UNITED STATES OF AMERICA
DEPARTMENT OF EDUCATION

NATIONAL MATHEMATICS ADVISORY PANEL

ADOPTION AND RELEASE MEETING

THURSDAY, MARCH 13, 2008

The meeting came to order in Gym 2 of Longfellow Middle School, 2000 Westmoreland Street, Falls Church, Virginia at 9:00 a.m. Larry R. Faulkner, Chairman, presiding.

Panel Members:
LARRY R. FAULKNER, CHAIR
CAMILLA PERSSON BENBOW, VICE CHAIR
DEBORAH LOEWENBERG BALL
A. WADE BOYKIN
DOUGLAS CLEMENTS
SUSAN EMBRETSON
FRANCIS "SKIP" FENNELL
BERT FRISTEDT
DAVID C. GEARY (PRESENT VIA TELEPHONE)
RUSSELL M. GERSTEN
TOM LOVELESS
LIPING MA (NOT PRESENT)
VALERIE F. REYNA
WILFRIED SCHMID (NOT PRESENT)
ROBERT S. SIEGLER
JAMES H. SIMONS (NOT PRESENT)
SANDRA STOTSKY
VERN WILLIAMS
HUNG-HSI WU

Ex Officio Members:
IRMA ARISPE
DANIEL B. BERCH
JOAN FERRINI-MUNDY
RAYMOND SIMON (NOT PRESENT)
GROVER "RUSS" WHITEHURST (NOT PRESENT)

Staff:
TYRRELL FLAWN, EXECUTIVE DIRECTOR
MARIAN BANFIELD
JENNIFER GRABAN
IDA EBLINGER KELLEY
JIM YUN

I-N-D-E-X

P-R-O-C-E-E-D-I-N-G-S

9:05 a.m.

CHAIRMAN FAULKNER: All right. I think we are ready to convene. I'm Larry Faulkner. I'd like to welcome everyone in the room to the twelfth and final meeting of the National Mathematics Advisory Panel. Panel members are present around the table. I'd like to also indicate that one panel member, David Geary, is on the telephone. Are you with us, Dave?

DR. GEARY: Yes, I'm here.

CHAIRMAN FAULKNER: Good. We have signing services available, as you can see here, and we are very pleased to continue with the signing services if they're being used. If not, then we will discontinue them with the proviso that they can be re-instituted at any time. Is there use being made of the signing services?

(No audible response.)

CHAIRMAN FAULKNER: None? Then we will discontinue. Thank you. I'd like to

begin by thanking our panel member, Vern Williams, who is where? Oh, here he is. Okay.

(Laughter.)

CHAIRMAN FAULKNER: Vern Williams for hosting and arranging for us to be here at Longfellow Middle School. Vern is a teacher here at Longfellow Middle School and has been teaching for more than 35 years in the Fairfax County Public Schools, more than 25 years teaching algebra at the middle school level. Right, Vern?

MR. WILLIAMS: Right.

CHAIRMAN FAULKNER: Vern's fourth period students will be joining the audience about 10:10 a.m. They have closely followed the work of the National Math Panel and are especially eager to meet Wu.

(Laughter.)

CHAIRMAN FAULKNER: Get your pen out, Wu.

Longfellow math students are very accomplished. They have placed first in the

state on the Virginia Math League contest for 24 of the last 25 years. Their Math Counts Team is one of the best in the nation, placing first in the state for five of the last six years. So I'd like to also take a moment here to recognize Vince Lynch, who's back, I think, in the corner there, principal of Longfellow Middle School. Thank you so much for allowing us to be here.

(Applause.)

CHAIRMAN FAULKNER: Now, Longfellow not only has an outstanding mathematics program, the school is also noted in science and music. Last year the Longfellow Science Olympiad team won the state championship, and the orchestra, band, and choral programs have also received recognition. So, we're proud to be at Longfellow Middle School. We've spent the last two years working on things to benefit students in schools and I think it's entirely fitting that we're closing this panel's work right here in an award-winning school.

So, thank you, Vince, for allowing us to be with you. Vern, thank you for allowing us to be on your site.

We are here with, really, one item of business and that is to complete our work by actually adopting the report that we've been working on. For the benefit of the audience, I might indicate that this panel has undertaken 12 meetings now, this is the twelfth; 11 meetings before where we have done quite a bit of work. Many members of this audience have been in other sessions and have observed some of that work.

Quite a bit of other work has gone on by e-mail. I noted to the Panel that my own files have about 14,000 e-mail messages for inbound and outbound. So, there's been quite a lot of traffic over the last two years. But we have arrived at a manuscript that the Panel seems to have broad support for. However, we won't actually know that until people vote. So I'd like to recognize our Vice Chair, Camilla Benbow, for a

significant action.

VICE CHAIRMAN BENBOW: Thank you.

Well, I think we've come to that point at the end of our journey where that final decision has to be made. I think we have an excellent report on our hands. I think it's a report that will benefit schools, our children, and our children of tomorrow. I think it's something of which we are all proud. So I move for adoption of the National Math Panel Report, Foundations for Success.

CHAIRMAN FAULKNER: Is there a second?

DR. GERSTEN: Second.

DR. SIEGLER: Second.

CHAIRMAN FAULKNER: So we have the report moved for adoption and seconded. I hesitate to ask if there's further discussion.

(Laughter.)

CHAIRMAN FAULKNER: But I must. If there's no further discussion, we'll move to a vote. Those in favor of adopting the report, please signify by saying aye.

(A chorus of ayes.)

CHAIRMAN FAULKNER: Any opposed, same sign.

(No audible response.)

CHAIRMAN FAULKNER: Any abstaining, same sign.

(No audible response.)

CHAIRMAN FAULKNER: Then, I declare that the report is adopted by unanimous vote here in the room and I think, also, by Dave Geary on the line. Is that right?

DR. GEARY: Aye.

CHAIRMAN FAULKNER: All right. Okay. Well, that's, I think, worth a round of applause.

(Applause.)

CHAIRMAN FAULKNER: Now, I think this meeting, this audience, and the long-term record of proceedings here will benefit from having each of the members comment on their view of important items that they would like to highlight for the audience and for posterity. So what we're going to do is to go

around the table.

I indicated we were going to start on the right and move around the horseshoe, and, what do you know, we've got a circular table or an enclosed loop. So I will have to start somewhere. I think what we will do is to start here with Irma and I'll go back around. I have indicated, for the audience's benefit, to each member that we would be doing this, so each member has given thought to what they want to say and we'll just try to move around.

Now, I've also indicated to everyone that they don't have but five minutes. We have a timer. I'll be watching the timer, and, when you get within a minute, I'll signal to you, but we're going to need to keep people on time. Secretary Spellings will be here later in the morning and we need to mesh perfectly with that.

So, let's start with comments from Irma Arispe from the Office of Science and Technology Policy.

DR. ARISPE: Good morning.

On behalf of Dr. Jack Marburger, the President's Science Advisor in the White House Office on Science and Technology Policy, I would like to thank the Panel for your tireless effort and for your extraordinary commitment, not just to this field, but to good science. I think the product that the Panel has produced -- the products, not just the main report -- but the task group reports will be the foundation of scientific policy deliberations and the setting of federal research agendas for many years to come. I think you should be very proud of yourselves.

I, personally, am just so truly honored to have been among you and working with you for the brief time that I have been here. I want to say that I look forward to working with you in the future and with our federal family represented on the Panel and the broader federal agency community that funds STEM education research to translate, not only the findings and the recommendations

of the Panel, but its tremendous spirit and enthusiasm. And so, I look forward to working with you further, translating that into action.

Thanks.

CHAIRMAN FAULKNER: Thank you, Irma.

Now, let me recognize Susan Embretson from the Georgia Institute of Technology. Let me also indicate that I've been asked to make sure your names are clearly announced. That's why I'm going through this formality here. Susan?

DR. EMBRETSON: Yes. My primary contribution was with the Assessment Task Group and I'd like to say a little bit about our findings.

We had two general areas of interest. One was test content and performance categories, the other was item and test design. Now, I'm sure that other committee members are going to say a lot about the test content and, possibly, the

performance categories. I want to say something special about the item and test design topic.

Now, that category, item and test design, can be interpreted in two different ways. One way is a statistical way, such that a test is constructed to provide optimal information about the central construct. Now, that sounds like jargon, I know, and it is. This is all the statistical hardware of item response theory and we had no reason to look at this because, in education, it has been implemented quite widely in its cutting-edge methods.

However, the Achilles' heel of assessment is the actual item content, what is going on with a particular item. And so when we look at item design in terms of the National Math Panel, we looked at the content of the items and whether or not they had, for example, mathematical versus non-mathematical sources of difficulty. We, of course, want them to have mathematical sources of

difficulty because that is the goal of our assessment. We do not want to have other sources of difficulty that may vary between kids, and would not lead to the best mathematical assessment.

