U.S. DEPARTMENT OF EDUCATION

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NATIONAL MATHEMATICS ADVISORY PANEL

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Thursday
September 14, 2006
9:00 a.m.

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Auditorium
Broad Institute
7 Cambridge Center
Cambridge, Massachusetts

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PANEL:

DR. LARRY FAULKNER, Chairman
DR. CAMILLA PERSSON BENBOW, Vice Chair
DR. DEBORAH LOEWENBERG BALL
DR. A. WADE BOYKIN
DR. FRANCIS (SKIP) FENNELL
DR. DAVID C. GEARY
DR. RUSSELL GERSTEN
MS. NANCY ICHINAGA (NOT PRESENT)
DR. TOM LOVELESS
DR. LIPING MA (NOT PRESENT)
DR. VALERIE REYNA
DR. WILFRIED SCHMID
DR. ROBERT SIEGLER
DR. JAMES SIMONS
DR. SANDRA STOTSKY
MR. VERN WILLIAMS
DR. HUNG-HSI WU

EX OFFICIO MEMBERS:

DR. DANIEL BERCH
DR. DIANE JONES
MR. TOM LUCE (NOT PRESENT)
DR. KATHIE OLSEN (NOT PRESENT)
MR. RAY SIMON
DR. GROVER J. (RUSS) WHITEHURST

STAFF MEMBERS:

TYRRELL FLAWN, EXECUTIVE DIRECTOR
IDA EBLINGER KELLEY
JENNIFER GRABAN
KENNETH THOMSON
HOLLY CLARK

I-N-D-E-X

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

(9:06 a.m.)

MR. FAULKNER: Good morning. Let me welcome everyone in the audience to this session of the National Math Panel. I'm Larry Faulkner, Chairman of the panel. Our Vice Chair is here next to me, Camilla Persson Benbow.

And we are going to begin this session by making a public thanks to MIT for providing great hospitality for the panel and its work over the last two days. We are fortunate to have with us Dr. Susan Hockfield, President of the Massachusetts Institute of Technology.

She is the 16th President of MIT. She is a noted neuroscientist whose research has focused on development of the brain, a member of the American Academy of Arts and Sciences, and having come to MIT in December of 2004 from her previous service as Provost of Yale University.

Dr. Hockfield, we appreciate very much what MIT has done for us, and it's been a pleasure to experience this marvelous institution over the last two days, thank you.

MS. HOCKFIELD: Thank you.

Well it's a great pleasure to welcome members of the National Math Advisory Panel and the

public to MIT's campus and to the Broad Institute, the building in which we sit. In addition to being a dynamic new building, it's the home to a breakthrough collaboration in genomics research; it's a collaboration between MIT, the Whitehead Institute for Biomedical Research, Harvard University and its affiliated hospitals. I wasn't able to be here yesterday to welcome you when you arrived, but I felt it was important to stop by today to express how essential we at MIT feel it is to improve mathematics education in the United States. I also wanted to give my very deepest thanks to the members of the National Math Panel for taking on this vital and substantial task.

As we look to the future, it could not be more clear that a solid foundation in mathematics will be crucial for every citizen in this country, because we are now in an era when technical and scientific literacy has become as important as language literacy. The future of the United States economy and our standard of living depend on innovation and technological advances.

Nobel Laureate Robert Solo, who is a member of MIT's Department of Economics, was the first economist to demonstrate the relationship between innovation and the economy. He showed that

more than half of the growth in U.S. economics, since World War II, derives directly from technological innovation, and I would say that we are only now beginning to grasp the full implications of Professor Solo's work. An important moment came last January when, in his State of the Union message, President Bush drew an explicit connection between economic growth and investments in research and talent. Science and math education is a prerequisite for innovation.

Now, you all know, we all understand and feel quite proud that the U.S. higher education system is often considered the best in the world, and MIT is enormously fortunate to attract some of the nation's best and brightest math students from their high schools, but we know that the attainments of this relatively small group of students is all too rare. Forty percent of four-year college students end up taking at least one remedial course when they are in college.

I feel very strongly that we need to repair the leaks in the K through 12 pipeline, that's the pipeline that feeds higher education. Other countries have already understood this and they have been building up their human capital through rigorous and comprehensive pre-college education. Thomas

Friedman coined the notion of a flattened world. More recently, I hear people talking about a world that's tilted, but tilted not in our favor. Technology increasingly drives the global economy, which simply demands skills based on mathematics. Some economists have predicted that by as early as 2020, the U.S. will be short something on the order of 14 million workers with a competency to compete for middle income jobs in a global economy.

Now, many of you may be asking yourselves why should MIT care about this, why should we be interested when we already receive the best students? Well, let me give you just one perspective that keeps us thinking about curricular innovation. For the salary of one engineer in the United States, a firm can hire 11 engineers in India so, to compete successfully in the global marketplace, our future engineers and scientists will need much more than simple technical skills, they are going to need technical skills at a level they never had before, but they will have to be leaders.

In addition to mathematics and engineering at a very high level, our students need interdisciplinary skills. They need business acumen, policy knowledge, foreign language facility and the ability to work effectively with diverse teams of

collaborators. One member of MIT's faculty, Woody Flowers, who is known throughout the nation and the world for his pioneering role establishing the first high school robotics competition, which now reaches tens of thousands of students. Woody talks of a new model of engineering education that prepares technology literate and philosophically grounded students.

For the United States to retain its preeminence in science and technology, we need to prepare our students to be engaged and effective leaders, but always a strong math foundation is essential. Now I'll be the first to admit that the central expertise of colleges and universities generally does not include the core work of primary or secondary education, but our first obligation of course is to our own students. Even so, I believe that we can build better bridges between K through 12 education and college.

MIT, as many of you have noticed, does not have an Education School, but our faculty and our students, in huge numbers, work with K through 12 students and teachers in a wide variety of settings, from their work in local schools, to on-campus programs that draw participants from around the country.

One of the truly innovative experiments in education and in broadening the reach of MIT's education has been MIT's Open Courseware Initiative, (OCW). OCW is now five years old, it's institute-wide and for those of you who haven't been on our website, it offers web access absolutely free of charge to all of the teaching materials in MIT's undergraduate and graduate courses.

The materials include syllabi, course notes, assignments, problem sets, and exams. Some courses are actually available in full video, but not a lot of them. OCW now includes about 1,200 courses, 90 percent of our courses, and our target is, in another year, to be closer to 100 percent. I want to be clear about what OCW is not. It is not distance learning. Instead, OCW allows educators, students and self-learners around the country and around the world to benefit from the materials created by our faculty, but it also allows them to join a learning community in which knowledge and ideas are shared openly and freely.

Let me give you just one measure of OCW's impact, every day. These numbers are April or May and they keep increasing, so I don't get an update on the numbers every month, but in May, OCW was receiving 36,000 visits to content a day. These are not just

hits. These are measured, people actually dwelling on the content, 36,000 a day. Our plans in the near future are to develop a similar model for the best high school teaching materials in math, engineering and science. What we want to do is gather the knowledge of exceptional high school teachers into an on-line, dynamic curriculum for the benefit of all, open access and free access again.

MIT's I-labs is another innovative approach to learning at a distance. I-labs allows students to conduct real laboratory experiments using our equipment but they conduct them remotely from any Internet browser. What we imagine is, in the future, laboratories like this could allow high schools to access college laboratories and also to share labs and instrumentation, and it would allow them to work together on math problems also. OCW reminds us to consider how to strengthen the use of technology in primary and secondary education.

While I believe fervently that technology will never replace the face-to-face, teacher-student relationship, computers can provide a powerful supplemental tool for boosting problem solving and invention. The young people of today know more about the potential of computer learning than we do, yet, even for someone like me, today, my office is

wherever I am with my laptop, future classrooms may be similarly mobile. The panel's assessments of pedagogy will be as important. It's a study of curriculum, and even as we examine the current best practices for math education, it's crucial that we continue to fund research, high quality research, in education and learning, including supporting new tools for education.

