

**UNITED STATES DEPARTMENT OF EDUCATION  
NATIONAL MATHEMATICS ADVISORY PANEL MEETING**

THURSDAY, JANUARY 11, 2007  
SUMMARY

The National Mathematics Advisory Panel met in open session at the Hotel Intercontinental New Orleans, 444 St. Charles Avenue, New Orleans, Louisiana 70130, on Thursday, January 11, 2007, at 8:49 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
A. WADE BOYKIN	Member
FRANCIS "SKIP" FENNELL	Member
DAVID C. GEARY	Member
RUSSELL M. GERSTEN	Member
TOM LOVELESS	Member
VALERIE F. REYNA	Member
WILFRIED SCHMID	Member
ROBERT S. SIEGLER	Member
VERN WILLIAMS	Member
HUNG-HSI WU	Member
DANIEL BERCH ( <i>via conference phone</i> )	Ex Officio
DIANE JONES	Ex Officio
RAYMOND SIMON	Ex Officio
GROVER J. "RUSS" WHITEHURST	Ex Officio

PANEL AND EX-OFFICIO MEMBERS NOT PRESENT:

NANCY ICHINAGA	Member
LIPING MA	Member
JAMES H. SIMONS	Member
SANDRA STOTSKY	Member
KATHIE OLSEN	Ex Officio

STAFF MEMBERS PRESENT:

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

## **CALL TO ORDER**

Chair Faulkner opened the session at 8:49 a.m. and welcomed the audience and members of the Panel to New Orleans for the fifth meeting of the National Math Panel. This meeting was hosted by Xavier University of Louisiana.

## **WELCOME REMARKS BY DR. NORMAN FRANCIS, PRESIDENT OF XAVIER UNIVERSITY OF LOUISIANA**

Dr. Francis asked the Panel that their recommendations about what kinds of strategies are needed to improve the study of mathematics for young people include holding young people to high expectations.

Dr. Francis explained that back in the 1970s, research was being done on the lack of young people, particularly African-Americans, going on to medical school, dental schools and the like. The reason for this was seen as the lack of opportunity and encouragement to study the hard sciences, and particularly mathematics.

Around that time, Dr. Francis' faculty went directly into the high schools with Xavier students to teach a few math and science classes for three weeks. The first program was a summer session called SOAR (Stress on Analytical Reasoning), which still exists today. For five years, they had oversubscribed admissions to that program from high school seniors. It was successful in raising PSAT scores from around 700-750 by 200 points in a four-week session. They also brought in junior high school students to prepare them for algebra.

Since the start of that program, the enrollment of Xavier has almost doubled and the number of science majors at Xavier has risen to 62 percent of the arts and sciences program. Only 40 percent of American students nationally are studying science in colleges. The global rate is 65 percent. Xavier believes their high numbers are a direct result of supporting young people in high school to understand the rigors of what they will have to know in college.

For the last 14 years, Xavier has been the number one producer of African-Americans admitted to medical school, and that admission rate is about 75 percent. The retention rate is 95 percent. They are number one in terms of African-Americans who major in the biological and the physical sciences in the United States. They are at the top, as well, in the production of African-Americans who receive medical degrees.

Dr. Francis asked the Panel to remember the fundamentals about good teaching, high expectations, the best strategies and not moving away from set standards and requirements.

## **OPEN SESSION**

Chair Faulkner introduced Dr. Joan Ferrini-Mundy, as a new ex officio member of the Panel beginning January 22nd. She has been named Division Director of Elementary, Secondary and Informal Education for the Directorate for Education and Human Resources of the National Science Foundation. Chair Faulkner also thanked Kathie Olsen, Deputy Director of the National Science Foundation, for her contributions to the Panel in her role as an ex officio member. She will be leaving the Panel effective at the close of this meeting, and Dr. Ferrini-Mundy will be her replacement.

He also acknowledged the helpful comments from the public that have formed the Panel's work. They have come in by writing, e-mails, briefing sessions and testimony at meetings like New Orleans.

### **PUBLIC COMMENT:**

#### **LORELLE YOUNG, PRESIDENT OF THE U.S. METRIC ASSOCIATION**

Ms. Young addressed measurement education in the United States. In 2003, the National Council of Teachers of Mathematics (NCTM) published a yearbook on the subject of measurement entitled *Learning and Teaching Measurement*. She reported that it states, "[r]esults from the NAEP international assessments indicate that students' understanding of measurement lags behind all other mathematics topics." She also quoted the 1996 NCTM yearbook, *The Metric System of Weights and Measurements*, which states "[f]rom the point of view of teaching and learning, it would not be easy to design a more difficult system than the English system. In contrast, it would seem almost impossible to design a system more easily learned than the metric system."

Ms. Young reported that published articles abound about the difficulty students have in learning measurement, even the most elementary aspects of reading and using a ruler. With respect to students' metric system knowledge, she said that chemistry teachers constantly complain that they have to take time away from teaching chemistry because students do not know the metric system, and they cannot teach chemistry without it. College professors report that too many students enrolling in university classes also do not have sufficient skill in math or the metric system to pass their courses. And companies complain that it is difficult to find metric-knowledgeable workers.

Ms. Young shared two sizable studies by researcher Richard Phelps and E. James Tew, when he was quality assurance manager at Texas Instruments. She stated that these works provide evidence of the unchallenged superiority of teaching using the metric system. In addition, her association compiled a metric bibliography CD, which is a database of references to articles about metrics from the mid 1940's to the present. More information can also be found on her Web site.

Each year in October, Metric Week is celebrated with teachers and schools where they try out teaching the metric system. Their association's newsletters chronicle these experiences. Teachers say they love teaching metrics and they would welcome in-service training on it. Students say they learned it without any problem.

Ms. Young also reported that teachers are confounded by trying to teach two measurement systems concurrently, resulting in students mixing up the units between the

two systems and learning neither system well, if at all. Student test scores support their conclusions.

Some in the United States insist that the inch-pound system be taught because it is still used in some applications. But Ms. Young stated that in the 21st century, the inch-pound system use is waning, and here in the United States the metric system use is accelerating.

Ms. Young's recommendation was to cleanse the curriculum of the inch-pound system through grade six as there is no evidence to show that teaching the inch-pound system helps students learn math concepts. Instead, she said, the reverse is true. After the fourth grade, students' scores in math and science plummet on the eight and twelfth grade tests, which she says shows that they didn't master basic skills in elementary schools.