So we looked at this and we were lucky to have a major study come out just as we started our work, the National Assessment of Educational Progress (NAEP) Validity Study. We do, indeed, find that, even in some of the most widely acclaimed tests, there are non-mathematical sources of difficulty that would lead children to not solve the items properly.

So our recommendation was that we need, on the item design side, a much higher level of expertise than has been traditional in the field. We need more mathematicians, more curriculum specialists from higher education, and so on, to review individual items. It's amazing. I've been on many committees to evaluate tests, and all too rarely does anybody want to look at actual items, and I think this should be done quite

more often.

The other thing I wanted to just say a couple of things about was, one aspect of item design that we did look at, as well, was whether or not we had a constructed response or a multiple choice format. There are many kinds of constructed response items and they differ. There's very short ones that you just fill in an answer or you grid in an answer versus where you have a more extended explanation of the phenomena.

What we found is that we did search widely for relevant literature about the comparison of these formats and what impact it has on performance, and we found that we didn't really have a lot of literature that's been published, or that the comparisons were done in such a way that we couldn’t make conclusions about the constructed response really providing more information or different information than standard multiple choice items.

In fact, we found that the

difference between the formats depended entirely on how both formats were designed. So this leads us to believe that, at the current stage, we don't have evidence that suggests that constructed response really gives us much different information. Possibly, multiple-choice items, when they're designed in certain ways, can pick up much of the information that was claimed to be the advantage of constructed response.

I think that's the end of my time. Thank you.

CHAIRMAN FAULKNER: Thank you, Susan.

Let me now turn to Dan Berch from -- Daniel B. Berch it says right there -- from the National Institutes of Health.

DR. BERCH: Thank you, Larry.

First, I want to acknowledge that I'm speaking here as a representative of the Eunice Kennedy-Shriver National Institute of Child Health and Human Development (NICHD) at the National Institutes of Health. We are

grateful to the U.S. Department of Education for permitting us to participate in this effort from its inception, and we believe that the Final Report is highly responsive to the Panel's charge as delineated in the Executive Order.

In my remarks, I want to focus briefly on the Panel's recommendation calling for more federally funded, high-quality research on designing instructional practices for improving the performance of low-achieving students. What I want to emphasize first is that there is a subset of these children whose impairments in mathematical learning are so severe and enduring, as well as unresponsive to routine instructional practices, that they can more appropriately be characterized as having an actual learning disability in mathematics.

A colleague of mine from the United Kingdom, who is a highly regarded researcher in this field, mentioned to me, after visiting the U.S., that he was struck by the

comparative lack of awareness in this country that there are children who can, in fact, be classified as having a mathematical learning disability. Educators and parents need to recognize that, not only are mathematical learning disabilities a reality, but that they are as prevalent as reading disabilities, namely, somewhere between five and nine percent of school-age children.

It is important to understand that these youngsters truly struggle with what would appear to constitute comparatively simple numerical skills, including various principles of counting, as well as the retrieval from memory of even the most basic arithmetic facts. Moreover, in comparison with low-achieving, but non-LD peers, children with a mathematical learning disability possess an even more deficient conceptual understanding of fractions and decimals. These findings are all the more disconcerting, given that the learning of rational numbers is not exactly straightforward even for typically

achieving middle school students.

For close to a decade, my institute, the NICHD, has been addressing these challenges by funding high-quality studies of the origins and development of mathematical disabilities, the cognitive and brain mechanisms that give rise to such impairments and instructional interventions for ameliorating them. Some of the important advances that have emerged from this research are discussed in the Panel's report. Moreover, consistent with the Panel's recommendations, we are currently running a grants competition that will permit the Institute to fund at least five more years of innovative research in this field.

Finally, on a personal note, I must say that working with my colleagues on this Panel has been one of the most challenging, rewarding, and humbling experiences of my career. I submit that any perceived shortcomings in the final report can be attributed primarily to the lack of a

sufficiently rigorous evidentiary base, rather than to a lack of expertise, effort, or commitment to excellence on the part of the Panel members.

Moreover, despite what at times could certainly be characterized as spirited, vigorous, and impassioned exchanges and debate, in my opinion, this group's collective sense of its overarching responsibility to produce a strong and impartial report superseded any individual biases or personal agendas that some may have initially considered bringing to the table.

Thank you.

CHAIRMAN FAULKNER: Thank you, Dan.

I think before we go to Sandy, I want to pick Dave up from the phone, because I don't want to forget him. So, Dave, you're on. This is David Geary from the University of Missouri.

DR. GEARY: Thanks, Larry. Yes, I'm easily forgotten.

I will keep my comments brief. It

hasn't always been fun, but it certainly has been a pleasure to work with this group. It's been a long and difficult process over the past two years. So I'll keep my comments brief and focus on two points.

First, it is clear that the report we are releasing today could not have been completed without --

CHAIRMAN FAULKNER: Dave, Dave, let me interrupt you for a second.

DR. GEARY: Yes.

CHAIRMAN FAULKNER: The sound is not coming through all that clearly. Could I ask you to just try to speak a little bit slower and more distinctly?

DR. GEARY: All right. Should I start over? Is this better? Hello?

CHAIRMAN FAULKNER: Yes, yes.

MR. GEARY: Okay.

It hasn't always been fun, but it has been a pleasure to work with this group. It has been a long and difficult process over the past two years, and so I'll keep my

comments brief and focused on two points.

First, it is clear that the report we are releasing today could not have been completed without an interdisciplinary team. Understanding how to educate millions of children in each and every generation, much less actually achieving this goal, is arguably more complex than decoding the human genome. It is important to recognize, and from now on begin with the assumption that not one of the academic or applied disciplines represented on this panel is up to the task without the expertise of the others. Neither educators nor scientists nor policymakers can independently develop and test programs that will educate American children to their full potential.

My second point does not apply to all educational researchers and certainly not to any of my colleagues on this panel, but I think we should reflect on why this country must constitute panels such as this one and others like it. On reflection, I must

conclude that the necessity of these panels arises because of a failure of schools of education in this country, and many professors in these institutions, to do what the country has asked of them, produce quality educators for our children and train them with sound, proven, educational practices that are scientifically research-based.

Schools are a public good. It's not a playground for trying the latest untested ideas about teaching and learning. Schools of education must take the lead on developing and scientifically testing educational interventions, and we should hold them accountable for the success or failure of their work. Ultimately, when the country no longer needs a National Mathematics Panel or related panels, then schools of education have done what we have asked of them. The continuation of such panels will reflect a continuing failure of these institutions.

That's all I have to say.

CHAIRMAN FAULKNER: Thank you,

Dave.

Let me turn now to Sandra Stotsky from the University of Arkansas and the Massachusetts Board of Education.

DR. STOTSKY: Thank you very much. It has been my privilege and honor to serve as a member of this panel. My comments are reflections on the significance of our report, based on my interests in curriculum and teacher quality. From my perspective, a basic goal of this report is to promote equity in the K-8 mathematics curriculum. We haven't stated this particular goal explicitly, but it is clearly implicit in our recommendations.

From this perspective, one might point to the two landmark reports by James B. Conant, *The American High School Today*, published in 1957, and *The Comprehensive High School*, published in 1967, as relevant historical predecessors to our document. He and the other members of a committee he chaired to study the American high school were also seeking to promote equity. At that time,

the question was how to academically strengthen public high schools in order to broaden access for their students to our institutions of higher education, especially elite ones whose student body then came largely from a longstanding network of private secondary schools.

Conant, a president of a major university, a scientist by training, and a former chemistry professor, was especially interested in increasing the opportunity to study advanced math and science in our public high schools. Among the criteria his committee used for judging the quality of a high school was the availability of a calculus course and a strong course in physics. Capable students couldn't prepare adequately for some of our most demanding, higher education institutions if these courses weren't even offered in the tiny public high schools that dotted our country.

The focus of these two studies was on the specific content of the curriculum.

That is also the major focus of our report, in large part because concerns about the specific content of the mathematics curriculum have received much less attention than matters of pedagogy in the past two decades.

The scope of our report is narrower than the scope of those two reports a half century ago only in the sense that we focus on math education in the schools. But the goal of our report is actually broader, how to strengthen both the elementary and the middle school math curriculum in all our schools in order to democratize access to Algebra I, the gateway course to advanced math and science in our high schools.

I want to highlight briefly what I see as five major, interconnecting recommendations to accomplish this. First, we spell out what the specific components of Algebra I and Algebra II should be. Second, we describe what components of K-7 math all students should master in order to do well in an authentic Algebra I course. Third, we

outline what should be included in mathematics course work for prospective elementary, special education and middle school teachers of math and what they should be tested on for licensure so that they are qualified to teach the foundations for an authentic Algebra I course or the course itself.

Fourth, we urge that all school districts provide an authentic Algebra I course in grade 8, and, fifth, we recommend that schools prepare an increasing number of students for success in an authentic Algebra I course in grade 8, if not earlier.