We are still very far from knowing all we can about learning. As you know, I'm a neuroscientist and watching what's happening in my field, I can assure you that the next several years will bring tremendous insights into cognitive processing and I hope that we'll be able to use those insights to improve our educational opportunities.

Now we all understand that there isn't one single, easy answer for improving American math education. It's a complex system's problems with multiple factors. Part of the complexity is that there is no single typical student. I want to put one word in for the exceptional students. We absolutely must get our strongest students more engaged and more challenged in math courses. We have to get them more inspired about the importance of math for their future lives and careers. Of course, at the same time, we need to amplify our efforts to

bring up those who have fallen behind. Socioeconomic forces and changing demographics add further complexity. To realize our nation's full potential, we have to develop math and science skills of students from historically under-represented groups.

The panel's job is far from an easy one, and we are all grateful that you are engaging your talents and your energies on this challenge. I believe that it's a challenge that may represent one of the greatest threats to American's future economic growth in prosperity and your work could not be more important.

Thank you very, very much for serving and welcome to MIT.

(Applause)

MR. FAULKNER: As President Hockfield is leaving, let me just say to her one more time how much we appreciate MIT's hospitality, and we appreciate her generous words on this occasion and her thoughtful comments on this occasion.

Let us now turn to the part of the session where we will receive comment on an open basis. The procedure here is that each person who is going to be speaking will have a five-minute allocation. There are 16 individuals who have registered to give comments on the executive order

and the panel's work.

We have people on the waiting list, and I want to say that we are sorry we have not been able to accommodate everyone, but we have filled the time that we have available in this particular, on this particular occasion. The people who have signed up have done so on a first come/first serve basis, and we will just start down that list. The panel will listen to everyone, and the panelists may ask questions at the end of comments. We won't answer questions. I want to make sure that everyone understands that. The panel here is to digest information. We are receiving information at this stage of our work. We have not formulated conclusions.

No individual here is ready to speak on behalf of the panel, as a whole, and the panel is not ready to speak as a whole, so we are here to hear what you have to say, what those who will be speaking have to say, and let's go ahead then and start. I, however, do not have a roster. You have a roster.

MS. GRABAN: Speaker number one--

MR. FAULKNER: Go ahead and call it out.

MS. GRABAN: Sure. Speaker number one, Mary Waight.

MS. WAIGHT: I believe you have, within

your binders, an expanded version of the comments that I'll make this morning, in the attempt to limit myself to five minutes.

Again, good morning, and I thank you for the opportunity to speak with you. My name is Mary Waight and, this past June, I retired as Associate Superintendent for one of the largest regional school districts in Massachusetts. My comments this morning address the implementation of Singapore Math, the Singapore Math program in the North Middlesex Regional School District and the resultant outcomes.

Now, if I could give you a little bit of background. In the Spring of 1998, the Massachusetts Department of Education inaugurated a mandatory assessment program for all public school students. The results from the first administration of the assessment were dismal, particularly in mathematics. The statewide failure rate in Grade 10 math was 52 percent. North Middlesex Regional High School's tenth graders did not fair much better with a failure rate of 39 percent. By the second year of testing, North Middlesex's failure rate had climbed to 46 percent. We were determined to find the cause of and a remedy for our own unsatisfactory outcomes.

In the Fall of 1999, we, meaning teachers

and administrators within the district, reviewed available data in mathematics, district data, and we concluded that the promise our fourth graders had shown on the Massachusetts Comprehensive Assessment System (MCAS) and other district assessments was in a precipitous decline by middle school. To provide more academic opportunity and rigor for our middle school students, among other things, we did the following: we eliminated all activity block periods at the middle school level; we established a goal that all middle school math teachers would have majors in their field; we provided more time for mathematics instruction; and we reviewed and revised curricula in mathematics.

Most important of all, we responded to a Massachusetts Department of Education initiative to host an institute on the acceleration of middle school mathematics. The institute was open to teachers in grades five to nine and introduced participants to the mathematics syllabus issued by the Singapore Ministry of Education. Later on this morning, you'll hear from Dr. Richard Bisk who actually was our college partner and the faculty member who delivered that curriculum. The Singapore Math Program calls for direct instruction. Its focus is on mathematical thinking with immediate

application of skills to problem solving.

There are a few topics covered every year and these topics are introduced in great detail. Understanding is enhanced through visual representation through a strategy known as model drawing. Beyond this, textbooks are lively without the distraction of many contemporary texts, paper bound and considerably smaller than the traditional texts. I think you'll be surprised if you haven't seen the textbooks, some of which I left at the front desk for your perusal, and when I think about the comment of Dr. Jones yesterday about the weight for children, considerably smaller than traditional texts.

In the Fall of 2000, five of the institute participants implemented the Singapore Math Program in six classrooms, five through eight, the experience was successful. Over the course of the next six years, we moved to grades one through eight and from six classrooms to 130 last school year. Throughout the implementation, faculty involvement was voluntary. Teachers, however, in participating in this implementation, were required to enroll in a district-sponsored mathematics course. North Middlesex trial or pilot of the Singapore Math Program was expanded because of the many indicators

of success.

Attached to my written remarks, which you have, are a number of tables that present outcomes and state assessments at grade ten from 1998 to 2005 and the Iowa Tests of basic skills from 1999 to 2005. As Appendix B indicates, North Middlesex grade two students, performing at the advanced level on the state math exam, increased from nine percent in 1998 to fifty-seven percent in 2005, and we await the results of this year's assessment, while the failure rate over the same period declined from thirty-nine percent to two.

But there are other indicators of success. All grade eight students in North Middlesex now enroll in Algebra I, in contrast with only 25 percent of the population in 1999. There has been a significant increase in the percentage of grade nine students ready to move to an Algebra II. And last year, for the first time, we were proud that there were students enrolled in Advanced Placement Calculus for the first time for North Middlesex. This fall, 100 percent of teachers in the district, grades one through seven, and 75 percent in grade eight are in the Singapore Math Program, 100 percent of students, excuse me. Singapore Math is not an innovation but the way that North Middlesex delivers math

instruction.

On almost a weekly basis, North Middlesex is contacted by school districts from across the country seeking information on the implementation of Singapore Math. Beyond requests for information, our classrooms are visited with frequency by local educators and those from afar. This month, Gene Mayeroff, the founder of the Hechinger Institute on Education and the Media at Teachers College-Columbia, released his latest book, *Building Blocks: Making Children Successful in the Early Years of School*.

MR. FAULKNER: I need you to wrap up. You are in your last minute.

MS. WAIGHT: I just wanted to say that North Middlesex occupies the chapter or the great part of the chapter on mathematics in there in an attempt to say that building a foundation for math in the early years, through Singapore Math, has been successful, and I will end at that point.

Thank you very much for your time.

MR. FAULKNER: Wait, wait, wait, don't go away.

Are there any questions from the panelists? Wilfried?

MR. SCHMID: Obviously you should be congratulated for the success of the Singapore

Program implementation and outcomes that you got from that. I saw some data about the Massachusetts Comprehensive Assessment System, MCAS, performance in English, which has also gone up, can you explain is there any connection? It can't be a coincidence.

MS. WAIGHT: It has not gone up as much. Thank you, Dr. Schmid, for bringing that to the attention of the panel. It has not gone up as significant as the math has increased. But I think that, when you raise the bar, I talked about a number of things, I talked about more time for mathematics, and I talked about the elimination of the activity blocks. We teach more than mathematics in our classrooms and my final comment was going to be about professional development, ongoing. Professional development continues in science, and social studies and English language arts and we believe that reading is fundamental and foundational and it occupies as much of our attention, particularly in the primary grades, as mathematics does.

MR. FAULKNER: Go ahead.

MR. LOVELESS: I'm sure you have experience with a number of math programs. Could you isolate, just from your own experience, what are two or three aspects of the Singapore curriculum that you think have caused the figures that you are sharing

with us, the success?