She stated that the "I hate math" syndrome, so common in the United States, is partly the outgrowth of trying to teach two measurement systems. The high-achieving students of Japan and Singapore learn only the metric system. Measurement is an easy subject for them because the metric system is easy to learn and use, and it gives them a foundation for success in advanced math and science courses. They quickly develop skill in using decimal measures, while U.S. youngsters are perplexed with fractions like  $11/16$ ths and  $3/8$ ths.

Ms. Young stated that our dual management philosophy leads students to confusion and fuels student's failure, and perhaps to their avoidance of taking higher math and science courses.

**PUBLIC COMMENT:**

**DR. JIM YSSELDYKE, UNIVERSITY OF MINNESOTA**

Dr. Ysseldyke is a Birkmaier professor of educational psychology at the University of Minnesota. He served as director of the National Center on Educational Outcomes and the director of the Institute for Research on Learning Disabilities at the University of Minnesota. He authored a textbook on assessment and special education, and served as editor of the journal *Exceptional Children*, which is the main journal of the Council for Exceptional Children. Recently his work has focused on policy issues, components of effective instruction and improving formative assessment practices and data-driven decision-making.

Dr. Ysseldyke addressed the Panel on a set of topics that he believes are critical to improving math achievement for our students in our nation. He began by stating that he is not a mathematician or a math educator, but he does train school psychologists. He also conducts research on effective instruction with an overall goal of enhancing individual student competence and building the capacity of systems to meet the needs of students. He focused his remarks on capacity building.

A firm knowledge base on effective instruction exists, stated Dr. Ysseldyke. But the problem he sees is with the difficulty of implementing that knowledge base with any degree of fidelity, and treatment or intervention integrity. To try to combat this, he developed a methodology to look at the extent to which effective instruction is occurring in class.

Dr. Ysseldyke urged the Instructional Practices Task Group and the Panel as a whole to consider the role of relevant, guided and monitored practice in improving

student outcomes in math. By relevant practice, he is referring to practice in which students are given adequate opportunity to work at high success rates with materials that are targeted specifically to their individual skill level. By continuous progress monitoring, he is referring to the use of systems that give teachers the information they need to systematically employ evidence-based principles and then to adapt their instruction based on the extent to which students are profiting from what they are doing.

Dr. Ysseldyke feels that the notion that kids need relevant, guided practice is obvious, yet the National Reading Panel in their charge to inform policymakers overlooked the importance of guided reading practice with feedback. They focused instead on the inconclusive evidence for the effectiveness of independent, unguided reading practice with minimal feedback.

Research has shown significant differences between these two types of practices. Yet this was not specified in the National Reading Panel's final report. Those recommendations now serve as the foundation for federal education policy in reading. They have been implemented in schools all across the nation, and one of the things he sees is that states, schools and districts have been left with an inaccurate impression about the importance of all reading practice and are unable to provide sufficient in-class time for guided reading practice with feedback. Dr. Ysseldyke stated that the Math Panel is faced with a similarly and equally large challenge as its recommendations will serve as a foundation for future practice.

Dr. Ysseldyke listed some studies that show the effectiveness of relevant guided practice, including ones by Black & Wiliam, Fuchs & Fuchs, and Deno. He also provided the Panel with a list of other references on the topic. He highlighted the findings from a recent study by Dan Bolt, University of Wisconsin, a two-year study, with 1,800 students in 41 experimental classrooms, and 39 students in control classrooms. The results of regression analyses using residualized gain scores showed significant effects for one dependent measure, as well as major school effects. When controlling for those effects, they found huge differences in implementation integrity with teachers, with students mastering from zero to 197 objectives over the course of a year. When the program was implemented with high integrity, they found from four to seven times the amount of gains compared to those in the implementation group.

Dr. Ysseldyke left the Panel with two major recommendations. The first is the need to recommend the relevant practice, and second, to recommend continuous progress monitoring.

## **PUBLIC COMMENT QUESTION AND ANSWER PERIOD**

Mr. Boykin asked Dr. Ysseldyke to comment on the various populations on which his research has been done. He replied that the research has been done primarily on students at the margins, including both gifted students and students who are at risk of academic failure. The research he reported on today was done in regular classrooms with a range of students representing high diversity. The range in math performance in sixth grade in the Minneapolis schools is about ten or eleven years, and many of the students are new immigrants. That diversity demands a system that will match instruction very

carefully to the skill of each of those learners. No sixth grade teacher is prepared to deal with that kind of range. Several of the reports focus on gifted kids.

Dr. Loveless asked which study from the list Dr. Ysseldyke provided to the Panel is good in terms of design, and whether any of these use randomized assignment. Dr. Ysseldyke replied that the one he did with Dan Bolt was a randomized, controlled study, randomized by classrooms. He provided the Panel with a copy of the next-to-final revision, and can provide a copy when it is final.

Dr. Loveless followed up by asking whether that program was tested in a hard-copy form or on a non-technological basis. Dr. Ysseldyke responded that the program is a technology-enhanced progressed monitoring system. It is not a curriculum, but works with any curriculum. It monitors the progress of students throughout the curriculum. Students who are in need of further instruction are flagged, and once they accomplish sufficient expertise on the practice items, they are then given an opportunity to take a test. They found that computer-assisted testing does not work very well, so that aspect is all paper and pencil. If they pass the test, they move on to the next level. Students are grouped using cooperative grouping strategies.

#### **PUBLIC COMMENT:**

#### **DR. JEROME DANCIS, UNIVERSITY OF MARYLAND**

Dr. Dancis is an associate professor of arithmetic in the Mathematics Department of the University of Maryland in College Park. He began by stating that when defining algebra, he would like the Panel to include algebraic word problems, especially non-trivial algebraic word problems. He feels this is where algebra interfaces with the world, and comfort with algebraic word problems is crucial for students to take a serious high school chemistry or physics course. These are the types of problems that are largely avoided in elementary schools today.

Dr. Dancis sees that No Child Left Behind has decreed that middle school math teachers will be highly qualified in math. A company called Praxis II has written a math content exam for middle school math teachers, which is used by many states to determine how they qualify for middle school math. He reviewed the sample questions on their Web site; they had two ratio questions and no two-step extended ratio questions.

Dr. Dancis also spoke about the importance of measurement in algebraic word problems. Betsy Darken, who was a math professor at the University of Tennessee and is now teaching math for elementary school teachers, shared with him a pretest she gave to her students. None of her students answered correctly the question that asked how many cubic feet were in a cubic yard. On the post test, half the students answered correctly. Teachers are making it through her program without knowing the answer to that question. A quarter of her calculus students were able to answer that problem. In his opinion, measurement is falling through the cracks.