This is the equity issue, a regularly increasing number of American students should be prepared to take an authentic Algebra I course in grade 8 or earlier just as are large percentages of students in the highest achieving countries on the Trends in International Mathematics and Science Study (TIMSS). More of our high school students can then take the advanced math and science courses in their junior and

senior years that qualify them for admission to the most demanding institutions of higher education in this country.

Thank you.

CHAIRMAN FAULKNER: Thank you, Sandy.

Now we go to Joan Ferrini-Mundy. Joan is representing the National Science Foundation.

DR. FERRINI-MUNDY: Thank you and good morning.

I've had the good fortune as part of my position at the National Science Foundation to serve on this panel for a little over a year, and I've been struck by the fact that, although many different perspectives are represented in this group, we are unified by our common commitment to the need to improve mathematics education. I also think that the commitment wisely required in the President's Executive Order for this group, to work from the best available evidence, has really been invaluable in helping us to avoid slipping

into the ideological positions that sometimes emerge in this type of activity.

I hope that this report will be seen for the careful and substantive, perhaps unprecedented, examination of the best available evidence about mathematics teaching and learning that it is. I hope that policymakers, researchers, and teachers will study the task group reports as well as the Final Report, which include valuable detail and elaboration of the ideas that are presented in the summary form in the Final Report.

I'd like to cite two major contributions that I feel this panel has made. We've come to agreement on ideas about specific mathematics content, particularly the recommended Critical Foundations of Algebra. This level of focus and specificity could have a powerful and profound impact on U.S. mathematics education through its potential to unify curricular directions, instructional practices, teacher education, professional

development, and research.

The report also provides a foundation based on evidence about instructional practices in mathematics and helps to refute some of the starkly dichotomous contrasts that have sometimes been made about instructional practice in mathematics education. I think we can draw the conclusion that, in the learning-as-we-go-along spirit, continued efforts to develop research-based instructional practices and materials and then to study their impact is a promising and needed activity that must continue. We reviewed work that generates possibilities and hypotheses, and helps us to sharply define the kinds of questions that need to be addressed in this area.

I must say that this has been one of the most intense and rewarding professional experiences that I have had and I thank the panel's leaders, Larry Faulkner, Camilla Benbow, and Tyrrell Flawn, as well as Russell Gersten and my fellow panelists for what has

been a remarkable opportunity to learn and I hope to contribute to the ongoing improvement of mathematics education. I certainly know that my colleagues at the National Science Foundation, Director Arden Bement and Deputy Director Kathie Olsen -- Kathie did serve as a member of the panel at the beginning -- have followed this effort very closely, have supported NSF's involvement, and will be eager to participate in continued conversation and efforts to further the work of this group.

CHAIRMAN FAULKNER: Thank you, Joan. Now we turn to Professor Wu from Berkeley.

DR. WU: Thank you, Larry.

My comments will be brief. I think we have written a report that unflinchingly confronts the major issues of mathematics education today. It does so with reason and scientific evidence rather than with any fantasy or what should have been but is not.

Most importantly, it recognizes the central role played by mathematical content in

our ongoing struggle for improvement in mathematics education, a fact you can witness in the first two bullets of this sheet. This recognition is a rare achievement among education documents, if not, indeed, a unique one.

I have given some thought to why this panel managed this singular achievement while others have failed. Certainly, this panel has a rare combination of very knowledgeable scholars from diverse areas, but just as a school is only as good as its principal, any panel writing a report is only as good as its leadership. Our Chair has helped us, and with his able associates, Tyrrell and Camilla, they have helped us navigate very treacherous waters and have led us to safety. He may have been exhausted in so doing, but we on the Panel and the children of our nation can only be grateful for a job well done.

I'm proud to be part of this report, but I must say that in the days of

peer activities I probably cursed this panel every day, if not every other hour. But now that we come to the end, I think I will miss it very much.

CHAIRMAN FAULKNER: Thank you, Wu, I think.

(Laughter.)

CHAIRMAN FAULKNER: Let me recognize Deborah Loewenberg Ball, Dean of the College of Education at the University of Michigan.

DR. BALL: Well, sometimes when Wu was cursing our work, I discovered that Wu was still awake on the west coast when I was getting up on the east coast and we could commiserate. I was honored to work with Hung-Hsi on this report. He was a member of the same task group that I was.

It has, overall, been an honor to serve on this panel and I brought myself as an experienced elementary school teacher, teacher educator, researcher in math education and teacher education to this panel, but, most of

all, today, I think of myself as the Dean of the School of Education of one of the leading education schools in the country and have been thinking a great deal about something that Sandy mentioned and that Dave Geary mentioned, which is the role of schools of education, together with schools, school districts, school leaders, and the rest of the universities they inhabit, to take this report and take action, and I take my responsibility -- and I'm sure my fellow deans do as well -- very, very seriously.

I want to make three categories of comments briefly. One, I want to comment on the things that stand out most to me about our report. I want to comment briefly on things that will deeply disappoint me if they are the product of what we've done, and I want to make one or two comments about the things I think this report can enable.

The things that stand out to me about our report are, first, that when you look at the table and see the diverse people

who populated this report, the fact that we've been able to vote unanimously to adopt that report and to reach the significant areas of agreement that we have is a remarkable feat and I think that shouldn't be overlooked.

I think, second, this report puts to rest some important myths that have plagued our efforts to make improvement in mathematics education. For example, that math teaching, as Joan said, can't be reduced to simple dichotomies. As long as we do that, we fail the children of this nation because we don't actually work on instruction.

And, third, what stands out to me is that there is a pressing need to build on the agreements that this panel has forged, to build the knowledge and the will and the action to actually make progress on mathematics education in this country to work on instruction, to work on the delivery mechanisms, and to equip our nation's teachers and those who work with them to deliver the knowledge that we've been able to forge about

mathematics content and about learning.

Now, what would disappoint about me about our report? It would disappoint me deeply if this is reduced to yet another math war story. This is not a math war story. This is a story in 2008 about the areas of agreement that we are able to discuss based on the research that's been done up to this point. It would disappoint me if people spent their time looking for all the areas of disagreement among panelists. Certainly there were many areas of disagreement, and if people spent all their time trying to dredge up the areas we didn't agree on, we won't be able to use this report in the way it deserves.

It will disappoint me if the report is reduced to simplistic slogans or messages about calculators or teaching styles, and it will disappoint me if our report is not used to make progress. I actually hold all of us as panelists and all the communities who have interest in math education accountable for doing the things I just said.

Finally, I'm going to comment on just a few things I think this report can enable. First, I think it can enable the leveraging of collective will to begin building a much more common curriculum in this nation in mathematics. The founding creators of our school system hoped in the 1840s to build a common school system. We still haven't achieved that. As Sandy said, we have significant equity issues and significant differences in our country in math in particular.

Does anyone really believe that mathematics in Idaho is different than in Louisiana? We clearly -- and I'm disappointed in this -- are not yet ready to follow our colleagues in the rest of the world in building a national curriculum. But we could use this report to take the steps forward that would enable us to say that there is a common set of topics and skills that are foundational for kids' success and we're going to teach them in every school in every district in

every state in this country. And I think, as an elementary school teacher, I take as centrally important our identification of competence with fractions as being absolutely essential to kids' progress.

A second thing I think this report can enable is recognition of the central role of teachers. I think this report can be read to highlight the significantly professional work that teaching is. It means that we need to take the report and work to build the kind of significant, disciplined knowledge, the research that we need on instruction. I'm struck by the need for us to develop high quality research on instructional methods that enable teachers to teach complex mathematical outcomes to students.

I was very impressed at our failure to actually unpack what it takes to teach complicated mathematics directly and explicitly to students. There simply wasn't the research base for us to do that. We also need similar research on teacher education.

In no other field would we dare to think that common sense and a bit of being smart could enable you to do such skilled work. We wouldn't do that about plumbing. We wouldn't do that about medicine. We wouldn't do that about hairdressing. And yet, somehow, in teaching, we continue to think we're going to solve the teacher quality problem by finding smart people and putting them with our nation's children. This report makes clear and shows us the way that we're going to need to work to build the instructional methods and the methods of training teachers, 3.7 million of them, to be able to do that.

Third, I think this report enables us to make fast progress on one of the most straightforward parts of the teacher quality problem, and that is teachers' mathematical knowledge. No one could disagree that teachers need mathematics to teach. How could they teach if they didn't know what they were teaching? But the report finally makes clear that it's not just the numbers of courses that

elementary school teachers take that will enable them to be effective with students.

Let's stop making a run at the wrong solution for a critical problem. Let's work with deliberate speed toward ensuring that elementary school teachers have the mathematical knowledge they need to hear their students, to teach the content clearly, to be precise, to teach them to reason and to solve problems and have the skills they need. That is something you can read as agreed upon by this panel.

And, finally, this report can be used to build the research capacity that we need around this country in schools of education, in research firms, in school districts by practitioners, that could enable the same kind of progress that we made in the medical profession almost a century ago. We need practice-based, practice-oriented, usable research that enables practitioners to not make up their own ways of doing things, but actually have proven methods that help

students to learn.