MS. WAIGHT: I think its simplicity, in the sense that there are fewer topics addressed in any given year, is clearly important. I think the visual representation that brings students to an understanding at a very early age, drawing out a solution to a problem. I think the professional development that accompanied it was an important piece in North Middlesex, raising the math understanding for our teachers. Let's see, certainly there is more than that.

MR. FAULKNER: Skip?

MS. FENNELL: Kind of tied to that, you had mentioned in your response to Dr. Schmid's question sort of the reorganization relative to instructional time and the elimination of certain periods and so forth. Could you comment, pretty specifically, about how much time is provided for teaching mathematics at both the elementary and middle school level? And then how much time, how many courses, what kind of ongoing work in the name of professional development was provided initially and then continues to this day?

MS. WAIGHT: Our students spend a minimum of 60 minutes a day, kindergarten, excuse me, first grade through fifth grade in mathematics. Beyond

that, teachers often use the opening meeting, the morning meeting that used to be devoted more to literacy, as a means to enhance mathematics, so we are talking a minimum of 60 minutes. At the middle school level, classes are an hour long, a little bit better than 60 minutes, and there is time in the course of the day to bring students together for additional math work, so it's a solid hour minimally and prior to that, 45 minutes.

Your second question?

MR. FENNELL: The professional development. You mentioned earlier about the kind of course work as you began the program, maybe a little bit more on that, and then to what extent does that continue? Has it continued? How are you monitoring it?

MS. WAIGHT: I honestly think when Dr. Bisk comes up -- and I hope he doesn't mind this -- but he would be the one to ask that, but I will say to you that there was an assessment done every year. We knew what our students' weaknesses were and that was corroborated when, at the beginning of every course, an assessment was given to the teachers. It tested not just if they could divide fractions, for example, but could they explain why one inverted the divisor in doing so? So we knew very early on, and

that's just one example, that our teachers' background was weak, more than even what their transcripts told us. That was something that went on every year.

And in addition to the three credit graduate course that was offered every summer and sometimes during the year, there were sort of mini courses around issues that were difficult for teachers, you know, whether it was fractions, difficult in terms of having their students come to understanding.

MR. SIEGLER: I read a report about Singapore Math, that it was a program, looking at it in four districts and all four registered substantial improvements in achievement. But at the end of the funded program, three of the four dropped it and on the basis that the mathematics directors and teachers found it too much trouble. I'm curious on your reaction to this problem and how your district was able to overcome it because you have kept it going for quite a long time.

MS. WAIGHT: Because we are the fourth district in that study you referenced, in the year study.

(Laughter)

MS. WAIGHT: I think I mentioned at the

end of my comments the significance of administrative support. I am an English major, I am not a mathematician, but the administrative support is essential. Our expectation was that the professional development would be there and that principals and assistant principals within the building would see what their role was. They were instructional leaders and they needed to monitor that.

And teacher enthusiasm continues to be as strong as it was when we began. I think I mentioned that it was a voluntary process of participating in the program, and you'll see a chart within what I gave you that shows an expansion over, sort of a visual, over six years, how it went. Those were all teachers coming forward saying me next, this looks like it's working.

MR. FAULKNER: Okay, Wade, you'll be the last question.

MR. BOYKIN: Did you have any challenges or could you comment on any challenges that you all faced in articulating the Singapore curriculum with the Massachusetts state standards in math?

MS. WAIGHT: Yes. I would say that there is a disjuncture, particularly through grade eight. I think we don't see that at grade ten at all, in terms of the MCAS exam. There was, and teachers

would often say to me, “I need to jump out of the curriculum.” Probability and statistics, for example, which isn't part of the Singapore curriculum, needed to be addressed. They would say often that, you know, their students were used to solving problems in certain ways and sometimes the expectation was different when it came to taking the MCAS exams.

But I think that we felt that we looked at traditional exams that we had given over years, the Iowa Test of Basic Skills, and we looked at our high schoolers outcomes. I mean that's where we are heading toward, and we felt that we were building toward a model of success.

MR. FAULKNER: Okay, Ms. Waight, I think we need to move on. I appreciate very much your comments.

MS. WAIGHT: I appreciate being here, as well as your work. Thank you very much.

MR. FAULKNER: Let me take a moment to ask if there is anyone in the audience who requires the services of the signer. The signer has been working since we began and if no one is using those services, we'll discontinue them. We can pick them up at any time. Is anyone in need of the services of the signer? Seeing no response, I think we'll discontinue, thank you.

Tyrrell tells me that the comments from people who are testifying are in tab four of your notebooks, if you haven't yet discovered that.

Let me go to the second speaker, Holly Horrigan, I think is what I've got on the list.

MS. HORRIGAN: I also provided a quick handout. Thank you all for this opportunity. I came to speak today as a concerned parent hoping to present an example of how curriculum choices and pedagogy can influence student outcomes.

I live in the Town of Needham, Massachusetts, an affluent, suburban community located on the Route 128 Corridor. Needham has a reputation for great schools. Last year, my oldest son began third grade at the Newman Elementary School. We expected a successful year for him, as he is an eager and able learner. I was taken by surprise when he began coming home and crumpling his math homework, exclaiming that math is nonsense and I stink at math.

He refused to do his homework. I don't usually get involved with homework, but I reluctantly went over one day to see exactly what was the matter. I was shocked by the work sheets I saw in his investigations workbook. The problem became clear. There were questions for which insufficient

information had been provided and, there was no room on the worksheets to write down any calculations. They were asking him to solve a subtraction problem, but they hadn't taught him an algorithm to perform multi-digit subtraction yet. It took only ten minutes for me to teach my son how to borrow and carry, and I instructed him to use the algorithm and use pencil and paper at school. He was relieved and happy.

But the next day at school, my son was told that he was not allowed to borrow and carry unless he could explain the algorithm in front of the class, which he did and with a complete description of place values too. I raised my concerns with one of his two teachers. A veteran teacher, he immediately substituted work sheets he had used in the past and instructed my child separately, while the other teacher taught investigations to the rest of the class. With this more traditional approach, the problem was solved. My son enjoyed math again, learned all the materials and advanced beyond Massachusetts's standards for his grade level.

I wondered how could the school have high MCAS scores with this poor curriculum? My research revealed that the curriculum was introduced five years ago. Since that introduction, the percentage

of fourth graders at the advanced or proficient level plummeted from 85 percent advanced or proficient to only 53 percent. I have provided this graph for your reference. Our curriculum leaders refuse to consider alternatives to investigations for our core curriculum. They ignore the poor MCAS results, complaints from concerned parents, and teacher survey results citing insufficiency of the program.

I have found that this constructivist pedagogy is deeply entrenched and the mathematical knowledge of the decision makers is sometimes lacking. A new teacher in our district related to me what she was taught last year while earning her teaching certificate. As if speaking from a script, she said that teaching multiplication tables is drill and kill and that there are often no right answers in mathematics. She admitted knowing nothing about algebra, saying algebra really isn't my concern, I just need to teach second grade math. How then can she judge what constitutes a good foundation for the algebra that lies ahead?

I am not a mathematician or an educator, but I have completed six years of undergraduate and graduate math. I have worked in applied statistics, and I've patented and published a novel mathematical model in my field. Upon reading the investigations

workbook, investigations appears to be a program designed to teach a child how to get by. It is reminiscent of a Scholastic Assessment Test, SAT, prep course I took decades ago that taught how to increase your odds of guessing correctly when you get stuck on a question. When you don't know how to solve the problem, the instructor would say, then estimate or guess one of the answers and see if it works.

I've attached three pages from my son's third grade Investigations workbook. Only question number 14 on page 41 asks for a precise manual calculation, and even that question expects the answer to be represented in an English sentence, rather than in a mathematical equation. The rest of the questions can be performed with a calculator, or require only approximations or have no answers at all.

Though Mr. Mayer from TERC told the *Wall Street Journal* that parents mistakenly believe Investigations doesn't value computational skills, I think these worksheets vindicate parents like me who think these materials are useless, if not counterproductive.