Dr. Dancis also added that science lessons that use arithmetic and measurement are needed in elementary and middle school. They also need reading instruction for arithmetic word problems, not just practice. He feels the Stress on Analytical Reasoning (SOAR) program is crucial in teaching the arithmetic word problems in elementary school and middle school because they stress analytical reasoning.

**PUBLIC COMMENT:  
BARBARA FRANKLIN, PLATO LEARNING, INCORPORATED**

Ms. Franklin is Director of Field Market Development at PLATO Learning, Inc., where she analyzes policy-making groups such as the Panel to ensure that her company's educational strategies and solutions are in line with current research and guidelines. PLATO has been in business for 44 years, beginning as a National Science Foundation grant to the University of Illinois. They were the first company to provide computer-assisted instruction in education. Continuously reinventing themselves and their products over the years, they now provide supplementary instruction and formative assessments for many diverse student populations all across America. When they began product development, they worked to understand the research that is currently available. There is not a lot of research in the area of math learning.

Ms. Franklin spoke about their Straight Curve Math, an elementary math product that they researched, developed and beta-tested in the past year. They released it for classroom use in the last few months. She provided a handout with the research body and design principles used in the development. The program is designed for math teachers and students in kindergarten through sixth grade, to be used daily during a 20-minute segment of the math period. The product has both technology and print components for teachers and students, and supports core instruction in the classroom.

Straight Curve Math has two primary objectives. The first is to increase student achievement in math through research-based best practices, which they see as good classroom instruction, investigations, workshops, quizzes and games. Secondly, the program aims to increase teacher effectiveness through professional development in math content, instructional strategies and technology product usage. The program is meant as a preventative strategy, rather than an intervention.

The program is designed with a landscape of learning methods, “big ideas” and “focal points” of its curricula. These big ideas allow teachers to grasp instruction and to seek connections that can be defined as central organizing ideas that define mathematic order. Some of the big ideas they include are numbers, operations, measurement, geometry and algebra, which they are beginning in kindergarten, and data analysis and probability. These learning maps and big ideas translate into hierarchical charts that align with NCTM curriculum focal points and some state standards. They did not try to cover everything, but instead identified concepts that inexperienced teachers struggle with teaching and students must have to lay a foundation for future learning.

Ms. Franklin asked that the Panel consider the following points: 1) consider that the amount, quantity and quality of differing state standards create difficulties for both teachers and students in American math classrooms; 2) allow and encourage systematic innovation on the part of smaller supplementary vendors to bring forth promising practices and emerging technologies to improve student achievement--do not be so prescriptive in your recommendations that innovation is blocked; 3) establish criteria for the review of commercial products that will allow all companies to undergo a fair and ethical process for participation in the future elementary Math Now program, other science and math initiatives, and other federal programs that will result from your report.

**PUBIC COMMENT:  
JAMES J. MADDEN, LOUISIANA STATE UNIVERSITY**

Dr. Madden is a professor of mathematics at Louisiana State University (LSU), and since 1996 he has become increasingly involved in designing and delivering education for future math teachers, including undergraduate math course curricula and programs and professional development programs. He has been the principal investigator on a couple of National Science Foundation course, curriculum, and laboratory improvement grants, and he is the director of the Louisiana STEM 2P grant that is funding a new program for preparing secondary math and science teachers. Since about 2000, he has been a member of the Cane Center at LSU, whose mission is to use the researchers of the university to effect positive change in mathematics and science education.

Dr. Madden commented on the difficulty of knowing or determining the effectiveness of what they are doing. They are attempting to provide for the teachers with whom they interact the best possible preparation for effective practice. But they find they are unable to determine whether or not they are having effects or what those effects are. They have numerous choices concerning what they can provide, all with recommendations that those are the best choices. These choices include content knowledge, specialized content, enabling teachers to become part of learning communities, helping teachers interact with one another and providing teachers with mentoring. While they all may be important, he says that they have to make choices.

Part of the problem Dr. Madden sees is that they lack good ways of describing what practices are already in classrooms. When the East Baton Rouge Parish schools, for example, asked him to design a summer program for the teachers, they only had a limited idea of what teachers in the district were currently doing. The research in this area, the TIMSS studies and the Learners Perspective Studies, say a lot about how to describe the things that are going on in classrooms. But Dr. Madden says that he does not have the tools that enable him to do that.

In a review of several handbooks of mathematics education, 3,000 pages of scholarly articles, he found only three pages that mentioned observation. He developed an observation protocol, which is used widely in Louisiana. Other observation protocols include one developed by Horizon Research and one that is in use in Arizona. But few of them could effectively answer the question of whether what they were doing is effective.

Dr. Madden urged the Panel to find a solution to the observation problem in order to determine how what he and others are doing affects teacher practice.

**CLOSE OF PUBLIC COMMENT SESSION**

**CONSIDERATION OF PRELIMINARY REPORT**

Chair Faulkner led a discussion to consider the Panel's Preliminary Report. He stated that the Preliminary Report does not contain sections that represent reports of individual task groups. Once the Preliminary Report is completed and finalized, he stated that it would be made available to the public as quickly as possible.



Section one of the draft report is called “The President's Charge.” The report provides background and describes the formation of the Panel through Executive Order 13-398, which is in Appendix A. The section then proceeds into a brief summary of the basis for national concern over the mathematical proficiency of young people emerging from U.S. schools, and cites information from the Program for International Student Assessment (PISA), the Trends in International Math and Science Study (TIMSS), the National Assessment of Educational Progress (NAEP), and the *Rising Above the Gathering Storm* report from the National Academies.

That section also includes a description of the debates that have existed in the teaching community about how teaching should be done. It comments on the belief among the public that it is important for students to improve skills in math, science and engineering.

In the first full paragraph on page three that begins, “The United States finds itself at a crossroads,” there was a question about the 3.7-billion dollar-a-year figure. Chair Faulkner proposed that sentence be dropped from the report, unless there was an objection. There was no objection.

The report continues with a section on the President's precise charge. It emphasizes that the President has asked the Panel to provide advice on how to foster greater knowledge of and improve performance in mathematics among American students. Specifically, it asks for guidance on the conduct, evaluation and effective use of results of research related to proven, effective and evidence-based mathematics instruction. It notes that the Executive Order calls for recommendations based on the best available scientific evidence, a particular focus of the Panel.

The report then proceeds through items “a” to “j” in the President's Executive Order. It gives a list of elements of the charge, and it notes in item “a” that the list clearly indicates that the Panel's focus should be on the preparation of students for entry into success in algebra, which itself is a foundation for higher mathematics. There were no questions from the Panel on that section.