No report like this would have been possible without the leadership we've had, and I also want to acknowledge the amazing support we had from the consulting firms who worked with us. Some of us, most of us, actually, had day jobs during the last two years, and without the consultants we had, we would have had great difficulty in identifying the resources we needed to scrutinize and examine in order to reach the conclusions we have.

It's been an honor to serve on this panel. I am, actually, quite glad it's over, however.

CHAIRMAN FAULKNER: Thank you so much, Deborah.

Our colleague, Wade Boykin, has just been able to join us. Wade, I'm going to skip over you and let you get settled and then come back to you.

So I will go to Doug Clements from the State University of New York Buffalo.

DR. CLEMENTS: Thank you. Flannery

O'Connor said, stories are considered not quite as satisfying as statements, and statements are considered not quite as satisfying as statistics; but in the long run, a people is known not by its statements or its statistics, but by the story it tells.

We on the National Math Panel reviewed thousands of studies and believe that our report's statements and statistics are usually satisfying and definitely useful. However, we were necessarily limited by the daunting scope of our work and other research approaches - as rigorous in their disciplines as those we reviewed - are also necessary components for a full scientific knowledge of mathematics education. The field needs to follow comprehensive research frameworks in its future research and development efforts to tell a complete story.

Technology is a case in point. The rigorous research reviews point to some effective approaches and some important cautions, but the full story reveals other

effective approaches, and, more importantly, reveals why some are effective and some are not.

A main story you'll read when you read the report is that students need to simultaneously develop conceptual understanding, procedural skill, and problem-solving ability. This story must be told and retold accurately to end the unfortunate habit of false dichotomies, the simplistic black/white divisions that harm our children's mathematics education.

I hope the story that's eventually told about this National Math Panel Report is that U.S. education becomes more student-centered in the broader and more powerful sense often seen in East Asian countries. That is, teaching is not just about what teachers do, but more about how teachers can encourage students to engage in effective learning activities.

Learning ultimately depends on what students do, and the teachers, and all who

support the teachers, at every social/political level, need to structure all aspects of the teaching/learning context to maximize students' engagement with mathematics. This is a vision for America's future story. Our country now needs the courage and will to realize this vision, understanding that profound efforts and changes will be needed at every level of the educational enterprise.

If we do these things, we'll have more personal stories, such as Chandra's. At the beginning of her school year, when asked, Chandra did not know how old she was. After just months of participating in a research-based, technology-enhanced math curriculum, she told her teacher, I'm five now; five, that's only two less than my sister is now; she's seven.

Thank you.

CHAIRMAN FAULKNER: Thank you, Doug.

Camilla and I are going to go last,

and Vern has asked to go at a specific time, so we're going to go to Valerie.

This is Valerie Reyna, member from Cornell University.

DR. REYNA: Buenos días, senoras y senores. Muchisimas gracias por todo su apoyo.

Good morning, ladies and gentlemen. Thank you all for your help and support, the Panel staff, my fellow members, and leadership.

I'd like to make a few comments as Chair of the Subcommittee on Standards of Evidence. First, it would have been easy for this panel to give in to the seduction of mediocrity and compromise. Low standards are easy, and it was touch and go for a while. But due in no small part to the steady leadership of our Chairs, Larry Faulkner, and Camilla Benbow, and Tyrrell Flawn, we did the right thing in the end. I want to thank you so much for making that choice.

Today, we stand strongly united in

support of scientific rigor. We stood up for standards. As you know, although much of the research we reviewed was eliminated because it was not relevant to our questions, the truth is, we were forced to eliminate a great deal of educational research because it was of low quality.

So one of our most important contributions going forward is this commitment to scientific rigor. Rigorous research generates the proven practices that improve achievement, and is ultimately the foundation for America's success.

Speaking of the future, we must continue to stand for standards in three ways:

1) We must increase the amount of experimental research that tests hypotheses to prove that some ideas about education are wrong. Disconfirmation is the source of progress in all sciences, including the educational sciences.

2) We need much more research about the mechanisms of learning, how and why

learning occurs. Learning is the alpha and omega of education. It is the goal of education. Learning is the destination we want to get to, the omega. Learning processes are how we get there, the engine of education. You cannot build an engine without understanding internal combustion, and you certainly cannot improve a process you do not understand.

3) The next director of the Institute of Education Sciences, a specialized position, must be an accomplished researcher, a clear-eyed, hard-nosed, bona fide scientist. It will be very hard to fill Russ Whitehurst's shoes, but it is imperative that his good work be continued.

In conclusion, on behalf of all the wonderful folks who attended our meetings, who sent us comments, the parents, the professionals, and most of all, on behalf of America's students, I would like to ask you all to stand for standards, and I mean both content standards and standards of evidence.

Thank you my esteemed colleagues. There are no words to express my respect for you. Thank you for making the hard choices.

CHAIRMAN FAULKNER: Thank you, Valerie.

Now, we turn to Russell Gersten. Russell is Professor Emeritus from the University of Oregon, and now with the Instructional Research Group.

DR. GERSTEN: Several panelists have talked about the rigor, and the fact that we've stuck with rigor in conducting our reviews, and my sense is that, when we look at this report ten years from now or so, that will be one of the major accomplishments of that. There has not been anything like this in mathematics instruction before. The paucity of studies with adequate rigor was no surprise to any of us.

One of the interesting things in our group that Joan and I co-chaired, when we got to the area of learning disabilities, was that there were many more studies regarding

students with learning disabilities than for average students, above-average students, and below-average students. There's a reason for this.

The office of special education programs, even during an era in the 1990s, where there was a devaluing of scientific research, ignored that trend, and actively supported rigorous research, for both students with learning disabilities, and their colleagues. In fact, I think in particular Marty Kaufman and Louis Danielson, who directed that office, one or the other for over 30 years, needs to be appreciated, and I think the findings from this will be.

In terms of what we actually found in the area of learning disabilities, there was a consistent finding, and it's both nice that you get, as Valerie would say, a replicated consistent finding, but there's a downside to that. The finding was that explicit instruction consistently helps students with learning disabilities and

students who are in the lowest quarter or so of their classes.

The downside of that is no two people define explicit instruction exactly the same way. We noted, as we went through the studies, that it kind of loosened up, and in some ways incorporating advances for cognitive science, the more recent studies, so I think that is very important. One thing I see the field doing is trying to unpack the concept of explicit instruction.

The other consistent finding, and it is a significant finding, is one of the few areas where we really say we have a replicated, consistent finding from high-quality experimental research. This finding is that, when teachers use formative assessment, student achievement in mathematics increases significantly. That is particularly true when they have some tools that go along with it, either computers helping them think of which kids need more help, or which groups need more help with these problems, or even just simply

a little chart, or a prompts sheet for a teacher to review what to do with the data.

The fact that this finding is replicated is, again, very, very good news. It certainly gives states and school districts a way to act, a place to act. The only downside of this is it has so far only been done with one type of formative assessment. It's a very valuable type. It's where it's a sampling of the year's states' standards, and can easily be aligned to our benchmarks in our report. But there are other formative assessments that have not been studied, that are developed in part of most course series, and it's very, very important that people start doing those.

I think at least we have two pretty solid bedrock findings in instructional practice.

CHAIRMAN FAULKNER: Thank you, Russell. Now, Robert Siegler, from Carnegie Mellon University.

DR. SIEGLER: One of the most

moving experiences having to do with participation on this panel is a sense of the immense patriotism that's present in the United States, not only among people on the Panel who spent hundreds, and, I suspect in the case of Larry and Tyrrell, probably over a thousand hours on this for zero dollars and zero cents. That's the sum total of what all of us gained financially from participating. Economists would say we're the worst idiots in the universe.

But also on the part of the immense amount of participation of people who came to meetings throughout the country for no reason other than that they were interested. Many testified, a larger number did not, an even larger number were unable to come to meetings, but they sent e-mails. There’s just incredible interest, broad and deep, in increasing our children's ability to do well in mathematics, and I was really moved by that. I knew some people cared. I was amazed by how many, and how deeply.

There are many, many important lessons in this report. I'd like to call attention to two that I think are particularly important.

One of them has to do with the vital need to increase preschoolers' ability and their readiness to learn mathematics. This was, it turned out to be, one of the most firmly grounded in research areas of all those that the Panel addressed. One of the things we found out was that many preschoolers enter school with quite a bit of knowledge of mathematics that helps them learn once they get there.

They know how to recognize numbers. They know how to count objects, and recite the number string. They know which numbers are bigger than which other numbers. They can do a few simple addition and subtraction problems. But many others cannot, and this is especially true of children from low-income backgrounds.

The fact is, these deficits

wouldn't matter so much if they went away quickly when the children entered school. But another firm lesson of the research is that they don't. The same children who are behind when they enter school in kindergarten remain behind in third grade, sixth grade, eighth grade, and high school. It's very difficult to overcome these early deficits, and, in fact, they grow ever larger. The children who start out behind, fall further behind.