As you continue your deliberations, I would ask you to consider curriculum materials and

pedagogy, as well as standards. Good standards are critical and are the first step, but they will be unattainable with poor pedagogy and empty or misleading exercises.

Thank you.

MR. FAULKNER: Thank you, Ms. Horrigan.

Questions from the panel or comments? We have one here, Dr. Schmid.

MR. SCHMID: This is not a question. It's a comment. You are of course not alone. I mean there are a number of mathematicians who became involved in mathematics education because of Investigations, myself included.

MR. FAULKNER: Deborah?

MS. BALL: I was just wondering if you had spent time investigating the sort of mathematical basis of the design of the program or did you mostly look at the student books and student materials. I'm just curious about the extent of your exploration of the material and the development of it.

MS. HORRIGAN: Yes. I have been exploring this material for approximately a year now, since my third grader first raised my awareness that perhaps there were some issues with the materials he was being given. I have explored the TERC website, the TERC philosophy, some of the ideas that went into

building the curriculum, and I also have lived with the lab rat, so to speak, and gone through the workbook with him. So obviously I'm not an expert in curriculum development, but I have spent a great deal of time looking at it.

MR. FAULKNER: Bob?

MR. SIEGLER: Well this is a real horror story, and I'm sure we all sympathize with you a great deal, and we'd have the same frustration and anger in the same position. I'm curious how the district has reacted. You probably have talked with people higher up, and these declining test scores and the inadequacy of the materials are pretty evident. What kind of reaction have you had when you pursued it? I assume you've pursued it beyond just talking to the teacher.

MS. HORRIGAN: Yes. I began with the teacher, I also talked to the principal of the elementary school, our district elementary curriculum math leader, our curriculum leader and the superintendent. Their reaction to me, what they said, was that the MCAS scores are unreliable, and in fact there was a push to purchase an alternative assessment tool sold by the publisher of TERC.

MR. FAULKNER: Diane?

MS. JONES: I have a question. As a

parent myself, one of the things that I've noticed is that in district scenarios where they've introduced new curriculum, we've seen a huge increase in the number of tutoring centers. And my own sister had the experience that when she went to the principal to talk about her child's performance, the principal said, well, you know, which tutoring center does your child go to? And she said, well, tutoring center? I paid almost a million dollars to live in a house with a good school district, why the tutoring center?

And that might just be a regional issue. I'm curious to know could you comment. Do you see other parents turning to tutoring centers, you know, commercial, or is that just a regional thing that I've seen in my own community?

MS. HORRIGAN: No, this is a trend that's becoming very common in the Needham School District as well, particularly at the Newman Elementary School. Though I don't have a large circle of friends, I would say I know five or six families who have enrolled their children at Math Advantage in Wellesley or the Russian School of Math and the very popular Kumon Program. I expect to actually see the MCAS results turn around with raised awareness, but it will be because we are an affluent community and parents will apply their personal resources and

supplement their children, to ensure they are getting what they are not getting at school. I also know at least three families that pulled their children out of the public school system this year because of the math program.

MR. FAULKNER: Thank you, Ms. Horrigan.

I think we need to move on. We'll go to the third commentator. This is Dr. Richard Bisk. Okay, Thomas Fortmann is also part of this testimony, I believe.

MR. BISK: Good morning, I'm Richard Bisk, Chair of the Mathematics Department at Worcester State College. I've taught in the Massachusetts State college system for 25 years.

Few of our students arrive prepared to do serious work in mathematics. This year, 24 percent of our 726 first year students needed remedial work in math, only 26, that's not 26 percent, and only 26 students are currently taking courses in our calculus sequence out of our freshman class. I'm more alarmed by what I see in my classes. There are large numbers of students whose mathematical development seems to have stopped at the middle school level.

They are uncomfortable dealing with fractions and percents. They view math as a meaningless set of rules to memorize and regurgitate.

They avoid math. Many of these students go on to become elementary school teachers. If your child had a teacher who was reading at the tenth grade level, you would be concerned. If they were reading at the sixth grade level, you would be outraged, but that's the situation that we have in mathematics and that's why millions of students who enter our college classrooms are operating at the sixth grade level.

I don't blame the teachers. I've taught mathematics content to hundreds, perhaps thousands of elementary and middle school teachers in professional development courses. They are incredibly dedicated and hard working. They are more than capable of learning the mathematics they need to become effective math teachers. I blame the programs that prepare teachers and the departments of education that license them. Talk to a group of elementary teachers and ask them how many math classes they took in college. The most typical answer I get is one. Then ask if the classes they took had any connection to the math they are actually teaching. The typical answer I get is “no.”

Reading a first grade book is a simple task for most of us. Teaching a first grader to read is not. We need to provide prospective elementary teachers with a sequence of mathematics courses that

develop a depth of knowledge of the math they will be teaching and the math that their students will go on to study. The Conference Board of Mathematical Sciences recommends at least nine credit hours of such course work for prospective elementary teachers. Few programs provide anything close to this. Our testing of new teachers supports the work at the colleges. In Massachusetts, only 17 percent of the elementary licensure test assesses math. It appears that you can get all the math questions wrong and still pass. As long as current graduates are passing the licensure test there is little incentive to change graduation requirements for prospective elementary teachers.

In summary, colleges should require stronger and more appropriate programs of study in mathematics for pre-service elementary teachers and our licensure process should require them to demonstrate a strong understanding of the mathematics they're expected to teach. Without these changes, we won't see improvement in the next generation of students. If I have a few more minutes, can I add to Dr. Waight's comments?

MR. FAULKNER: You're using up our ten minutes, why don't we do that after.

MR. FORTMANN: I'm Tom Fortmann, an

applied mathematician with a Ph.D in electrical engineering from MIT.

I've worked in both academia and industry, as a professor and engineer, a high tech executive and more recently as a volunteer teacher of mathematics. Working in a variety of urban schools, I soon realized that students' appalling math deficits are grounded in elementary school where teachers lack knowledge of the subject. I founded the Massachusetts Mathematics Institute, a professional development program inspired by the Vermont Mathematics Initiative and attended by a thousand or more K-8 teachers since 2003.

Based on pretests and classroom interactions, it's clear that a large majority of K-6 teachers do not understand K-6 mathematics, i.e. elementary arithmetic. Many middle school teachers are similarly deficient. Indeed the publishers alluded to this yesterday when they said that textbooks are bloated to compensate for teachers' inability to explain mathematics. This is a national problem vividly documented by Liping Ma, but I regret to report that the teachers in her study appear to be well above average.

A large majority of our participants can not correctly answer pretest questions about

fractions, decimals or percents, do not understand place value, cannot locate rational numbers on the number line and are surprised to learn that addition and subtraction are inverse operations. In one group of veteran fifth and sixth grade teachers, 24 percent were able to find two numbers between one and 2/5 and one and 41/100. 43 percent correctly answered the question 75 is 30 percent of what number. Fifth and sixth grade teachers.

The Panel's charge is to use scientifically-based research and focus on the preparation of students for algebra, but algebra is simply out of reach when teachers don't comprehend and are intimidated by the very concept of a variable. Moreover, how much research do we need to confirm what Will Rogers observed nearly a century ago? He said you can't teach what you don't know any more than you can come back from where you ain't been.

(Laughter)

MR. FORTMANN: I hasten to add, he did. I looked it up.

(Laughter)

MR. FORTMANN: I hasten to add that none of this is the fault of current teachers. A random sample of 100 people off the street would yield the

same results. It is the fault of our current system where most high school graduates don't even have a working knowledge of K-8 mathematics, and pre-service teachers are not required by either colleges or states to learn the mathematics they need in elementary classrooms.

Professor Bisk's comments raised this latter issue. Addressing it aggressively in college programs and certification requirements will eventually produce future generations of teachers with adequate math content knowledge.

