they are taught differently.

Dr. Hiebert concluded that while change will happen slowly, there is a need to develop a consensus about the key learning goals for students and to keep them in place for a long enough time. He added that there needs to be new contributions to the knowledge base about what effective teaching toward those goals looks like. He said there needs to be teacher and student buy-in to reforms.

PRESENTATION ON RESEARCH AND INSTRUCTIONAL PRACTICES: QUESTION AND ANSWER PERIOD

Dr. Loveless stated that the TIMSS video studies did not collect achievement data, which Dr. Hiebert confirmed. Dr. Loveless wondered whether there could be causal assumptions made without data. Dr. Hiebert stated that even though there was no data, over time, the same two features kept popping up as common.

Dr. Loveless then asked about one of the example lessons Dr. Hiebert provided and how he would have coded that in his research. Dr. Hiebert responded that to code something as making connections it would have to include explicit time in the lesson where students or teachers or both made clear what the important connections were.

Dr. Siegler asked whether a teacher's knowledge of math or pedagogy might have to do with the teaching differences between countries. Dr. Hiebert does not have that data, but he stated that those reasons could account for the difference. He stated that what was clear from the research was that teachers in the United States get very uncomfortable with student confusion.

Dr. Stotsky asked about some conflicting TIMSS data on time spent lecturing. Dr. Hiebert stated that the two numbers she referred to are from different classrooms. The first numbers she mentioned came from the questionnaires. The differences could be from the different ways teachers classify their time.

Mr. Williams asked about an example of a math problem Dr. Hiebert provided in his presentation and wondered if that really would be clear for a student. Dr. Hiebert stated that the point was that there are common ways in which teachers might work on that problem that would have been classified in their coding scheme as making connections. Mr. Williams added that students can make connections abstractly through examples at the board without having to physically engage in learning, and Dr. Hiebert agreed.

Dr. Wu made a statement that he is worried that people are only concerned with presenting the basic minimum amount of mathematical information, and not going all the way to make sure students are making connections. The presentations, he said, are treating the examples provided as something new, but they are really absolute rock bottom minimum.

Dr. Ball asked Dr. Hiebert about finding research to inform the Panel's work in such a way to make reasoned and analytic comments about mathematical content and instructional work. Dr. Hiebert responded that he would think about that.

Dr. Liping Ma asked that Dr. Hiebert make his examples more specific as they might be misleading. Dr. Hiebert responded that these were examples from the video studies, but he agrees with the discussion about what makes for productive learning in one case and not in the other.

Dr. Gersten commented that math education does not go far enough to help students understand.

TASK GROUP REPORTING SESSION

CONCEPTUAL KNOWLEDGE AND SKILLS TASK GROUP REPORT: DR. FRANCIS "SKIP" FENNELL

The members of the Conceptual Knowledge and Skills Task Group are: Dr. Francis "Skip" Fennell; Dr. Liping Ma; Dr. Wilfried Schmid; and Chair Larry R. Faulkner.

Dr. Fennel reported that their work dealing with conceptual knowledge and skills leading to algebra has been driven by some work by the Institute for Defense Analyses/ Science and Technology Policy Institute (IDA/STPI). The Task Group asked STPI to conduct five analyses based on some of their questions. That work was provided through funding by the White House Office of Science and Technology Policy and the project leaders are Pam Flattau and Nyema Mitchell.

The first question deals with algebra. They did an analysis of content topics from a sample of algebra textbooks from 1913 to the present. They conducted a content analysis of state-based curriculum frameworks, specifically for algebra in the 22 states in this country that have frameworks. They also included the Singapore algebra curriculum in this analysis.

Findings so far show the content of commercial textbooks in algebra has changed very little over the years with the exceptions of additions on probability, statistics, reasoning and proof. The number of pages in the textbooks has doubled. There are many color, photo and activity pages.

This group found dramatic differences in depth and content of algebra across the 22 states. Across those states, 16 had seven common topics. For Singapore, there were eight major topics. However, Singapore has no distinction between algebra I or algebra II. There were three topics of commonality between the seven states and Singapore. They are continuing that research.

The second question deals with integrated curriculum, which is now going on in different ways in eight different states in this country. They are looking specifically at a case study in North Carolina. They noted that seven of the eight content expectations for geometry were covered in the integrated curriculum versus the traditional curriculum. Virtually all of the content expectations for algebra I were covered in the integrated curriculum, but only nine of the fifteen of the content expectations were covered in algebra II.