It's also the case that relatively brief interventions, interventions on the level of an hour or two, can make a substantial difference in low-income children's knowledge of mathematics, and their ability to learn more mathematics. It's also true that there are several very well documented programs that are curricula for preschoolers, which help achievement in an even larger range of domains. Both these kinds of programs need to be implemented on a wider basis.

The second main point I'd like to

make, that Deborah alluded to earlier, and several others just in passing, is the importance of improving elementary and middle school students' understanding of fractions. I was very surprised that such a range of people on the Panel agreed on this. This was probably the single point that everyone on the Panel would immediately sign on to, the mathematicians, the public policy analysts, the math education people, the cognitive psychologists, teachers, everyone agrees that fractions is a vital bottleneck in our students' ability to learn algebra.

When we surveyed algebra teachers in a nationally representative sample carried out by the National Opinion Research Committee, they found that algebra teachers rated their students' understanding of fractions, that is, their poor understanding of fractions, as one of the single largest impediments to their succeeding in algebra.

Students in the U.S. receive algebra instruction again and again. They

receive it in third grade, fourth grade, fifth grade, sixth grade, seventh grade, and in eighth grade. Yet, this spiral curriculum isn't working. Many students emerge from this when they take algebra in eighth, or more often in ninth or tenth grade, still not understanding fractions that they need for algebra.

This lack of conceptual understanding of fractions is probably the single biggest impediment. For example, a majority of eighth graders will, when asked to estimate the closest answer to 12/13ths plus 7/8ths, will choose 19 or 21. They'll add the numerators or the denominators. They don't even view fractions as single numbers.

Similarly, a large percentage of fifth and sixth graders, a majority, will say that .345 is bigger than .67, presumably on a flawed analogy with whole numbers. These are very serious problems. If you really believe this, you cannot possibly understand fractions, and this is really going to harm

your ability to understand algebra.

It also harms your ability to learn fractional arithmetic, which is why students persistently confuse the algorithms for addition, subtraction, multiplication, and division. They quite literally make no sense to them.

Research on how to improve elementary/middle school students' learning of fractions is urgently needed. We don't yet know how to do this, but we sure better find out fast.

CHAIRMAN FAULKNER: Thank you, Bob.

And now we turn to Tom Loveless from the Brookings Institution.

DR. LOVELESS: I want to thank my colleagues for the professionalism they've exhibited over the last two years, and especially to Larry Faulkner for his wise stewardship of our group. I value the experience of serving on the Panel, and also the friendships that I have made.

I've read some press accounts

recently that this report will end the math wars, and I want to go on record as dissenting from that point of view. First of all, we didn't seek to do that. We did not wade into the arguments that are present in the math wars, and say, well, on this issue, one side is right, and on another issue, another side is wrong.

The math wars, and the reading wars, and all the other curricular wars, and they extend across all subjects that are taught in schools, are not just about best approaches. They reflect values and ideologies. They reflect beliefs about what knowledge is of most worth. That was Herbert Spencer's definition of these conflicts. They reflect disagreements about the role of teachers and students, and education's place in a democratic society. This panel is not going to settle such arguments, nor should we.

The report represents our best effort at dispassionately summarizing what is currently known about mathematics education.

Much of the report is based on empirical evidence, but it is also informed by professional judgment. Arguments about beliefs, which historically sit at the center of debates over what to teach and how to teach it, are best settled by elected bodies and representatives, and in education, in particular, that means legislatures and school boards.

I think the main message of this report is simple; content is king. This report defines the content of algebra and the skills and knowledge leading up to the study of algebra. The National Math Panel Report finds that important tests, such as the NAEP, the National Assessment of Educational Progress, do not currently assess the content that we're recommending. So the message is, get the content of the curriculum right, and then give tests that assess that content, and I believe these are the two most consequential recommendations in the report.

Now, how should this report be

used? There is something for everyone. Federal policymakers should immediately begin a review of NAEP and the National Science Foundation projects in mathematics education in K-12 to determine whether they are in accord with the findings laid out in this document. State policy officials should sit down with this report, and examine whether their state's math standards or curricular frameworks reflect the mathematics described here for K-8 math.

School boards should do the same, and examine the chapters on how children develop mathematical abilities, and what is known and not known about instruction, so that we can sweep away policies that support fads and myths. Too often, the beliefs of school principals, math specialists, and school superintendents are based on little or unreliable evidence.

Teachers can use this document to check the content of their courses, to support lobbying efforts to get stronger content into

classrooms, and to protect themselves from unwarranted mandates. Parents can use this document as a guide to what their children should be learning in mathematics.

Finally, as many of my colleagues have said, more research is needed in the field of math education. This panel's report represents a first step, but only a first step in improving the mathematics education of American youth.

Thank you.

CHAIRMAN FAULKNER: Thank you, Tom.

Now we go to Frances “Skip” Fennell, from McDaniel College, and during the past period of time, President of the National Council of Teachers in Mathematics.

DR. FENNELL: Thanks, Larry.

As with my colleagues, I have appreciated the opportunity to serve. It has been all those things, enjoyable at times, frustrating a lot of times, and also a tremendous learning experience, I think, for

all of us. Like my colleagues, we wouldn't have this report without the able leadership, not only at the head of that table, but kind of scattered around this room in a variety of ways. As I think the thirteenth speaker now, I'm in one of those positions where many of us have been, well, you know, I was going to say that kind of thing. So I think, partly because this is probably how our report, at least in the next 48 hours, will be disseminated anyway, and that's in sound bites, I'd like to give some sound bites, or at least lead with words that I think are important. And I'm going to use the word validation twice.

Validation, recognition and support for the importance of focus and coherence within the pre-K up to algebra curriculum, as noted by the work of Conceptual Knowledge and Skills Task Group, and as was also noted and affirmed in the work of the subcommittee on instructional materials.

States and school districts must

strive for greater agreement regarding which topics will be emphasized and covered at particular grades. Only then will publishers produce programs that include a clear emphasis on the material that these states and districts agree to teach in specific grades.

Validation. The curriculum must simultaneously develop conceptual understanding, computational fluency, and problem solving, and that debates regarding the relative importance of these aspects of mathematical knowledge are misguided. Furthermore, teachers should emphasize these interrelations: conceptual understanding of mathematical operations, fluent execution of procedures, and fast access to number combinations together, which support effective and efficient problem solving.

Recognition and Caution. Recognizing that the critical foundations found in this report are but a subset of the full pre-K up to algebra curriculum -- and that's the caution part -- but knowing how

important, how foundational such work with whole numbers, fractions, and particular aspects of geometry and measurement are as critical prerequisites to algebra. Knowing that the benchmarks will serve as useful guideposts for educators and parents as we strive for focus and proficiency with foundational topics, regardless of where a child lives in this country.

The Graduate. How does this reference to Dustin Hoffman's classic film fit? Do you remember the scene? "Ben, it's about plastics." Well, fast-forward that DVD. Now it's teacher, teacher/leader, teacher/educator, and it's about fractions, defined here as fractions, decimals, and percent. Do them well, develop them, understand them, and know how they're interrelated. They link so critically to higher-level mathematics. The work of the Conceptual Knowledge and Skills group, the Learning Processes group, the Assessment group, the teachers survey, all point, as Bob

just indicated, to the important role fractions play for all of our students. It's about fractions.

Sense-making. Context really does matter when solving problems. Yes, more research is certainly needed. But given the constant demands from students, literally every day, probably in Vern's school, when am I ever going to use this stuff? The findings here represent a first step with the importance of real world problem solving, and putting math in a situation where students can actually solve the problem. I think this is an important step.

Importantly, from the Learning Processes group, yes, effort matters. All children must not only be provided with the opportunity to learn important mathematics, but we must recognize that the effort students put into learning makes a difference, a difference in their achievement, and importantly, in their own self efficacy.

Teacher/educators take note. While

teaching well requires substantial knowledge, existing research on the aspects of teacher education, including standard teacher preparation programs, alternative pathways into teaching, support programs for teachers, and professional development, is not of the rigor or quality to permit this panel to draw conclusions about the features of professional development and training that have effects on teachers' knowledge, their instructional practice, or their students' achievement. If this is not a clarion call for research in mathematics teacher education, I don't know what is.

And finally and importantly, this panel has worked extremely hard for close to two years. The work has not been easy. The findings, the story, the takeaways from this effort must not be reduced to some sort of treaty or compromise in the so-called math wars, or yet another shop-worn story about reform versus traditional mathematics. I can now refer to that as the dichotomy thing that

you were mentioning earlier. To do so trivializes this effort, and frankly, disrespects my colleagues all around this table, and all those associated with this panel.

This work is about important foundations that lead to algebra, and about learning, teaching, and assessing mathematics. These foundations for success are the necessary ingredients for every student in every classroom in this country.

Thank you.

CHAIRMAN FAULKNER: Thank you, Skip.