Section two outlines the composition of the Panel and the process of work. It notes that the Panel comprises 22 members designated by the Secretary of Education. It states that 17 are experts not employed by the federal government, and 5 are ex officio designees from federal agencies. The members were sworn in to serve as the Panel began its work on May 22nd, 2006. Chair Faulkner noted that edits need to be made to the list of members.

The document then proceeds to note that the Panel has met five times over the last eight months and that there will be five additional meetings. At each meeting other than the first, the Panel has used a portion of the time working in task groups and the balance in public sessions. The testimony has been open to the public on a first-come, first-served basis, and some other testimony has been organized topically according to the needs of the Panel that cover things like textbooks, TIMSS or the use of technology.

The proceedings have been recorded and documented, and transcripts and other information have been posted on the Panel website. The report goes on to indicate that organizations likely to have an interest in the Panel's work were contacted by mail to inform them of the work plan. They also have been invited to provide testimony in writing and orally, as well as to attend a meeting in Washington in early December where questions and answers were handled.

At the Panel meeting in May, the report noted that the Panel divided into task groups, including Learning Processes, Conceptual Knowledge and Skills, Instructional Practices and Teachers. The document then proceeds to give the rosters of the task groups, and notes that subcommittees were organized to address standards of evidence and a survey of teachers in the field. The task groups are being supported by Abt Associates and the Institute for Defense Analyses, Science and Technology Policy Institute. The report provides a description of the basis for the work of the contractors and the way they are providing searches of literature and other information.

The Panel and task groups set the standards for and will make decisions about rigor, adequacy and conclusion of the findings. The task groups report periodically to the entire Panel and discuss all final work products such as the language in this report. The report declares that the Panel intends that every assertion or statement of fact in its final report either be labeled as definition or opinion, or be backed up by citation. Wherever practical the Final Report will also convey the quality of evidence that exists for findings or conclusions, principles they deem to be consistent with the President's emphasis on best available scientific evidence.

Chair Faulkner then asked if there were any questions about section two. Dr. Boykin asked about item "c" in the President's Executive Order that states, "The processes by which students of various abilities and backgrounds learn mathematics," and if that clause could be inserted on page 6, so that it reads, "What is known about how children learn mathematical concepts and skills." Dr. Loveless had a problem with that wording because he believes that it implies that there are no general findings or principles about how all children learn mathematics. He recommended that a second clause be added that states, "the processes by which students of various abilities and backgrounds learn." That suggested edit was agreed upon.

Ms. Jones had a concern with the statement in section one about characterizing the *Rising Above a Gathering Storm* as "documenting diminishing competitiveness," and she suggested changing it to "questions future American competitiveness." That change was agreed upon.

Chair Faulkner moved on to section three, "Current Status," which describes the progress of the Panel. The section states that all four task groups are deeply engaged in the substance of their tasks, and are in the process of examining relevant literature and materials. Subcommittees are also addressing various uses of pertinent evidence. The report states that it is premature for the Panel to convey major findings and conclusions with confidence. The findings from task groups will inform each other and will ultimately be aligned in forming conclusions.

The Subcommittee on Standards of Evidence has made good progress toward a guide. However, the Panel believes that the details will be further refined as members review the research. The Subcommittee on a Survey of Teachers is working to develop goals and a plan for the survey.

Continuing the review of the progress of the Panel, Chair Faulkner stated that as the work continues, they expect to examine parts of the President's charge that cannot be covered in the current task groups. The piece of the charge that is in the forefront of the Panel's mind is assessment, and the President has called for comments on needed research.

Dr. Whitehurst had a question about section one, page 2, third bullet, which cites a publication from his office. He believes the citation references a portion of kids who meet basic standards, but it could be read as supporting a claim for the need for a certain level of skills, which is not in that publication. Dr. Loveless added that the citation is likely from the Richard Murnane book, *The New Basic Skills*. Dr. Schmid suggested splitting the sentence into two and citing both parts. That change was agreed upon.

Chair Faulkner went on to explain section four, "References," where there were only four citations. Appendix A of the report is the Presidential Executive Order. Appendix B is a list of Panel meetings and where the next meetings will be held. Appendix B also provides brief meeting summaries of the five meetings to date, and includes a list of the kinds of testimony they have heard. That concluded the review of the report.

Chair Faulkner announced that the eighth Panel meeting will be held in September, and will be in St. Louis at the Washington University School of Medicine. The ninth site is still to be determined.

Chair Faulkner then asked if someone would move the adoption of The Preliminary Report as they intend to edit it, with the understanding that the Panel will be shown the final edited version before its release. Dr. Ball agreed to move for the adoption. Dr. Wu seconded that motion. Chair Faulkner then asked if there was debate or discussion on the question of adoption, and there was none. He then asked that all in favor of adoption signify by saying "aye". The motion was adopted by the Panel as whole with none in opposition.

Chair Faulkner then stated that the preliminary report was adopted with the understanding that those corrections would be made, the Panel would be given a final chance to review it and then it would be released. He thanked the Panel for their work.

## **TASK GROUP REPORTS: TASK GROUP ON CONCEPTUAL KNOWLEDGE AND SKILLS**

Francis "Skip" Fennell, Chair; Liping Ma; Wilfried Schmid; Larry R. Faulkner and Sandra Stotsky

Dr. Fennell began by stating that their charge is to look at essential knowledge and skills for Pre-K through eight and algebra. He added that Hung-Hsi Wu and Joan Ferrini-Mundy, who is a new ex officio member of the Panel, and several outside reviewers also provided assistance to the task group.

Dr. Fennell described the "topical lists" of knowledge and skills his group had developed that were derived through careful analysis of the following: state curricular standards in the U.S.; American Diploma Project Benchmarks; K-8 Benchmarks; intended math curricula for Japan, Korea, Flemish Belgium, Singapore, Chinese Taipei; the work of William Schmidt with TIMSS and the recent work of the National Council of Teachers of Mathematics (NCTM).

Dr. Fennell presented the list and noted that balance is expected between opportunities for students to develop concepts, solve problems and compute using the mathematics. The list is organized by topics: number and operations, algebra; geometry; measurement; data analysis and probability.

Chair Faulkner went on to state that the task group is willing to make the statement that the NCTM is on sound footing with its recent publication of the “Curriculum Focal Points.” While not ready to endorse a single curriculum, they believe the “Focal Points” document represents a positive step. The Panel's Final Report may articulate grade-by-grade expectations.