In the meantime, we need comprehensive professional development for current teachers; it must be rigorous; and it must be challenging and extensive. Learning mathematics can't be made easy and decades old deficits cannot be erased overnight. I have good news to report. Most teachers in our programs realize their own shortcomings and are anxious to learn the mathematics that they know they need in the classroom. They work very hard, make substantial progress and feel good about their accomplishments. Most importantly, they gain confidence that they can understand and do real mathematics and that they can impart real mathematical understanding to their students.

Teachers' content knowledge is the long

pole in the math tent. Curricular materials cannot compensate for its absence, nor will old fashioned curricula that rely on rote memorization or new fashioned ones that rely on pseudomathematics help. Moreover, research comparing such curricula is futile unless the teacher understands the subject. We need, first and foremost, teachers who know the mathematics, and second, curricula that meld skills with understanding to support those teachers in presenting real substantive mathematics. The new focal points that were presented yesterday appear to be a giant step in that direction.

Thank you.

MR. FAULKNER: Thank you both.

Questions or comments from the panel?

Skip?

MR. FENNELL: Dr. Bisk, you referred to the test that was only 17 percent mathematics for accreditation.

MR. BISK: Correct.

MR. FENNELL: Could you identify that test? Is that a state assessment?

MR. BISK: That's a state, Massachusetts' test for teacher licensure.

MR. FENNELL: Is that a variation or is it derived from what I know to be Praxis?

MR. BISK: I believe we have our own test here.

MR. FENNELL: Okay, it's your own test.

MR. BISK: And my understanding is, and Dr. Stotsky might know more about this than I do, is that anybody who wants to take a test to become a teacher takes two literacy tests and those tests are the same, regardless of the field. I don't believe the literacy tests include any mathematics at all, which is an interesting comment in itself. You also take a specific test for the license you want. So, if you want to be a high school math teacher, you take a test that's all high school math. If you want to become an elementary teacher, you take a test that has some math, some science, some history and so on. 17 percent of that test is math.

MR. FENNELL: Let me push that just a little bit. What about middle school?

MR. BISK: I believe for the middle school license, right now, the test is all math.

MR. FENNELL: All math?

MR. FORTMANN: Middle and high school teacher have to take a specific test only on mathematics, math teachers.

MR. FENNELL: But both groups, middle and high, are in the same pool, as opposed to a separate

pool for middle.

MR. BISK: Excuse me?

MR. FENNELL: They are in the same pool. It's the same test for both middle and high school?

MR. BISK: No, there is a middle school test and then high school math.

MR. FENNELL: You also referenced the Conference Board of Mathematical Sciences, Mathematical Education for Teachers Report, which was released in 2001, which does outline very specific mathematics for the levels. You were primarily talking about elementary but it also outlines for both middle and high. I suspect that that report, which really hasn't gotten the due that it probably should, could go at least some way in getting at some of the concerns you raised.

MR. BISK: There is also a report that the University of Chicago put out from a conference they had, I believe in--

MR. FENNELL: Yup, I have that one too.

MR. BISK: --recommendations so, 16 years later, we are still talking about these recommendations and I'm getting the next generation of students with the same skills.

MR. FAULKNER: Deborah?

MS. BALL: I appreciated your comments,

Dr. Fortmann, about the importance of teacher content knowledge. And I was very interested in your comment that one could use a variety of curricula and what would matter most is the teacher's ability to understand the content and to use the curriculum wisely. I also heard you say, and I think it's worth underscoring, that the mathematical knowledge that teachers need is not simply the kind of math that anybody on the street needs to know but actually they need to know it in a kind of depth and complexity that's beyond simply answering questions, and of course they need those questions.

I wondered if you could speculate about the relative importance of any particular curriculum? That is, could a teacher, who knows math well, produce good results in students using that material well because of his or her mathematical judgment? Or, since the Singapore curriculum, for example, doesn't provide professional development or teachers guidance, I'm curious about your comments about the interplay between curriculum supports, professional development and teacher content knowledge. Could you speculate on that?

MR. FORTMANN: I haven't spent a lot of time in classrooms with teachers, but I've spent a lot more time with the teachers in teaching the

actual mathematics. I've always felt that clearly the knowledge of the subject comes first. A good teacher will compensate, and work around and do something good with whatever materials there are. I've seen some materials that I think are pretty weak and if I were teaching with them, I know I would be supplementing a lot but, other than that, I'm not sure how to answer your question.

MR. FAULKNER: I think we are going to need to move on. I want to thank Dr. Bisk.

MR. SCHMID: Can I just ask one more question?

MR. FAULKNER: Okay, Wilfried.

MR. SCHMID: This is for Richard Bisk.

You provided the professional development for North Middlesex, the implementation of the Singapore Math Program. Could you just comment on, let's say, the kind of professional development you did in the way in which that was affected by Singapore Math, the characteristics of Singapore Math?

MR. BISK: The one thing I should say is what I probably did six or seven years ago is not what I would do now because I think I've learned a lot since then. If I was doing the program right now, I would focus primarily on the number and

operations strand because I think that's the basis for all the strands. At the time, I think the professional development was more geared around helping them see what was in the books and also helping just to generally see that mathematics is a logical system. I mean Dr. Waight answered the question about what's different about Singapore Math, and to me the two big differences are there is a clear, coherent development to the mathematics.

Second is most topics are taught for mastery and not simply for exposure and in too many books you see this business of we'll teach a little bit of it to you now. If you don't get it, you'll see it next year, and it gives students the wrong message and they never will actually learn very much.

MR. FAULKNER: I think we do need to move on. Thank you, Dr. Bisk and Dr. Fortmann.

Our next person is Solomon Garfunkel.

MR. GARFUNKEL: Good morning. My name is Sol Garfunkel. I'm the Executive Director of the Consortium for Mathematics and its Applications. I have a doctorate in mathematics from the University of Wisconsin. And I have been a principle investigator on one or more National Science Foundation projects and in mathematics education continuously since 1976.

Basically, my comment to this panel is don't do this, don't write the report that we all expect to come out of this Panel, because I think it will set back mathematics education for a number of years. Don't write a report that says there is a lot we don't know, or a seemingly reasonable report that says there is a lot we don't know about mathematics education. There is a lot of research that needs to be done. It should be funded by the Department of Education. And until that research is complete, we should stop innovation in curriculum development, except if we adopt something like the Singapore Program, and that we should cut off funding for that curriculum development, we should cut off funding for the National Science Foundation. I suspect that that's what this report will eventually say and it's a terrible mistake.

I think people forget, purposely possibly, why the standards were written in 1989 by a much more courageous National Council of Teachers of Mathematics. They were written because we were here. The problems were there, we recognized them and things were not working. And to be honest,there was a remarkable consensus about that. Everyone came up and said the kinds of things you are hearing today, students don't learn, teachers don't know any

mathematics, nothing good is happening. By the way, nothing good is happening at the low end and the high end and we've got to do something about it.

The NCTM Commission issued standards with their own funding. It was a very brave act. What the standards said and what I think gets lost, by the way, is that those standards were supported by every major mathematics organization at the time, including the American Mathematic Society (AMS) and the Mathematical Association of America (MAA). And what those standards said was we need to innovate, and we need to look at content, pedagogy, applications, and technology. We have to think hard about the choices we've made and the choices we might make.

Yes, they made some suggestions about ways to go, but the point was dissatisfaction with where we were and a desire to try some new things. The National Science Foundation supported a lot of grants, a lot of work of innovators, of content developers, not, and I say this at every possible opportunity, not with the sense that we've got to replace where we were. We've got to take the pre 1989 materials, throw it out and replace it with these new curriculum just to see whether we could, on a day to day basis, make the vision of NCTM extend, that we could actually create materials that embodied that

vision, those ideals, and to experiment with them, to innovate, to try things, to see what worked, to give researchers a body of material that they could work with to see in fact whether this was going to do any good.