Let me go now to Bert Fristedt. Bert is with the University of Minnesota.

DR. FRISTEDT: Thank you, Larry. Our report is addressed to a variety of audiences. I'll focus on two: the preparers of books for K-12 math education, and the creators of NAEP and the various state tests.

It is important that the coherence and focus encompassed in the Critical

Foundations for Algebra portion of our report be reflected in the organization of and emphases in K-8 school materials, and in the types of items on assessments at various grades. I am aware that there are other important aspects of K-12 math education besides algebra and the paths leading to it. For these topics, data, probability, trigonometry, and geometry beyond the aspects mentioned in the Critical Foundations, coherence is also essential, requiring well-considered sequencing of topics.

As indicated in the Instructional Materials portion of our report, tables of contents in textbooks should reflect a coherent organization. In particular, teachers, and especially math curriculum coordinators, should be able to discern from tables of contents a clear path through the items mentioned in the Critical Foundations for Algebra, both within grades, and also from grade to grade.

Even with good tables of contents,

clear paths toward desired objectives can be severely obstructed by distractions in textbooks, which are only tangentially related to the essential mathematics at hand, even if the distractions themselves are quite interesting. For instance, in an example about children arranging some collection of objects, it is the objects, possibly in some arrangement on a table that might warrant a picture or diagram, whereas a picture of the children themselves can cause loss of focus on the math.

With respect to instructional materials, our report is very critical of the large numbers of pages in some books. The comments I have made about coherence, and the undesirability of tangentially related distractions, are intertwined with the length issue.

While word problems constitute an important part of mathematics, the Instructional Materials section of the report also advises, for math textbooks, relatively

few applications where the primary challenge is posed by the science or social studies content. On the other hand, learning - and it is not an easy thing to learn - how to convert relationships described verbally into mathematical symbolism is a central feature of mathematics.

The distinction I have just mentioned between math focus problems having words, and those having words for which math is peripheral, is even more important in connection with assessments, since, for broadly given assessments, it is certainly the case that there will be students at the same level mathematically whose general, cultural, science, or social studies background are vastly different, it is appropriate that some items on state assessments, and NAEP, be on the difficult side. But the difficulty should arise out of the mathematics itself, rather than some puzzle-type setting, or non-math knowledge that should not be expected to be taught in all classrooms.

On a more specific issue, I fully agree with the recommendation in the Assessment portion of our report that probability not be assessed on NAEP at the grade 4 level, since basic knowledge of fractions and their operations is required for even an elementary, coherent understanding of probability. I say this as a mathematician who has a tremendous liking for probability, and who has done probability research for several decades.

A sketchy introduction to probability that ignores some subtleties of language can cause students to get long lasting, erroneous impressions. For instance, students might come to believe that it is quite likely that five heads will occur in ten flips of a fair coin, whereas the actual probability of that occurrence is less than one-fourth.

Thank you.

CHAIRMAN FAULKNER: We'll now go back and pick up Wade Boykin, please. Wade is

from Howard University.

DR. BOYKIN: Thank you, Larry.

Let me start out by apologizing to my colleagues on the Panel, and to the audience. I'm a local guy. I had to deal with a family emergency this morning. Sometimes life gets in the way.

But Larry, I also want to vote yes on the adoption of the report.

(Laughter.)

CHAIRMAN FAULKNER: Thank you.

DR. BOYKIN: I want to get my vote in.

CHAIRMAN FAULKNER: Your vote is gratefully received.

DR. BOYKIN: Thank you. Broke the tie.

(Laughter.)

DR. BOYKIN: It's been both an honor and a privilege to serve on the Panel over the last two years. Quite frankly, I have been genuinely thankful for the opportunity to serve. It has truly been a

learning experience for me, a mind-expanding, eye-opening experience for me. I feel I took part in a very remarkable process, a collection of professionals who function from different disciplinary perspectives, who brought to bear different intellectual priorities, who saw the issues from often different conceptual frames, who spoke in a variety of professional lexicons, were still able to find common ground to converge their efforts with respect to the pursuit of what will actually lead to better mathematics learning and achievement outcomes for American children in general.

Yet, it is also crucial for us to acknowledge that, within our society, persistent math achievement gaps exist, gaps that simply cannot be easily explained away by socio-economic status, by income level, or by lack of material resources. And in looking to close these important gaps, research clearly suggests that there seems to be promise, promise in paying close attention to the

dynamics of classroom life in terms of the daily transactions that go on between teachers and students, and among students themselves. These transactions are to be understood in terms of cognitive, but also in terms of social, and motivational, and affective considerations, and also, that there is promise, and that it seems likely, that math outcomes, to a notable degree, are linked to alterable, changeable factors, rather than fixed factors. Some of the changeable factors are student engagement, effort, self-efficacy, and these factors are impacted on by the quality and the quantity of teacher and peer classroom support.

I'm also struck that what we know that seems promising to raise achievement and close gaps has actually been available in the research literature on learning processes for quite some time. But for whatever reasons, these research findings have simply not substantially been translated into educational practices in American classrooms. This matter

requires our future, concentrated, and concerted attention.

Well, all in all, my esteemed colleagues put forth considerable effort, expended considerable intellectual sweat, and I believe that our work over the last two years has been a successful enterprise. Although there still is a lot that is not yet known about enhancing math outcomes, I do believe we know a lot more now about the foundations for success than we did when we first started on this collective journey just two short years ago.

Thank you.

CHAIRMAN FAULKNER: Thank you, Wade.

I now turn the microphone over to Vern Williams, our colleague from Longfellow Middle School.

MR. WILLIAMS: Well, I get to be almost last. I wanted my fourth period class to be here when I spoke, so this is the first time people were actually going below their

time limit, and I thought we were going to end up getting to me before they came here. So this was the first time that I actually wanted Panel members to speak for a long time.

(Laughter.)

MR. WILLIAMS: So I've been teaching in Fairfax County for about 35 years, and the school system has allowed and encouraged me to be the best teacher possible, and it's only fitting that our Superintendent, Jack Dale, be here today, so I'd like to acknowledge him, and of course, my Principal, Vince Lynch. I'd also like to acknowledge one of my former students, whom I taught back in the '80s, and who is now a math teacher at our school, Eugene Huang, who is here also with his fourth period class. So he's in the back.

(Applause.)

MR. WILLIAMS: Mr. Huang, would you raise your hand? Make some sort of movement back there.

And, most of all, I'd like to acknowledge the most important people here,

and that's, of course, the students, who I'd like to welcome, my fourth period class.

(Applause.)

MR. WILLIAMS: So the debate over how to teach mathematics to our nation's students will continue, but there should be no debate over its content, which you've heard quite a bit today. I never envisioned that mathematics content could ever be compromised or trivialized, until I woke up one morning and discovered that some mathematics educators had decided that correct answers were overrated.

Some of those educators also decided that Algebra I topics, such as rational expressions, and certain forms of factoring, were also overrated, and should be deleted from the course. Algebra, as taught in many schools, was redefined to include data analysis, pattern recognition, and a host of other topics, while some of the more familiar topics were deleted.

At our first meeting, I suggested

to the Panel that we define algebra, and I commend the Panel, especially the Conceptual Knowledge and Skills Task Group, for doing precisely that. Students with a strong background in algebra, as defined by the Panel, will be well prepared for the rigorous math courses that they will study in high school and college if we are to compete globally in science, engineering, and technology.

I feel that teachers of math, at both the middle and elementary school levels, will be pleased that the Panel has suggested, through the Critical Foundations and topics of algebra, a focused and coherent body of knowledge and skills that will include computational fluency, conceptual understanding, and problem solving. Hopefully, teachers will glean from our report that it is not only acceptable, but crucial, to give major importance to mathematical content, and to require correct answers from their students.

I will now read, verbatim, the essence bullet from the Instructional Practices group, of which I was a member, under the principle messages section of our report.

"Instructional practices should be informed by high-quality research, when available, and by the best professional judgment and experience of accomplished classroom teachers. High quality research does not support the contention that instruction should be either entirely child centered, or teacher directed. Research indicates that some forms of particular instructional practices can have a positive impact under specified conditions."

I hope that everyone takes from our report that classroom teachers should have a major role in deciding their instructional practices.

And lastly, I'd like to state to the Panel, I've been asked many times, were you intimidated by some of the people on the

Panel? When you read the list of biographies, you'll see doctor this, and doctor that. I think even Wu has a doctor in front of his name. And then there's Vern Williams, middle school math teacher.

When you're around such high-powered people, do you ever feel intimidated? And I suspect the Panel can probably answer that for you. If anything, I was probably a bit the other way. And I guess the reasoning is, if you teach middle school math for 35 years to seventh and eighth graders, nothing on earth will ever intimidate you.

(Laughter and applause.)

CHAIRMAN FAULKNER: To the contrary, Vern; I have been intimidated by you.

(Laughter.)

CHAIRMAN FAULKNER: Let me now turn to Camilla Benbow, Vice Chair of the Panel.