Their third question deals with Pre-K through eight essential knowledge and skills. They reviewed course expectations for Pre-K through eight in nine states. They are also reviewing a case study at the fourth grade level. They continue to study the Curriculum Focal Points presented by NCTM at the last meeting.

The fourth area of study looks at TIMSS and NAEP content similarities and differences. They also examined the gap between state-based assessments and NAEP results. The fifth question deals with the issue of college readiness and the important mathematics students need to be successful in college. The ACT studies on student preparation for college level mathematics show that state standards and assessments alone do not accurately reflect college readiness. They do see some modest improvements in recent years in terms of ACT test takers, but he notes that many students are not ready for college level mathematics. Algebra I and II are included in the core curriculum that ACT recommends as being necessary for college, as well as entry level jobs. But, he said those courses are not enough..

The research question they are having Abt Associates help them with is the aspects of mathematical understanding that relate to success in algebra.

LEARNING PROCESSES TASK GROUP REPORT: DR. DAVID GEARY

The members of the Learning Processes Task Group are: Dr. David Geary; Dr. Valerie Reyna; Dr. A Wade Boykin; Dr. Robert Siegler; and Dr. Daniel Berch.

Dr. Geary reported that they are looking at the concepts, procedures and declarative knowledge that compose mathematical competencies in a number of core

mathematical domains related to algebra and leading up to mastery of algebra. They will be working out these domains with Dr. Fennell's group.

They are working with Abt Associates on refining the search criteria for identifying high quality research related to questions of learning in these domains. They hope to have 1,000 or so identified articles reduced between now and January. By January they hope to have a preliminary discussion on what children bring to school, or the types of competencies children enter kindergarten and first grade with and how these may relate to the ability to acquire other competencies.

They also hope to have a section on basic mechanisms of memory and learning. This will cover the general principles of learning that are true across the content areas. They also will include information on social and emotional mechanisms that may influence motivation to learn, engagement in classroom activities and diversity issues.

After that, they will review particular content domains looking at children's conceptual learning, procedural skill development and declarative knowledge. They will also begin to look at whole number arithmetic from simple addition through long division algorithms, fractions, geometry and algebra. They will review future questions and new issues as they arise. Their report will include a brief statement regarding the usefulness and limitations of research on cognitive neurosciences and brain sciences as related to learning.

INSTRUCTIONAL PRACTICES TASK GROUP REPORT: DR. RUSSELL GERSTEN

The members of the Instructional Practices Task Group are: Dr. Russell Gersten; Mr. Vern Williams; Vice Chair Camilla Benbow; Dr. Tom Loveless; Ms. Diane Jones; and Dr. Kathie Olsen.

Dr. Gersten reported that their group has about eight or so topics that keep coming up as topics of interest. They refined these for Abt Associates, and came up with the question of, what the research and/or other evidence says about effective instructional practices in teaching K-8 mathematics. They realize it is broad, so they also started to raise some sub-questions, which will be refined. They also will be asking about the role of the teacher, selecting what to teach and how that intersects with practice, and the use of representations. They will begin by looking at causal, high quality experimental and quasi-experimental research that has proof of equivalence of groups. In the January report, they will report on the first question and sub-questions.

The second question for Abt Associates is, what is the small body of research that talks about real world or authentic problem solving, and then what other insights might one gather from more qualitative case study work into this including how that fits into the sequence of teaching. They will start with a hypothesis and then look for causal evidence, no evidence or contradictory evidence.

Dr. Loveless asked Dr. Gersten to clarify whether they are looking at a continuum of direct instruction/ teacher-led instruction on one end and student-centered/student-led instruction on the other end. He also asked if they are looking at the research on the evidence and effectiveness of those methods, and of all the variations in between. Dr. Gersten responded that, yes, that is what they are looking at.

Dr. Stotsky asked if they would be looking at the role of the materials the teacher is expected to use for instructional practice. Dr. Gersten said that was on the back burner, but they do expect to use it as context.

Dr. Siegler worried that the people reading this report will want to see something about textbooks and curriculum, or just some cursory introductory comments. Dr. Gersten said that they had to choose two questions now and then they will continue in January with others. Dr. Loveless agreed that it has been difficult to narrow down the questions to two, but they should narrow it down to the most important and he wanted to make sure theirs included an analysis of direct instruction versus student-centered, and the question of real-world problems.