Dr. Schmid explained that, when they talk about the definition of algebra, it cannot be determined through existing research. The definition of algebra is something that requires expert judgment. There are many sensible ways to define it, and the Panel should not be prescriptive. The intent should be that there needs to be an appropriate balance between the three pillars of conceptual understanding, problem solving and computational facility. What really has to come across in the classroom is the logical connection between the three; and similarly there should be examples of what problem solving in algebra means and what computation in algebra means.

Dr. Schmid then presented a list of the components of algebra, and in summary, it includes: symbolic notation and calculating with symbolic expressions; linear functions; linear equations; quadratic functions and quadratic relations. In addition, it includes the more general notions of functions, including exponential functions, logarithmic functions and trigonometric functions. Then finally it lists polynomials.

Dr. Fennell said that his group’s next steps would include spending more time on the important elements of mathematics that lead to algebra and the extent to which they take the list into a grade-by-grade analysis of Pre-K through grade eight.

#### **TASK GROUP ON CONCEPTUAL KNOWLEDGE AND SKILLS: QUESTION AND ANSWER PERIOD**

Dr. Whitehurst suggested that the task group consider sharpening or eliminating language about the “balance” among the three components because “balance” is an ambiguous term. One cannot balance elements unless they have known weights, and so he feels it is an invitation for people to do anything they want in terms of the distribution of activities across the day, as long as there is something from one of those elements in the week. Dr. Schmid replied that the point of the language is to make sure that all three components are covered.

Dr. Loveless had a question about the “acknowledged sequence of skills in K-8,” and who has acknowledged that sequence. Dr. Schmid answered that they are not making the statement that there is a clear-cut sequence, so he would remove that reference.

Dr. Siegler echoed Dr. Whitehurst’s point that it is important that they say these different components of math are not in opposition to each other, but rather they are mutually reinforcing. There is research he can share that shows that better procedural understanding helps people gain conceptual understanding, and similarly better conceptual understanding helps people gain procedural competence.

Dr. Ball raised the point that they should be cognizant of the fact that mathematical proficiency, as it is referred to in the report, includes more than conceptual understanding, procedural skill and problem solving. It also includes mathematical reasoning, which the Panel has not been spending much time on.

Dr. Wu stated that there is no reason to reinvent the wheel, and he thinks the process for mathematical proficiency is pretty well accepted.

Dr. Boykin stated that in many school systems, courses are taught in algebra and in pre-algebra, and he wondered if this was a false dichotomy. Dr. Fennell stated that it is a false dichotomy. He explained that what his group is trying to do is establish the mathematics that would lead students to begin a serious study of algebra, without a lot of topics outside of it that would prevent students from being prepared.

## **TASK GROUP REPORTS: TASK GROUP ON LEARNING PROCESSES**

David C. Geary, Chair; Valerie F. Reyna; A. Wade Boykin; Robert Siegler; Daniel Berch, ex officio

The Learning Processes Task Group's charge is to provide a review of the best available evidence on how children learn mathematics and mathematics-related material, and how this learning may vary across different groups. They begin with a basic overview of learning, including cognition, basic concepts and how learning actually occurs. They continue with a review of the research and an overview of the mathematical knowledge children bring to school. They then do reviews of math learning and key content areas. These include whole number arithmetic, fractions, estimation, geometry and algebra. The latter two will follow the lead of the first task group in terms of specific areas that are of high interest.

The task group reported that it is often noted that brain science issues form the basis for education, but the stated knowledge is such that those claims and such implementation will be premature. Nonetheless, they report that there is interesting work in this area that can be used to test specific hypotheses regarding learning, and changes in brain functions or cognitive functions.

With respect to methodological issues, the task group is typically reviewing theory testing with demonstration through multiple methods. These methods may involve observations of children's problem-solving or verbal reports. There are various experimental procedures that are used to study these issues, including task procedures, where one aspect of working memory may be engaged in solving a particular type of task. They also will look at the effects of practice on random assignment groups to different types of practice. Computer simulations of learning and cognition in these particular areas are also common. Finally, brain imaging and related technologies are being used increasingly in this area. Conclusions that this task group will draw will typically be based on convergence and results across one, or typically multiple, procedures.

Learning Processes hopes to cover, in the first section of their report, information about cognition, which covers the fundamental capabilities of the brain. Learning involves improvement of these capabilities as a result of maturation and experience. Some of that experience occurs in the classroom, and much of it occurs elsewhere, depending on exactly what is being learned. A considerable amount is known about the aspects that affect learning. Of particular importance is working memory, which is a holding of information in mind and then doing something with that information, a process

required for learning. That information will be represented in several areas including specific representational systems, the language base, the spatial base, or memories or personal experiences.

Long-term memory is storage of information for later use, and contains different types of skills, such as verbatim or declarative. Verbatim learning typically requires extensive practice that is distributed over time. Gist conceptual learning may occur with insight, demonstration, exploration, instruction or discussion. Practice leads to the automatic retrieval of declarative information or the execution of procedures, which frees up working memory to learn more material.

The task group then offered an example of “choking,” which research has shown to happen when competency-related thoughts intrude into working memory (i.e. high-stakes testing). As choking occurs, attention shifts from the task at hand to the internal representation. Experimental studies have shown that choking is eliminated if the material on the test is taught to a point where it is retrieved or executed automatically.

A considerable amount is known about what children bring to school, and an example of what Learning Processes will be reviewing is the evidence that children have an innate sense of numbers. At five months of age they are sensitive to small additions and subtractions. However, even though preschool children can count, add, subtract and make simple measurements, they do not possess a sufficient basis for learning mathematics at school.

This early sense of quantity does not vary as much across different groups, but when they look at more formal mathematical knowledge, such as knowing number words one to ten, they see large differences. Empirical studies show that children who start behind tend to stay behind. Learning Processes will also review promising interventions that can reduce these early differences.

Learning Processes is approaching completion of the review of whole number arithmetic, which includes the factors that influence fast and efficient retrieval of facts involving declarative memory. They have a very good understanding of the learning and cognitive mechanisms that are involved in this. They also know that most children in the United States do not achieve fast and efficient retrieval of basic facts. A fair amount is known from research about the mechanisms involved in learning addition, subtraction and multiplication procedures. Little is known about long division, but the task group will review what is available. Other areas for review include commutativity, associativity, distributive identity, inverse relations, base ten and training. U.S. children and even college students do not do well on tests that require knowledge of these skills.

A review of individual and group differences will look at skill development in the areas mentioned as it relates to race, ethnicity, gender and learning disabilities. The task group has begun a review of learning disabilities and know from multiple large-scale studies that 5 to 10 percent of kids who show significant problems relative to their peers are from 1 to several degrees behind expected performance on mathematics tests. The reason for this is related to a mixture of procedural development, late acquisition of arithmetic facts, and perhaps underlying brain and cognitive deficits for some. The task group has also drafted a review of research related to gifted students, and they know that students who are bright learn the same things, often in the same sequence, but with less practice and less exposure to that material.