VICE CHAIRMAN BENBOW: God morgon damer och herrar, flickor ochpojar!

Good morning, ladies and gentlemen,

girls and boys.

Let me begin by saying that it was an honor to be asked to serve on the Math Panel, and to be able to assist our strong and effective leader, Larry Faulkner. It's been a pleasure.

And for me, it has been a simply amazing experience. I have never worked so hard on a committee in all of my professional life. No wonder. We were asked to cover a lot of ground, content, learning, instruction, assessment, and teacher education, and we were to do it all in less than two years. And we did it all.

Even though we began our journey starting from such different places, different perspectives, and different backgrounds, yet, by the time we reached the end of this adventure, we had pulled together, we had hammered out a consensus on issues where agreement is hard to achieve. We all came to hear the signal emerging from all of the noise in the research base, and we could hear that

signal, even if faint at times, because we reminded ourselves that, when we are making recommendations for policy, which was our task, the research evidence that enables you to do that must come primarily from experimental and quasi-experimental designs.

I am proud of what we accomplished. So I hope that, while our journey comes to an end today, another journey begins for others, that others will initiate the dialogue necessary for implementing what we have learned in the past two years, and for moving forward the agenda of making our schools into evidence-based organizations. I think our collective work should be seen as a model for how this can be done.

In addition, for someone who leads another leading college of education and human development in this country recognized for its work in special education, and someone who has worked with mathematically gifted students for her entire professional career, it was personally gratifying to see that we made

recommendations that did not just apply to the typical student in our classrooms, if there is such a person, but also recommendations applicable to those who differ significantly from the norm.

Our recommendations span the range from benefiting those with learning disabilities, or who are at risk, to the gifted students. With regard to the gifted - that's my area - there was support for allowing students to accelerate, if they so choose, and some indications that enrichment can be beneficial, as well, especially when paired with acceleration. Unfortunately, a story we heard over and over again, there weren't that many studies we could consult on that topic, but there was a signal we could detect, nonetheless.

I led the task group on assessment, so let me comment there. To me, this was a critical assignment, as what we measure often drives instruction. It is akin to the budget of many organizations. We have a strategic plan, but the budget is actually the strategic plan. How we

spend the money actually shows where we are heading, our priorities, and what we're doing, whether intentional or not.

In education, what we measure is what we value, and what people will do. We felt that high-stake tests, like the NAEP and the state tests, could do a better job of measuring those skills and concepts that really count, that we think are critical to success in algebra. And, believe it or not, I, too, mentioned that one of those things was fractions. Moreover, we came to the conclusion that current tests need to be improved in quality.

My last observation: we could not resolve cleanly many of the big debates in math education. The research base just was not there. Over and over again, we lamented the thinness of the evidence. We can only blame ourselves. We have not invested sufficiently in educational research to build a solid research base. I hope we will become serious about this.

Thank you.

CHAIRMAN FAULKNER: Thank you, Camilla.

I forgot to give your affiliation. You're Dean of the Peabody School of Education at Vanderbilt University. Do you say Peabody, or Peabody?

VICE CHAIRMAN BENBOW: Peabody in the South.

(Laughter.)

CHAIRMAN FAULKNER: All right. Well, we've heard from everyone on the Panel except me, and I am going to make some comments, but I'd like to begin by noting to the audience that this report that you have in your hands is what the Panel has distilled, and refined, and taken as its own from a much larger body of material that will also appear.

Underneath the Panel's work as a whole is the work of several subcommittees and task groups. Five task groups were developed, membership being from the Panel. Those task groups covered conceptual knowledge and skills, learning processes, instructional practices, teachers and teacher education, and assessment. And three subcommittees were on the standards of evidence, the teacher survey, and instructional

materials. Each of the task groups and subcommittees has a report that is still in the process of production, but will appear shortly, and they, together, constitute a body of material that is on the order of 800 pages or so.

Those reports are the elements of this panel's work that have the documentation, the references, the citations to original literature, much more detailed analysis and augmentation than exists inside this report. So what I wanted to indicate to you is that there is an underwater portion of this iceberg, and it will be forthcoming.

Tyrrell has just given me a note that the task group reports will be posted in final draft at 11:00 this morning, in final draft, whatever final draft means. She says final draft means not final. Anyway, there are production refinements still happening, but no substantive changes still happening, right?

MS. FLAWN: Right.

CHAIRMAN FAULKNER: Okay. But anyway, the material will be available on the website at

11:00 this morning, and this report will be available on the website at 11:00.

Also, I might point out to you that the copies you have do not represent advances in the art of binding.

(Laughter.)

CHAIRMAN FAULKNER: This is what it's possible for us to achieve today. A regular, Government Printing Office publication with a real binding will appear in due course.

Now, let me make some final comments. I'd like to say something that really hasn't been said. Camilla hinted at it, but I would like to actually take this moment to hand off.

What this panel is doing today is reporting to the Secretary, and to the President, and to the public. The next steps in the improvement of mathematics education are in the hands of people in this audience, you, and people all across the nation. This panel evaporates after having done its work, having given the best analysis and set of recommendations that it can provide.

And there has been comment here today about the exceptional effort that this has represented, and it is an exceptional effort. And I don't mean it to come across as simply bragging about the amount of time that has been committed by this body. It is a spectacular amount of time.

But what I think is the important point is that very rarely, in the life of a nation or a life of any society, is it possible to bring together the resources that have been brought to bear on the problem of improving mathematics education that this panel has been able to bring to bear. There is the skill and knowledge of all the people around this table. There is the time they have committed. There is the two-year time allocation. There is the scope of charge. There is a sizeable dollar expenditure from the U.S. Department of Education, and from external sponsors. There is the work of a set of dedicated and skilled consultants who were hired to help get this panel's business organized.

It's rare to see a group that can handle and does actually address the scope of

literature, the scale of literature, the range of phenomena, the number of times this can be done, the likelihood that it will be done, again, any time soon. All of those facts help me to realize how unusual an event this is, and how important it is that this panel has done everything it could to make the best judgments that it possibly could on behalf of the American people, and I can testify to you now that I believe that that has happened.

I know that this panel has contributed every last ounce of energy and commitment that was possible for it to give, and that has been given consistently, faithfully, to a standard of judgment that I think has been remarkable in my experience. So I think we've done the very best we can, and we will see now what the public does with it.

There's an observation in this report that I think is an important one, and that is that public education in the United States is in the hands of a great many different players across the country, in individual districts, in individual schools, at the state level, at the federal level,

in textbook publishing houses, in accountability and assessment organizations, in lots of other places. All of that is knitted together, most importantly, by a set of associations. This panel has consistently believed that one of the most important sets of constituencies is the associations that do bind together all these people who are important in actually bringing about improvement in the schools, or actually just carrying out the day-to-day work of the schools.

Many are seated here in this audience, and I simply wanted to re-enforce for the audience how important it is that you walk away from this room thinking about mathematics education as your responsibility, the improvement of it as your responsibility. What we've given you here is our best thinking about what next steps to take, what kinds of investments to make, what kinds of changes to engage in. In the end, you'll decide, but there is work to do.

Mathematics education in this country is something that can be improved without an act of Congress. I think whenever a federal panel is

created, there is a kind of sense that the primary responsibility is with the federal government. The primary responsibility in this case is really not with the federal government. It's with countless people and organizations across the nation, and it's important for these messages of improvement to be thought about, and to be acted upon by people other than Congress, by you.

Congress may help. They may appropriate some money that might help mathematics education in this country, and they might have a significant role, but they aren't going to have the determinative role. The determinative role is local, and I want no one to lose sight of that.

There is quite a lot in this report that could be implemented, could be acted upon tomorrow at almost no cost, and I think that's also an important message. This is not really about dollars. This is about getting our ideas straight, and making the right choices first. There are dollars for some of the things that we deal with here. We can get to those as we get along, but there are actions that can be taken

right now, and that aren't dependent on legislation, and that are not dependent on pending financing.

Finally, I'd like to say that mathematics education isn't just about a school subject. It's easy to think about what we're doing here that way. It's fundamentally about the chances that real people all across this country will have in life, and it's about the well being and safety of the nation. Those are very important things, and they are worthy of our best effort at mathematics education in every level in this country.

Let me close this portion of the meeting. The next part of the meeting is going to be to present the report to the Secretary. We will await the Secretary's arrival. But let me simply close by thanking my colleagues on the Panel. You have been an experience.

(Laughter and applause.)

CHAIRMAN FAULKNER: You have also brought great skill, and knowledge, and dedication, and passion to a process that probably

wouldn't have turned out anywhere near as well without all of those things. I will remember you always, and we will go our separate ways, probably largely after today. But I thank you.

But I also want to thank the staff of this panel. We have been supported in Washington by a staff that is headed by Tyrrell Flawn. That staff has worked very hard to marshal all the material, and the logistics, and even has occasionally curbed a little passion, dealt with government regulation, and I think has done an outstanding job in support of this panel, and I invite the Panel and the audience to thank that staff.