Dr. Fennell thought it would be good for the task groups to take the work they received today from Dr. Good and Dr. Hiebert to help frame the questions.

TEACHERS TASK GROUP REPORT: DR. DEBORAH LOEWENBERG BALL

The Teachers Task Group includes: Dr. Deborah Loewenberg Ball; Ms. Nancy Ichinaga; Dr. Hung-Hsi Wu; Dr. Sandra Stotsky; Dr. James (Jim) Simons; Dr. Grover (Russ) Whitehurst; and Mr. Raymond Simon.

Dr. Loewenberg Ball reported that the questions they have developed for Abt Associates included reviewing the evidence on the relationship between teachers' mathematical knowledge and students' achievement gains, as well as a number of sub-questions that ask about: 1) the effects; 2) their size; 3) mathematical knowledge that has been conceptualized and measured across available studies; 4) student achievement that has been conceptualized and measured; 5) any differences by student populations, levels, content, or other student or context variables; and 6) any differences by grade levels, years or experience of the teachers.

The second question is what sorts of programs, such as pre-service, teacher education or in-service teacher education, help teachers develop the necessary mathematical knowledge they need for teaching. This group will also explore which of these programs have done so in ways that demonstrably affect their instructional effectiveness and their students' achievement. They will be reviewing what teachers' instructional practices look like and what their students' achievements look like.

The sub-questions that arise are about what is known about how pre-service or in-service programs can effectively increase teachers' knowledge. This will include the types of designs that have been shown to make a difference for teachers' mathematical knowledge and then all the usual questions about how that has been measured and conceptualized.

The other questions to be looked at later include whether there has been research that might inform recommendations related to specialization of teachers at the elementary level in mathematics, what models exist and whether there has been research relating that to instructional effectiveness, school improvement, students' achievement and the like. They also will look at evidence related to the recruitment and retention of mathematics teachers.

Chair Faulkner closed the meeting by announcing that the National Math Panel will have its next meeting in New Orleans, Louisiana, on January 10 and 11, 2007. He stated that most of that meeting will be devoted to task group work to prepare for the

report, which will be made available to a peer review process just after the New Orleans meeting. There will be a short amount of time set aside for public comment at the New Orleans meeting. He then declared this session adjourned at 5:33 p.m.

I certify the accuracy of these minutes.

Chair Signature_____Date_____

Vice Chair Signature_____Date_____

ADDENDUM: PUBLIC PARTICIPANTS

Last Name	First Name	Organization
Appleyard	Sara	Widmeyer Communications
Barber	Tori	WestEd
Barchers	Suzanne	LeapFrog
Bass	Hyman	University of Michigan
Baughman	Marcy	Pearson Education
Beers	Jack	Metropolitan Teaching and Learning Company
Blakely	Robin	Holt, Rinehart, Winston
Blaunstein	Phyllis	Widmeyer Communications
Blythe	Diane	Renaissance Learning
Bradley	John	National Science Foundation
Carroll	Cathy	Leadership Curriculum for Mathematics PD
Cherrington	April	San Mateo County Office of Education
Coe	Kaplin	Key Curriculum Press
Collins	Carla	CTB/ McGraw-Hill
Collins	Bob	iLearn, Inc.
Conry	Tamra	National Education Association
Coulson	Andrew	N/A
Criswell	Paul	Learning.com
Crotti	Patti	California Comprehensive Center
Dhaliwal	Jivan	Santa Clara County Office of Education

Last Name	First Name	Organization
Dilger	Luke	Monterey Peninsula Unified School District
Dilger	Linda	Monterey County Office of Education
Dodge	Cheryl	SchoolSoft, Inc.
Duckhorn	Pat	Sacramento County Office of Education
Easterday	Joan	Sonoma County Office of Education
Evans	Yvonne	California Department of Education
Evers	Williamson M.	Hoover Institution
Fisher	Linda	Noyce
Fitzgerald	Colette	Marilyn Burns Education Association
Flattau, PhD	Pamela Ebert	Institute for Defense Analyses (IDA)/ Science and Technology Policy Institute, Social and Behavioral Sciences and Education
Foster	David	Noyce Foundation
Fraser	Mary	Holt, Rinehart and Winston Publishers
Fraser	Sherry	N/A
Gill	Lisa Brady	Texas Instruments, Incorporated
Gilliland	Kay	National Council of Supervisors of Mathematics
Good	Thomas L. (Tom)	University of Arizona
Grazioli	Maureen	CTB/McGraw-Hill
Hamada	Lori	Fresno County Office of Education
Hanson	Ward	Stanford University (Stanford Institute for Economic Policy Research)
Hennessy	John	Stanford University