And I think what's happened is that there is evidence, a significant amount of evidence, that some of those innovations, some of the changes that we've made in content, some of the changes that we've made in applications, in pedagogy and technology have done some good. Look at the ARC Center report. Look at Joe Boehler's research. I'm not saying it says take this curriculum and replace it with that one, but it does say that there is a place for that innovation. What this panel should not do is, in their report, cut off that funding, cut off that generation of people who have started doing this work, who you will need when it comes time to do the kind of actual changes, homemade, not imported, real change, with real innovation, with the American mathematics educators who have been working on this problem for 20, 30, 40 years. And that's all I have to say.

MR. FAULKNER: Questions or comments from the panel?

MR. SIEGLER: Why is it relevant if a

program was developed in the United States or in Singapore?

MR. GARFUNKEL: Well I will say the relevance is there are two kinds of --. By the way, the people in Singapore, I go there, I talk to them. They come here to look for innovation. They come here to look for creativity. They argue that their students can do lots of very nice and manipulative technical things that we test for, but they can't create. They are not the students who come to MIT. They are the students who do well on these exams, fine. But I'm worried about that pipeline as much as anybody else here and unless we have that innovation, unless we have that creativity, unless we build in the things that Americans are actually good at, then we are just doomed to having kids who do well on tests. Fine, if we want kids who do well on tests but can't compete in the society. People from Singapore come here to learn how we get creativity.

MR. WU: Sol, there are just a few points of factual error. One is that AMS, yes, approved of the NCTM standards in 1989, but the fact had been documented that it was approved with actually no reading of the standards, that's number one. Number two, about Joe Boehler's research, it's in great dispute, and there are scholarly concerns about the

quality and the methodology. Number three, about Singapore, indeed Japanese educators and Singapore educators came here to look for answers. They looked for answers and in the case of Japanese educators. They took a lot of information back, and I believe that three or four years ago they have since made a U-turn and decided that it couldn't be done, so I think I should stop here.

MR. SCHMID: I mean of course there is a frequent complaint that somehow the East Asian countries emphasize calculation at the expense of mathematical thinking. You should be very careful when you say that Singapore children don't get mathematical understanding and then they have no ability to excel, let's say, at a higher level. First of all, Singapore of course is rather small, so if you talk about the number of people who do various things, we have to be careful in making such comparisons.

Take South Korea, South Korea has a curriculum that in many ways has similar characteristics to the Singapore curriculum. Of course it isn't written in English, it is therefore not as well known as the Singapore curriculum. At Harvard, we see a very large number of graduate students from South Korea, who have gone through a

curricula of that sort, who are certainly capable of functioning at the highest level. What you said about the Singapore curriculum is a slur.

MR. GARFUNKEL: My point is that the answer is not to simply import a curriculum because you find it to your liking. We have in mathematics education in the United States, we are quite capable of taking the best of those other curricula and the best of what's done here. You wouldn't do it with other things. You only do it here because this curriculum happens to be to your liking. I will say that you should not cut off the research and the development of materials that are going on by homemade people just because one curriculum happens to appeal. It's a mistake.

MR. SCHMID: This committee cannot cut off funding for curricular innovation in the United States and even if we could, we would not ask for that, that is not the point. It is, as you say, one needs to be guided also by international comparisons, that is one reason for focusing, let's say, on the Singapore curriculum, to see what is good there and that that be properly appreciated. It does not mean that there has to be a wholesale importation of foreign curricula.

MR. GARFUNKEL: But you don't focus on

the Dutch curriculum, for example.

MR. FAULKNER: Let me go to Tom.

I think we are not going to get to everyone who is signed up if we aren't crisp with our comments.

MR. LOVELESS: Just one quick question. I assume you heard the testimony of Holly Horrigan just before you. As someone who supports these new curricula, how would you respond to her, as a parent, with her concerns?

MR. GARFUNKEL: I want to be careful about this. What I am supporting is not any one curriculum, what I am supporting, what I am supporting are the ideas behind a number of those curricula. There were horror stories in 1989. You think you couldn't come up with a parent in 1988 who said that their kids, who were very bright at home, weren't doing well at school, hated math, aren't going into math. Read those reports, read those articles, we could easily, of course that's going to happen with any experimentation, we don't have the right, the one curriculum.

But if you look at data over large numbers of students, take the ARC Center report, for instance, you do see positive effects. I think a horror story here, a horror story there, it's just

anecdotal. It doesn't do any good, it doesn't tell you what the policy should be.

MR. FAULKNER: Thank you, Dr. Garfunkel, I appreciate your being here.

We now go to Mark Driscoll.

As he is getting set up, let me indicate that I think, to the panel especially, we are in this session to listen to members of the public, what they have to say. I think we do need to receive the information from them. It probably would be best if we proceeded by asking questions only in order to make maximum use of the time here. I think debate has a place, but probably at a different time than this one, which is budgeted for our colleagues in the audience here.

So, Dr. Driscoll?

MR. DRISCOLL: I'm Mark Driscoll from Education Development Center, representing both TODOS and the National Council of Supervisors of Mathematics (NCSM). I'm a member of both, an editor of the NCSM Journal of Mathematics Education and Leadership. We are very grateful to the panel for inviting us to be represented here today.

My remarks pertain to the panel's category of interest, learning processes, with implications for the instructional practices

subgroup. Specifically, on behalf of TODOS and NCSM, I want to call your attention to the issue of enhancing mathematical success of English learners and to the associated issue of galvanizing mathematics education leadership in this regard.

This presentation is a truncated version of my written remarks, which have a supporting bibliography. In the past three decades, the number of U.S. children living in households where the native language is not English more than doubled from 9 percent to 19 percent. The total number of students labeled as limited English proficiency is 9.6 percent of the student population of 4.5 million.

Many of these children are taught mathematics in English, which adds a considerable learning hurdle for them. Results, tools and practices already exist that can help transform English learners' experience in mathematics classrooms, yet we lack coherent programs for scaling up their use and that requires galvanized leadership.

Let me elaborate. Consider first the results of the Quasar Project from the 1990s. Quasar was a five-year innovation in six middle schools serving poor communities with both a school demonstration project and a complex research study of

educational change and improvement. One strand focused on types of classroom mathematics tasks and on the nature of student engagement with tasks. The researchers distinguished tasks according to cognitive demand. They noted that different mathematics tasks create different levels of cognitive demand and that the cognitive demand of a task can change during a lesson, depending upon what teachers and students do in implementing them.

Through classroom observation analysis, along with a project developed cognitive assessment instrument, the study concluded that student learning gains were greatest in classrooms in which instructional tasks consistently encouraged high level student thinking and reasoning, for example, conjecturing, justifying, interpreting, at least in classrooms in which instructional tasks were predominantly procedural in nature. For English learners, the phrase meaningful tasks takes on even more complexity because of the role of academic language, this provides a pointed challenge to teachers and administrators.

Particularly because of current testing demands, many are tempted to address English learner needs by separating language work from mathematics work and with strategies such as vocabulary drills.

Often this lack of integration of language and content development results in a lack of active engagement by English learners in the mathematical work being done in the classrooms.

However, despite the added challenge of academic language, there is no need to cease heeding the Quasar message, as evidenced in the story of one fifth grade teacher whose work has been studied by Chevalle and Kristey. Sarah, a pseudonym, teaches in a school that is nearly 100 percent Latino, in one of the poorest neighborhoods in a large, urban school district. Year after year, students have entered Sarah's classrooms about a half year behind the expected 4.8 in the Iowa Test of Basic Skills (ITBS), and typically leave her classroom eight months later outperforming the other fifth graders in her school, as well as other fifth graders in her district with the majority at the 5.8 level or higher. In tracing the roots of this success, Chevalle and Kristey document a consistent use by Sarah of writing assignments and classroom discourse related to challenging mathematics problems used as occasions for clarifying, not simplifying, mathematical language.

For example, it's the first week of school and the children are being engaged in a

challenging geometry problem. The word congruent has been introduced. Sarah says look at that word, everyone, "Congruent, what does that mean?" A student says, "Like another copy," Sarah says, "An exact copy." This here, look here at this circle, is this circle congruent to that circle? Chorus, no. Sarah, "No, they are not exact copies, they are similar." They are both circles but they are not exact copies, the first week of school.