Finally, Learning Processes will review a bit of the evidence on brain science and

learning. They know there is considerable evidence that in initial learning the prefrontal areas of the brain are engaged, which are the parts of the brain associated with effort. They also know that the inborn sense of quantity may be involved in a strip called the intraparietal or at least part of that strip in the parietal lobe. The learning they describe that is associated with cognitive studies is now being substantiated in brain-imaging studies and results, to a large part, are very consistent with each other.

Learning Processes' next step is to review fractions, estimation, core areas of geometry and algebra, and other areas that Conceptual Knowledge and Skills determines are key. They will then review differences in similarities across race, ethnicity and gender for key areas, and draw explicit links to the other task groups.

### **TASK GROUP ON LEARNING PROCESSES: QUESTION AND ANSWER PERIOD**

Dr. Loveless asked, in relation to “choking,” whether the Learning Processes Task Group would include the studies over the last ten years of stereotype bias, including gender, and specifically Steele's work. Dr. Geary replied that yes, they would be covering motivation and social affect mechanisms as related to mathematics.

Dr. Wu asked about the inclusion of estimation as something on par with the other topics. He feels that estimation, both in terms of depth and scope, is not on the same level, and not a key area. He also thinks that one key area is actually missing, which is rational numbers. Dr. Geary stated that rational numbers would be covered in fractions. He added that by providing a list, it does not mean that all of those areas would be given equal weight. Dr. Schmid added that he also was concerned about the way estimation was portrayed.

Dr. Fennell stated that the intent is to create a role for estimation, along with proficiency with whole-number operations, rational numbers and so forth. He also asked what the Learning Processes Task Group found relative to algebra. Dr. Geary responded that they still need to do work in this area.

Dr. Siegler responded to Dr. Wu's comment about estimation. He feels that estimation is important to build math literacy, as it is used frequently in everyday life. He also sees a false dichotomy given a large amount of research to totally separate estimation from computation. Estimation is also important for learning algebra. He feels that students often generate totally implausible answers to algebra problems, and they don't have the estimation skills to check whether those answers make sense or not.

Dr. Wu clarified that he does not want estimation to be listed as key content area because the Panel is not discussing preparation for life. He is making a mathematical statement. He is concerned that publishers will think this is a topic within itself. He also thinks that estimation should not be singled out, but it should be emphasized every time numbers are discussed.

Dr. Ball asked about group differences and if the task group could elaborate on what they are doing, and if this is the only task group that would be handling it. Dr. Geary responded that they do not expect to cover everything that should be covered in this area. They will look at the data on where differences emerge and work to determine whether those differences are larger for some areas than others. This would then inform

the other groups. Dr. Reyna added that they should include socioeconomic status in their discussions.

Dr. Loveless agreed with the conversation about estimation and asked that Dr. Wu's point be noted. He agrees that estimation is important, but his problem is with the word "content." Dr. Reyna added that they are not referring to mathematics per se, but to topics that have been researched on learning processes.

Dr. Whitehurst followed up on how they were going to address social and motivational processes. Dr. Geary clarified that they will have a considerable amount of material on that.

Dr. Boykin added that they will look at theoretical frames like goal theory, attribution theory, intrinsic motivation and social culture theory, as well.

Dr. Gersten asked if they had found the same precision or any precision in the measure of conceptual knowledge compared to procedural or declarative. Dr. Geary responded yes, in some areas.

Dr. Siegler also answered that there are a lot of paradigms using judgment of the worth of various mathematical procedures by children that indicate conceptual understanding.

## **TASK GROUP REPORTS: TASK GROUP ON INSTRUCTIONAL PRACTICES**

Russell M. Gersten, Chair; Vern Williams; Camilla Persson Benbow; Tom Loveless; Diane Jones, ex officio and Joan Ferrini-Mundy, ex officio

Dr. Benbow presented the task group report, which covered how they would frame their questions, and how they would determine the issues they want to tackle and in what order. First, in terms of trying to organize the literature on instructional practices and materials, they thought the instructional triangle described by Ball and Cohen was a way to help organize the issues. Instruction is really an interaction among teachers, students and mathematics. The Task Group considered a long list of topics and issues, and prioritized its work to pick two problems to tackle first. Issues to be pursued later include instructional materials, formative assessments and practice tools, such as manipulatives, calculators and technology.

The Instructional Practices Task Group is conducting a literature review on two key areas, which they are beginning to organize. The first question looks at direct instruction versus inquiry-based instruction. It can also be called explicit instruction versus discovery learning or teacher-centered versus student-centered instruction. They are aware that what they are describing are extremes of instruction, and it is rare for anyone to teach to one extreme. Instruction in the classroom is a mix of various methodologies. They will specifically look at which one is more effective, when, for whom and if there are differences between groups of students.

Dr. Loveless described the second question about real-world instruction, which will specifically address research that supports the different points of view and its overall relevance. They will also address how they will broaden the topic.

Dr. Loveless reviewed their findings to date. Currently, real-world instruction is embraced by federal policy. The National Science Foundation stipulated that their grant



programs in the 1990s focus on applications of real-world problems that interest and motivate students. The NAEP framework calls for real-world problems 12 times and across fourth, eighth and twelfth grades.

Real-world problems are also embraced by state standards. A recent report on state standards conducted for the Thomas B. Fordham Foundation by David Klein and a task force he put together reviewed the standards of all 50 states. Their findings described an excessive emphasis on real-world problems. The review warned that, “[e]xcessive emphasis on the ‘real-world’ leads to tedious exercises in measuring playgrounds and taking census data, under headings like ‘Geometry’ and ‘Statistics,’ in place of teaching mathematics.”

The questions the task group will be asking of the existing research include when they are effective, if they are effective, how they are effective and the various interactions involved in the use of real-world problems.

Those who argue for a greater emphasis believe that real-world problems either motivate students, boost student engagement during lessons or raise student achievement by making learning more meaningful—which then leads to long-term knowledge. The task group will review the research on these claims, including a debate from the mid-1990s between John Anderson of Carnegie Mellon and James Greeno of Stanford. Greeno, an educational researcher of situated learning, addressed the literature on real-world instruction, and the two took opposite points of view on what that literature says.

Because Panel members believe that the real-world problems topic should be broadened, the direction the Instructional Practices task group will take is to look at it in terms of the sequencing of tasks (i.e. at the end of a lesson or at the beginning) and whether it takes longer to teach. They also will look at whether there is a subset of research on problem-solving.