Last Name	First Name	Organization
Hiebert	Jim	University of Delaware
Iida	Susan	N/A
Janov	Lauren	N/A
Johnson	Erin	N/A
Kammerzely	Jon	Renaissance Learning
Katzir	Avivit	N/A
Kel-Artinian	Anne Halley	N/A
Kel-Artinian	Sarkis	San Jose Unified School District
Kelly	Shawn	Nexus Educational Publishing
Kessel	Cathy	Association for Women in Mathematics
King	Marsha	Sacramento County Office of Education
Kohlberg	Gavi	Digi-Block
LaFontaine	Phil	California Department of Education
Lenhertz	Elizabeth	Pearson Prentice Hall
LeTendre, Ph.D.	Gerald K.	Pennsylvania State University
Long	Donna	Macmillan/McGraw-Hill
Lowell	Mandy	Palo Alto Unified School District
Luce	Tom	N/A
Magner	Timothy J.	Office of Educational Technology, U.S. Department of Education
Manaster	Alfred	University of California, San Diego
Martin	Dr. Michael ("Mick") O.	Boston College
Martinek	Larry	Mathnasium Learning Centers

Last Name	First Name	Organization
Martinez	Alina	Abt Associates
Means	Barbara	SRI International
Menvielle	Linda	N/A
Milgram	Jim	Stanford University
Miller	Katie	Stanford Teacher Education Program
Mitchell	Nyema	Institute for Defense Analyses (IDA)/ Science and Technology Policy Institute, Social and Behavioral Sciences and Education
Morton	Erwin	Commission of the California State Parent Teacher Association (PTA)
Munger, Ph.D.	Charles T.	Curriculum Development and Supplemental Materials Commission
Muzslay	Leigh	Key Curriculum Press
Nanny	Margo	Interactive Learning Design and Learning.com
Newman	Denis	Empirical Education Inc.
Newton	Xiaoxia	Stanford University
Newton	Stephen	Stanford University
O'Reilly	Fran	Abt Associates
Panduro	Luis	Imperial County Office of Education
Peresman	Claudia	Wright Group/McGraw-Hill
Peterson	Sara	City College of San Francisco Mathematics Department.
Peterson	Ryan	Palo Alto Unified School District
Peterson, Ph.D	Matthew	MIND Institute

Last Name	First Name	Organization
Ploucher	Dale	Key Curriculum Press
Portela	Lisa	San Joaquin Valley Mathematics Project
Rauh	Grace	Oakland Tribune
Ritter	Steve	The Cognitive Tutor Company
Roschelle	Jeremy	SRI International
Ross	Doreen	University of California, Irvine Math & Science Outreach Center
Rusczyk	Richard	Art of Problem Solving (AoPS), Inc.
Ryan	Jim	Key Curriculum Press
Sandberg	Lisa	Tehama County Department of Education
Sarginger	Kirsten	Santa Clara County Office of Education
Saxberg	Bror	K12, Inc.
Schaar	Richard	Texas Instruments, Incorporated
Schneiderman	Mark	Software & Information Industry Association
Schwartz	Martha	Mathematically Correct
Schwartz	Richard	University of Southern California
Setzen	Robyn	Holt, Rinehart and Winston
Shakrani	Sharif	Michigan State University
Singh	Satinder	San Joaquin County Office of Education
Smith	Marianne	N/A
Smith	Ted	MIND Institute
Speer	William	University of Nevada, Las Vegas
Stallcup	John	APREMAT/USA

Last Name	First Name	Organization
Stigler	James	University of California – Los Angel
Surr	Seija	Riverdeep
Tan	Sun Sun	Stanford University
Townsend	Camille	Palo Alto Unified School District
Usher	Lisa	LA County Office of Education
Vahey	Phil	SRI International, an independent, nonprofit research institute
VanderVeen	Arthur	College Board
Veater	Carl	Fresno County Office of Education
Vuong	Sydney	MIND Institute
Wilkinson	Bill	Harcourt Achieve Rigby Saxon Steck-Vaughn
Wurman	Ze'ev	Community activist, active in math ed in CA
Xia	Jian Feng	Society for Modeling and Simulation International (SCS)
Yang	Steve	MathScore.com
Young	Lorelle	U.S. Metric Association, Inc.