Of course Sarah is but a case of one. However, we believe that scaling up success like hers is possible if our leaders, national, district and school level leaders, increase attention and teacher professional development to the importance of, one, integrating content and academic language development in classroom instruction; two, attending to cognitive demand in the mathematical work done by all students but especially by English learners; and three, creating learning environments that use multi model mathematical communications, speaking, writing, diagramming, etcetera, to reinforce the learning of mathematical language.

Thank you for your time and attention.

MS. STOTSKY: Just a quick question. Have you done or are you aware of any research that has been done on English language learners that looks

at any differences in their learning of mathematics using language-heavy mathematics materials as opposed to less language-heavy mathematics materials, both modern programs? I'm just curious if you know of any research or have done any.

MR. DRISCOLL: I don't. I'd love to, but I don't.

MS. STOTSKY: Okay, thank you.

MR. FAULKNER: Thank you.

Next on the list is Mary Jane Schmitt.

MS. SCHMITT: Good morning. Thank you for the opportunity to speak with you this morning. I'm going to change the subject a little bit. My name is Mary Jane Schmitt, and I'm representing today the Adult Numeracy Network, a national professional organization of educators concerned with the mathematical literacy, sometimes referred to as the numeracy or quantitative literacy, of our nation's adult population. Most of us teach math in General Educational Development (GED), adult basic education or development community college programs. We work with adolescents and adults of all ages, many who have dropped out of school and are now returning for a second chance at education.

We believe these school returnees, seeking this second chance, deserve and require a

mathematics education that is first rate. We in the Adult Numeracy Network are in the business of teaching K through 12 mathematics content to students who didn't get it when they were in the K through 12 system. First, we ask the Panel to pay close attention to the mathematics learning of those students who are presently at risk of joining our classes. And I think you see that as your job, but we want you to also pay attention to anticipate, not only to anticipate, but also to address the mathematical learning needs of the people who are no longer in the K through 12 system but who are at risk because of their lack of math knowledge.

Therefore, we ask the Panel to create an inclusive agenda that not only addresses the needs of every student currently in the K through 12 system but also extends somewhat beyond that system. The Executive Order sets forth a policy to "foster greater knowledge and improve performance in mathematics among American students." But what about the adolescents and young adults who have dropped out of the system and have yet to obtain a high school diploma? The members of your Panel have been directed by the President to focus on the need to create a competitive future work force. Well what about the adults in the current work force who lack

sufficient mathematics knowledge and skills to succeed?

And the Panel is interested in parents having input to their children's education. What about the need of parents to develop their own mathematical skills as heads of family, citizens and workers? And the Panel is finally interested in preparing students for college and careers. Well, what about those who, when enrolling in community colleges, find themselves unprepared to take on college level mathematics? The numbers here are not insignificant and must motivate the mathematics education community to take action.

Here are some statistics we think are salient: there are estimates of a 70 percent high school graduation rate, every nine seconds a student drops out of school in America. When they do, their journey through K through 12 mathematics education is cut short. Each year, over 400,000 high school diplomas awarded in the United States are GEDs, and of those who fail to pass the GED, the mathematics test is the most frequently failed section.

And about the work force, most of those who are going to be working ten years from now are already working. Yet results of large scale surveys of the adult population indicate that 58.6 percent of

U.S. adults have skill levels below the minimum level for coping with today's skill demands.

Finally, in the community college system, so many kids and adults are taking remedial courses. Community colleges are quickly becoming the space where students need to take catch-up courses. Few who begin those developmental math courses continue on to complete a degree. As one professor graphically stated on the front page of the *New York Times* on September 2nd: "It's the math that's killing us". To omit this large group of adolescents and adults from the Panel's agenda does a disservice to countless individuals, to our nation's families, communities, work places, and to the economic prosperity of the nation.

Individuals are impacted because a person's numeracy skill level may be even more predictive of economic success than the literacy skill level and our nation's economic health is impacted. There is one international comparative study that suggests increasing the quantitative prose in document literacy levels of the segment population with the lowest skills has a greater positive impact on the nation's GDP than increasing the mathematics literacy of the segment with the higher skills.

MR. FAULKNER: I need you to wrap up.

You're in the list minute.

MS. SCHMITT: I am concluding.

We trust that you conclude as we do, that your agenda must include the mathematics education of not only those at risk of dropping out but also those who drop back in, working adults in need of more math for work place and career advancement and adolescents and adults seeking higher education.

Thank you for your attention.

MR. FAULKNER: Thank you, Ms. Schmitt.

Any questions from the panel?

Then we will move to the seventh commentator, Herbert Ginsburg.

MR. GINSBURG: Thank you for the opportunity to speak today. I'm a cognitive developmental psychologist at Teachers College-Columbia. And I've been deeply concerned with early mathematics education, particularly in children from three to six years of age. I've been involved in the development of curriculum, tests and programs of professional development. At present, I'm working with Wireless Generation on the development of a system that uses the handheld computer to guide teachers' mathematics assessment. Many have argued that early mathematics education is crucial, especially to narrow the gap between low and middle-

income children.

I want to argue today that technologically guided assessment of young children should play a prominent role in our education agenda. Several points, and I'm improvising on the document I gave you. The ongoing assessment of the learners' performance and thought process, the skill and knowledge, the facts and ideas is crucial, regardless of your point of view or curriculum. The existence of individual differences and the fluctuation within the individual makes this kind of assessment imperative. Teachers need to learn how to assess their students more effectively than they do now so as to improve instruction. Most teachers do this informally. They need to do it more deeply and more efficiently.

At least in the case of early childhood, researchers have given us a good idea of what aspects of thinking and learning are important to assess. We know about strategies, and we know about various aspects of number sense. We know about key concepts that kids have to learn. A system of assessment then should have three basic features. One is the ability to screen. We know what predicts later failure in young children and we can screen for this. We need flexible, cognitive diagnostic interviews. We need

flexible questioning of children, as used in cognitive research and as used in many classrooms informally. We need progress monitoring. We need to know how well the kids are doing and how instruction helps them to improve.

We are now developing technologies that can play a transformative effect on assessment and help us to do these things. They allow the teacher to use the handheld computer as a basic tool in assessment. This is technology in a very human context. The computer guides the teacher in a process of screening, in a process of interviewing children in a contingent manner and in progress monitoring. A system like this helps teachers efficiently measure individual student performance, get insight into their thinking, guide their instruction and help them overcome learning difficulties.

It also can help administrators to review classroom, school and district data, useful for evaluating success of educational reforms, and to recognize which students, classrooms and teachers are making progress. It also helps to evaluate intervention.

An assessment of this kind offers important benefits beyond assessment. It's a form of professional development in itself in which teachers

learn to think to the test, rather than merely teach to the test. If the test has interesting things to think about, this will help teachers. So, in the process of administering assessments like this, teachers learn to think more deeply about what is involved in math learning and teaching.

An indirect benefit is that teachers learn to incorporate sound forms of testing and interviewing to everyday instructional practices. They learn that these methods can help to monitor what students are doing and to improve instruction. Students also learn a great deal from good assessment.

MR. FAULKNER: You're in the last minute. You need to wrap up.

MR. GINSBURG: Students also learn a great deal, particularly if there is a flexible interview component. When students are asked to describe how they solved a problem and justify their solutions, they may learn language, learn to think about their own thinking and learn, as does the teacher, that thinking about math is an integral part of learning the subject.

And so, as you develop recommendations, please give serious consideration to the importance of math education in grades pre-K through 3 and how a

formative assessment system can help to improve learning outcomes in these critical, foundational, early years.

Thank you.

MR. FAULKNER: Okay, Professor Ginsburg, let's see if there are questions.

Bob?

MR. SIEGLER: This sounds like a really interesting professional development and assessment tool. Do you have anything written up and what kinds of evidence are there that this does in fact enhance both accurate screening and enhance the student learning?