Dr. Gersten then gave an overview of how they will handle the social science literature. They will gather the studies and do an initial screening, especially on methodology. They have three tiers of studies that will be potentially used in their analysis. The first tier studies will begin to indicate causal relationships, experiments and quasi experiments. Their standards will be related to those of the U.S. Department of Education’s What Works Clearinghouse. Abt is helping them to determine if studies are flawed and need to be discarded.

Tier two includes other quantitative studies, which could include correlational, longitudinal or descriptive studies, such as the TIMSS. They will not initially receive the same rigorous analytic review that tier one will.

Tier three will be qualitative studies, which include case studies, the more qualitative parts of beat-the-odds school studies, and descriptions of either teaching and learning processes, or student’s perceptions of things in a classroom situation.

Tier one studies will look beyond just the net analysis, to review the context, the type of students, who is doing the teaching and the quality of the mathematical tasks. Mr. Williams added that they have not yet reviewed all the research.

## **TASK GROUP ON INSTRUCTIONAL PRACTICES: QUESTION AND ANSWER PERIOD**

Dr. Ball cautioned about the need to define terms while there is little definition to be found in the field. For example, she stated that real-world instruction is a strange phrase and the group did not offer a definition. Dr. Loveless clarified that what they intend to do is to cast the broadest net possible at the beginning and review the literature when researchers said they have studied real-world problem-solving. They will then take a look at what researchers meant by that term and what was going on in those lessons. The definition of real-world problem-solving may differ a great deal from study to study, and the task group will take that into account as they review their findings. Dr. Gersten added that it is less a framing of things and more a way to sort through the actual studies.

Dr. Schmid stated that problems on tests within the real-world context can be a very thin veneer and they should be careful about how they classify them. Dr. Gersten responded that they are expanding the idea of the kinds of problems students encounter, not the type of computational problems. One other dimension they will look at is the mathematical richness and complexity of the problems.

Dr. Whitehurst commented that with the evidence standards they set--tier one, tier two and tier three--it is important that they be very clear about the context in which one type of study is not as good as another type of study. He stated that it appeared that from their tier system that there could not be a high quality qualitative study.

Dr. Siegler added that their empirical review would be an important part of what their task group can accomplish, but the real-world problem solving question is so vague and multidimensional that it will be important to do some kind of conceptual analysis of what it is. He also noted that some quite high-achieving European countries such as the Netherlands and the Flemish part of Belgium base a large part of their early curricula on rich and complex real-world problems.

Dr. Gersten replied that real-world problem solving provides an engagement and motivational factor, and a way to apply math to situations in chemistry, physics and engineering. Dr. Siegler replied that since there are multiple rationales for real-world problem solving, it is important to enumerate them separately. It is common sense that students have to apply the math they learn to real-world situations.

Dr. Fennell noted that there is a difference between real-world instruction and real-world problem-solving, and these two terms might have been used interchangeably. He also noted in regard to direct versus inquiry instruction, it might be more interesting to look at the elements of direct instruction and inquiry mode of instruction where there is research that shows where each might be important for math instruction. It should not be a “versus” question.

Mr. Williams commented that as a teacher, he sees grant applications or in-service course catalog choices listed using the terms “inquiry” and “student centered.” In today’s school systems, it may be assumed that inquiry/ student-centered is a much better route to take than direct instruction. He also commented that his concern about real-world problems is their sequencing. They are sometimes used to introduce topics, but he feels that at that point, the focus needs to be purely on the mathematics and the procedures involved.

Dr. Benbow reemphasized that when looking at direct instruction versus inquiry based instruction, the task group members have definitional issues to deal with, but they know nobody does just one or the other.

Dr. Loveless agreed that the two methods are extremes and should not be pitted against each other. It is the mix that the task group is interested in. However, in the experiments they do see an inquiry condition and a direct-construction condition.

Dr. Fennell noted that when looking at that research, it would be important to parcel it out to make note of the effective elements of each.

Dr. Gersten added that the horse race study that has been noted was teaching one thing over a period of several days, so it is shown as a component of teaching as opposed to a way to structure a full year.

Dr. Ball commented that she still believes there will be definitional problems, which create issues with knowing what has been implemented and what the research actually shows. She also expressed concern that the Panel was talking a lot about their personal views, and that their responsibility is to report what the research says.

Mr. Williams stated that as the only practicing K through 12 teacher on the Panel, he needs to bring a little bit of opinion based on the reality of what is happening in classrooms.

Dr. Loveless agreed that there are definitional issues and it will be important for the task group to state in their report that a lot of different research gets lumped together under one big term called “real-world problem-solving.” Dr. Schmid commented that legitimate use of real-world context should be recognized as such. Dr. Siegler agreed about the usefulness of those kinds of problems, but he wants to be sure they are categorized correctly. It takes away the meaning of the word if the category is too large. He also added that it will be important to code studies by the amount of time that is taken on the problem as well as if it is used to get away from math to turn it into another activity.

Dr. Gersten added that they should stay away from anecdotes and focus on published research.

Dr. Boykin went back to the issue of cost-benefit analysis, and asked how important that should be to the Panel. Dr. Gersten replied that they will report that as much as it is available and try to think through those implications.

Dr. Loveless added that they almost need a separate subgroup that looks at policy, and says: Now given all of our recommendations, what are the policy ramifications? How will they be implemented? What will those look like?

## **TASK GROUP REPORTS: TASK GROUP ON TEACHERS**

Deborah Loewenberg Ball, Chair; Nancy Ichinaga; Hung-Hsi Wu; James H. Simons;  
Grover “Russ” Whitehurst, ex officio; Raymond Simon, ex officio

Dr. Ball emphasized that teachers are one of the important aspects of the Panel’s response to the Executive Order, because they have an enormous amount to do with students’ opportunities to learn. The task group will review the evidence that helps build the kind of teaching force needed to help American students learn.

Teachers are the largest occupational group in this country, which creates a problem of scale. There are many areas of the country where not only are there teachers who lack the training they need, but also teachers who are wholly unprepared for the challenges they are facing. The task group will need to have the best possible evidence about what constitutes quality teacher preparation, what it means to be a good teacher and what kinds of programs are successful. There currently is a great deal of policy and public interest in teacher education, and there are many debates about the effectiveness of different pathways into teaching, different kinds of programs and different qualifications.

The task group hopes to bring the best evidence to bear on the effectiveness of different kinds of programs and policies that are designed to attract and recruit the best qualified individuals, and prepare, support and retain them in the profession.