(Applause.)

CHAIRMAN FAULKNER: And I also want to thank a set of consultants. We have had quite a lot of work done with us by folks who were contracted to do it, but they did it with great skill. Abt has been especially effective, and I want to thank the Abt staff, some of whom are here. The Institute for Defense Analysis, STPI program also helped us, and Widmeyer

Communications has been the group that has helped us get publications and other materials prepared. These have all been folks who have been very valuable to work with this panel, and let me invite thanks to them.

(Applause.)

CHAIRMAN FAULKNER: And finally, I'll thank the audience. There are members here who have been very faithful. Your faces are recognizable. We've seen you in many places around the country, but whether you've been to multiple meetings or just this one, public interest in what this panel has been undertaking is very important, and we appreciate your attention to it, and your participation.

With that, I think I can declare us adjourned, at least for 15 minutes or something like that, until the Secretary arrives. Thank you.

(Whereupon, the foregoing matter went off the record at 10:47 a.m. and resumed at 11:01 a.m.)

CHAIRMAN FAULKNER: Well, I'm honored

to be sharing the podium with my long time colleague and friend, Secretary of Education, Margaret Spellings. As you all may know, the Secretary is the first mother of school-age children to serve as Secretary of Education. She attended public schools, and is working hard to ensure that every young American has the knowledge and skills to compete and to succeed in the 21st century.

As a leader in educational reform at the state and national levels, she believes in setting high expectations for all students, and places a high priority on shrinking the achievement gap. She understands the essential role of teachers, and supports strengthening the profession.

It was her vision that led to the establishment of the National Mathematics Advisory Panel, with its charge to review the best scientific research, and make recommendations on improving mathematics learning.

Madam Secretary, this is a highly anticipated moment for the Panel. For the last

several months, we have been entirely engaged in synthesizing the findings, drafting the report, negotiating the language - I repeat, negotiating the language - revisiting the research, and revising the text countless times. The Final Report grew out of draft 90, which itself had several subsequent iterations. I can sincerely say that we have all longed for this day when the report would be submitted to you for the next phase of action and implementation.

I commend this panel for their dedication and commitment to the Executive Order. For the last two years, and especially since December, the panel has essentially put their lives on hold to complete this report, with generosity and good humor most of the time. They have given untold hours, as well as their expertise. It's been my sincere pleasure to work with them. We've produced a solid report that provides clear, cost-effective, and evidence-based recommendations to improve mathematics education in this country.

Madam Secretary, I am proud to present

to you the Final Report of the National Mathematics Advisory Panel.

SECRETARY SPELLINGS: Congratulations, Larry. I'm proud of you. Thank you. Congratulations.

(Applause.)

SECRETARY SPELLINGS: Thank you, Larry. Congratulations to all of you. What a terrific contribution you've made. I'm just really thrilled. I've anxiously awaited this job, this day, maybe not as along as you have, but Larry, does this mean you're available for another assignment? All of you?

Anyway, thank you, thank you, thank you for the tremendous contribution, and thank you. I think we have to honor our Chairman, Larry Faulkner, who's just terrific.

(Applause.)

SECRETARY SPELLINGS: He, as you know, is a person of intellect and skill, and to get this report together, and to have it be the historic kind of document that it is takes incredible leadership, and I'm really indebted to

him.

Camilla, thank you for your leadership as Vice Chair. Vern, thank you for your hospitality at your school today. What a great place. I bet it hasn't been this quiet in this gym for a while. And Jack Dale, I see the Superintendent back there. Thank you for your hospitality. I was intrigued to learn that you started your career in mathematics. So this is a good day for all of us.

Obviously, we all owe you, as committee members and panel members, just a huge debt, and I appreciate your contribution, your sacrifice, the time you've given, but I will assure you that it has not been for little good, or no good. I intend to be very vigorous about distributing this work, and I look forward to working with all of the organizations and groups that are represented here today, including the National Council of Teachers of Mathematics, the National Council of Supervisors of Mathematics, the College Board, the American Association for the Advancement of Science, the American Federation of Teachers,

administrator groups, parent groups, on and on. I think our responsibility now is to take this excellent work, this wonderful product, and make sure the world knows about it.

Since we're talking about math today, I think it's important to reframe and understand who it is that has done this work. Together, you all are experts, who represent more than six centuries of experience in the field. You have together -- I know. Some of you don't look that old, but you've published more than a thousand books and papers together. I know you've worked for free, on your own time, and since you all were formed, I need not remind you, you have heard from over 150 organizations, and looked at more than 16,000 studies. You've visited cities all across this country, and you have left no stone unturned, to be sure.

The report respects absolutely the role and the value that our teachers play as the best people to determine how to teach a skill or concept, but it also provides a lot of useful information to them about the timeline as to when

students must master critical topics. As you all point out rightly, in the early grades, our students need rapid recall. They need facility with facts, and that students, obviously, should master fractions before embarking on Algebra I in middle or high school. By building on a strong foundation of skills, students will be ready for rigorous courses in high school or earlier.

Why does the report focus so much on algebra? That's one of the questions that I'm being asked a lot because, as you all know, research shows us that, if students do well in algebra, they are much more likely to succeed in college and beyond. We know that for sure. We know that algebra helps today's students learn problem solving and analytical skills that are so essential to our global economy. It tells us that students who complete Algebra II in high school have much greater prospects for success. We know that increasing access to algebra and rigorous course work will help close the achievement gap and the opportunity gap that we often see in this country between poor and minority students, and

their more advantaged peers.

As job growth in the fields of science and engineering is outpacing overall job growth by a rate of 3:1, this is the place we must get value. We must go to work. As many of you know, and I know it's been some days difficult, your report weighs in on the long-standing debate in math education about the relative importance of concepts, or conceptual understandings, and more standard problem-solving approaches, and naturally, you have found that both are important.

And I love when Larry and I were talking a little bit when I walked in that, I guess, Deborah, you were the one that observed the news here is not what disagreements there are, but what agreements there are, and I think that's absolutely right. Very well said.

So in addition to that we have to all work to combat this idea that some students are gifted in math, and some are not. You know, like my mother used to say, how do you get to Carnegie Hall? Practice, practice, practice. You work at it, and we, together, I think share responsibility

for making sure that this myth begins to be broken down by moms and dads, by our educators, that this is a place that expectations matter a lot.

Finally, the report tells us that the earlier we start teaching our children math, the better, and I think this is very important for parents. We talk a lot, and I think parents understand about the importance of re-enforcing or enforcing reading skills and developmental skills around those topics, but maybe pay less attention to the value that those early years play in math education. It's a commonly held belief that kids are not ready to take on those sorts of concepts, but every time you slice a pizza, or pour a glass of juice, or measure something, that's an opportunity I think for moms and dads, and all of us, to talk about math, even before kids go to school.

These insights, together, are all the more important when we know that, today, fewer than half of our African-American and Hispanic kids are getting out of high school, and when our nation's report card shows us that most 17 year

olds lack basic math skills required to work in a modern automobile plant, about half of our students. That's simply an untenable kind of result for this country.

So, as I said in the beginning, I pledge to you to do everything I can to share this information, to make it more available to everyone, from moms and dads, to teachers and administrators, to policymakers, so that we can bring greater results and greater understanding to math, and I look forward to working with the organizations represented here, and lots of those who are not represented here.

I also think we have a responsibility to put our money where our mouths are, and I think it's right and righteous, and it will be very helpful as we debate the budget. I hope the Congress will see the merit of the President's request for $100 million for the Math Now program, which will do a lot to feed the early pipeline of our little, young mathematicians. We often think a lot about the higher education experience, and research experience. All of those are very, very

important, but we have under-invested in math education in our early grades, and I'm hopeful that your report will help bolster that argument to policymakers, not only here in Washington, but all around the country.

Again, I thank you for your service. I want to take a moment to also thank Tyrrell Flawn and her fantastic staff for this labor of love, and I appreciate so much every single one of you, and I look forward to your continued messaging around this very, very important issue, and I trust that you stand at the ready to continue to help carry this message to our important public.

Thank you.

(Applause.)

CHAIRMAN FAULKNER: I think, Madam Secretary, I can adjourn this meeting?

SECRETARY SPELLINGS: Yes.

CHAIRMAN FAULKNER: The Math Panel is concluded, and, are we discharged?

SECRETARY SPELLINGS: Well, actually, the Executive Order doesn't expire until April of next year. So why don't you all stand at ease.

(Laughter.)

SECRETARY SPELLINGS: And you can adjourn. But I do think, as I said, there are going to be ongoing - and this is certainly discretionary - opportunities for us to communicate. I mean, I'd like to have a summit on this topic. You know, there will, obviously, be opportunities for articles, and publications, and on and on. So I think we're all about communication, and getting the word out from this point forward.

CHAIRMAN FAULKNER: With that, we stand adjourned. Thank you.

(Whereupon, the above-entitled matter was concluded at 11:13 a.m.)