The members have initially chosen four critical areas of focus: 1) evidence about teachers' knowledge of mathematics; 2) teacher education and professional development; 3) elementary mathematics specialists; and 3) programs, policies and evidence about alternative ways to recruit and retain effective teachers of mathematics.

The teachers' knowledge in mathematics question will include a review of the studies that help the task group understand what has been learned about the relationship between teachers' knowledge, and what they do in classrooms and what their students learn. There is a substantial difference of opinion about what constitutes the knowledge teachers need that will actually make a difference in their effectiveness with students. What the Panel will bring to bear is the research on what has been shown to affect student achievement and other instructional practice, and how large those effects are.

They will be particularly interested in the ways in which mathematical knowledge has been conceptualized and measured, both for students and teachers. They also will look at whether there are differences across a host of variables, for example, level of teaching, context, students' content areas, whether there are variables that mediate the effects of teacher knowledge or the kinds of knowledge that teachers need.

The second question will address what is known about the programs that increase teachers' mathematical knowledge. Drawing on what is learned from the first question, they will look at the kinds of programs that have been shown to help teachers develop the kinds of necessary mathematical knowledge and skills needed for teaching. Their focus will be on the mathematical knowledge shown to have an effect on what teachers are able to do effectively to help students learn. Specifically, they will look at pre-service programs, in-service programs, professional development curriculum, and requirements for mathematical knowledge and skill.

The third area the task group will examine is sometimes referred to as elementary math specialists, an idea that is referenced in recent reports on math instruction. This term refers to a wide range of kinds of roles. For example, an elementary math specialist might be somebody like an art or a physical education teacher who has his or her classroom, and students move to that classroom. It also might refer to the compartmentalization of the elementary level where teachers divide up the work of different subject areas such as in middle or secondary school. Another might be a kind of model in which a specialist teacher moves from classroom to classroom working with teachers to assist them in implementing the curriculum and/or working with individual students. It was noted that Title I funds could be used for mathematical specialists.

The task group will review the range of models that exists and work to provide some clarity on the definition of a mathematics specialist, both in this country and others. They will look at the evidence on the effectiveness of different models comparatively, based on achievement, if there is any evidence on successful preparation programs and what types of requirements exist to consider someone a mathematics specialist.

Finally, they will look at the different ways to recruit the kinds of people into mathematics teaching who possess mathematical skills and a commitment to teach students. They will look for evidence of program success in recruiting, retention, hard to staff districts, alternative pathways to teaching, salary structures and incentives. They will also look at disincentives to enter teaching.

Dr. Whitehurst added that the task group's interest in elementary math specialists is an attempt to deal with capacity issues. They have reason to believe that many teachers in elementary school have very poor preparation in mathematics, much less the teaching of mathematics. To think about approaching that workforce issue by training a whole new generation of teachers is daunting. So, the question would be how to increase capacity in a realistic way, and it might be that the evidence would show that specialists are a way to achieve that.

Dr. Whitehurst added that a key tenet in No Child Left Behind is effective teachers in the classroom, and the Panel has the opportunity to inform that debate. And as the debate shifts from highly qualified teacher to highly effective teacher, it will also be important to inform that debate.

#### **TASK GROUP ON TEACHERS: QUESTION AND ANSWER PERIOD**

Ms. Jones asked if they will be looking at recruiting people into teacher education majors and what helps people decide whether they will pursue a degree in teacher education. Dr. Ball replied that yes, they will be looking at recruitment into teaching itself. Some of the programs they will be looking at, like Teach for America, for example, are at the initial entry point.

Dr. Siegler asked about math specialists, and their focus on elementary school grades where there currently is not this kind of specialization. These specialists might be more important in middle school and high school, where NAEP and TIMSS show that U.S. math achievement has basically flatlined over the last 20 years.

Dr. Ball replied that the reason elementary math specialists show up is because they are frequently cited as a potential area for reducing the scale of the problems involved in equipping elementary schools with good teaching. She agreed that the data has shown problems in the high school level, yet closer studies of instruction continue to show serious problems in the kinds of mathematical opportunities that students have at the elementary level.

Dr. Fennell noted that the mathematics education of teachers and the principles of standards for school mathematics seem to endorse and support the notion of specialists. He added that he sees two of their question areas, both teacher education and professional development, and recruitment and retention, having an impact on each other.

Dr. Boykin asked about the overlapping goals of the task group on Instructional Practices and the task group on Teachers. He noted that no matter how great

instructional practice is, it is not going to be well-implemented unless teachers are well-prepared to deliver it.

Dr. Ball replied that she agreed that the Panel needed to ready itself for this type of work. She added that if they broadened their question about the nature of teacher education programs, it might properly ask the question: To what extent are those programs teaching teachers to do the things the Instructional Practices task group will find are known to be effective practices? The Panel should find a way to integrate its work over time to address these types of questions.

Dr. Wu stated that they teacher education programs have trouble teaching teachers the basic knowledge they need to do classroom teaching, and if these programs can get over that hurdle, clearly all the other things mentioned will come into focus; but at the moment, he does not believe the country's universities are teaching teachers the basic knowledge they need for the most elementary functioning in the classrooms.

Dr. Loveless clarified that on NAEP, fourth-graders have gained about two years of knowledge since 1992. In the NAEP long-term trend study, that progress has been much less. He then added that there has been a change in grade configurations over the last 30 years in terms of what teachers and students encounter at grade six through eight. Most teachers in grade six through eight, including teachers who are teaching algebra, have multiple subject credentials. They were trained as elementary school teachers, and not in math. He asks that the task group add that to their list of considerations.

Dr. Wu asked Dr. Loveless about the statistics on the percentage of teachers in middle school with the subject major in mathematics. Dr. Loveless replied that the National Center for Education Statistics collects that data through the school staffing survey.

Dr. Ball stated that they would also look at who is actually in the classroom, because part of what is seen across the states is a teacher shortage so great that they do not require credentials.

Dr. Siegler asked if the task group was going to look at licensing requirements and the faithfulness with which universities are enforcing those rather low bars. Dr. Ball replied that they would look at licensure exams and the range of things that are involved.

Chair Faulkner thanked the task groups and called the session to a close. He noted that the Panel would adjourn and go back into task group work. The next public session will be in Batavia, Illinois, at Fermi National Accelerator Laboratory in April.

The session adjourned at 12:45 p.m.

I certify the accuracy of these minutes.

Chair Signature \_\_\_\_\_ Date \_\_\_\_\_

Vice Chair Signature \_\_\_\_\_ Date \_\_\_\_\_

## ADDENDUM: PUBLIC PARTICIPANTS

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