MR. GINSBURG: We are beginning to write up what we are doing, and this work is being released this fall, actually. We have plans to obtain large amounts of data and to answer some of the questions I know you are interested in, Bob. We don't have a lot of evidence yet. There are studies by others showing that progress monitoring, for example, can be effective in improving student performance.

MR. BOYKIN: Could you comment on the kind of professional development that will be required for teachers to use this kind of assessment technology?

MR. GINSBURG: Yes, that's a very good

question. We are engaged, at the same time, in developing professional development programs. Right now we are actually working with the State of Texas to develop a program of this sort that will be used widely, starting in, I think in January. So, yes, we need supplemental work for teachers. To some extent, the training and the use of the tool itself can be done in a relatively narrow manner. It can explain how you use it, how you interview the kids. The teachers will in fact learn a lot. That is my prediction. But supplemental professional development of a more extensive type, focusing both on the mathematics, and on the learning and on the curriculum, all this needs to be tied together.

MR. FAULKNER: Thank you very much, Dr. Ginsburg.

We now go to Holly Concannon who is the eighth commentator.

MS. CONCANNON: Good morning. My name is Holly Concannon. I would like to thank you for this opportunity today. I've been teaching in the Boston Public Schools for ten years, I've enjoyed my job immensely and have learned just as much as my students every year.

I'm currently a looping teacher for grades four and five. I'm very pleased that the panel

has a working group focused on teachers and professional development because that is what I would like to speak to you about today, my growth as a teacher. I spent my first two years as a teacher teaching kindergarten and first grade. I started teaching fifth grade eight years ago, and I admit I was a little bit anxious about teaching in the upper grades.

Moving up to the fifth grade gave me a chance to revisit some of the math that I hadn't seen in a long time. I was handed a textbook accompanied by a teacher's guide and was told basically what I should do. The book was easy for me to understand and I assumed that, if I followed the book's instruction, I would see success with all of my students. For the most part, I did. The majority of the students were able to answer questions in the book after being told what steps to follow. The students got it or they didn't. Some felt very successful and confident in their abilities and others began to feel as if math was just not their subject or strong point. After all, that was what my method of teaching was telling them and me.

What else strikes me about the memory of teaching in this fashion is the way the students responded to the higher level questioning. Oftentimes

they would defend their answers by saying things like, “I just knew,” or “I did it in my head.” Explaining their thinking was not a strength of any of the students, and they often weren't asked to do that. Therefore, I couldn't assess their understanding or identify any gaps in their thinking.

I now teach grade five with a more balanced approach, using the investigations, and number data and space curriculum. This rigorous curriculum helps the students develop computation skills with an understanding of the underlying concepts.

In my classroom, students get daily skills practice, and they apply these skills to meaningful problems. We hold the children to high standards, which include having them explain their thinking. By getting to know my students this way, I now have multiple ways to assess their thinking. I can figure out what they need to do in order to progress.

When I reflect upon the way this more balanced approach has affected my students, there are many children who come to mind. One in particular is very easy to talk about. She entered the Murphy School very shy, timid, and to some extent, academically damaged. She transferred into our

school from a private school that she had been attending in her neighborhood since kindergarten. She was terrified of her new school setting and especially her dreaded subject of math. You see, she was one of those students who thought she just didn't get it. She assumed that she would also do poorly in math because she was used to failing grades on traditional assessments. She wasn't used to being asked how she was thinking about the numbers or how she arrived at her answers. After a few weeks of being asked those questions and feeling as though she was able to think mathematically, she was able to progress.

I was able to identify what she knew and understood, along with what she didn't. Because I was able to get to know her in this fashion, I was able to provide experiences for her to grow. Along with her confidence and desire to learn, her achievement in math skyrocketed. For the rest of the two years she spent with me, she looked forward to math and figuring out why numbers worked the way they did. She, like many of my students, grew to love the idea of figuring out the why along with the how. She grew to think like a mathematician, rather than a girl on an individual education plan who hated and was not good at math.

It's easy for me to talk about the progress I have seen because I have experienced it firsthand. However, the students in my room are not the only students who have benefited from this rigorous and challenging curriculum. The Murphy School has seen success in all of our classrooms, not only are our teachers talking about the improvement we are seeing on our city-wide assessments and the higher level of classroom discussion. We are also seeing results on the state assessment, the MCAS.

I'm proud to share with you today the gains that we have made in math. In 1999, our school had devastating results on the statewide test. 54 percent of our students landed in the warning category. Six years later, we have just nine percent in that same category. The number of students achieving advanced or proficient has risen 32 percentage points.

These statistics have given the Murphy reason to celebrate. However, we are not the only school worthy of the celebration. The Boston Public School District, as a whole, is making progress. Early this year, we made national headlines for having the greatest gains on our NAEP scores, among 11 other urban districts.

I credit these gains to our district's

commitment to professional development, and I believe strongly that the successful implementation of any curriculum depends on strong teacher support.

Thank you.

MR. FAULKNER: Thank you, Ms. Concannon.

Any questions from the panel?

Skip?

MR. FENNELL: Holly, I actually have kind of a two-part thing, but you are a tenured teacher, you can handle it.

(Laughter)

MR. FENNELL: We've heard earlier some concerns, criticism, relative to the Investigations curriculum by a parent. In your ten years, you have had to deal with a number of parents in a number of contexts. You heard the other Holly parent and with her initial concern, how might you have responded to her?

MS. CONCANNON: Well it's a pleasure for me to speak on behalf of myself and the teachers at the Murphy School. Boston has been a joy to work for because of the support they have given to us. Not only are all of our teachers involved in K-6 mathematical professional development, we've also been offered courses for every single unit that we teach. So our teachers are being supported and they,

I feel, have the opportunity to learn as much as we can in order to help our kids so we are not sending kids home with homework that looks brand new to them. We are sending kids home with work that should be an extension of what has gone on in the classroom.

I'm also happy to say that, in Boston, we offer parent workshops. The math that our children are facing is much different than the work that we faced as children and often the parents say it looks like another language to them. Not only are we able to offer parent workshops where they get to know the math, we are also now working with some of the revised materials where parents get a letter home not only about the math but with examples of what the math should look like that their kids are dealing with.

So parents can see an example of the work that their kids should be doing in class. Hopefully that helps them and hopefully they also take advantage of the parent workshops. I do believe the professional development, among teachers especially, and parents is the most important part of our curriculum.

MR. FENNELL: Now, for the second part, I'm kind of quoting here from your response. Your students get daily skills practice. Is it your sense

that your kids, at the fifth grade level, have an understanding of whether it is multiplication or division, and are they okay with algorithms? I mean are they okay with working through things that we might even call the standard algorithms with some notion about how and why those things work?

MS. CONCANNON: I sound like a proud mother, but I feel very strongly that my students have a strong understanding. I would also like to say that students in my class have seen traditional algorithms, and that is one way to approach mathematics. It's not something that's disregarded. It's not something that they are not allowed to do.

MR. FENNELL: So they have access to that?

MS. CONCANNON: They have access to that and many times they bring it from home. It comes up in our classroom, and it's a great teaching point.

MR. FAULKNER: Dr. Wu?

MR. WU: Hi. It's an interesting experience. In fact, I myself have come across this, and I've come to understand certain things concerning the present theory of mathematics education. About six years ago I was in Wisconsin, and I was hearing a teacher relating experiences quite like yours. Never having any mathematics explained to her, and then she

came across Investigations and she grabbed onto it because it seemed like a savior.

However, as I slowly got to know more about school education, I came also across another phenomenon and that is exemplified, for example, by the professional development institute I just gave in late July to early August. And I was teaching about 28 coaches of teachers, and it was a one-week professional development on whole numbers. I explained to them that it's really about standard algorithms. I explained to them why it's worth learning what's the main theme connecting all the standard algorithms and what algorithms are for.

And afterwards, the teachers, they were all, many of them, most of them, actually, were using it because Ohio dictated the use of Investigations and Everyday Math. And many of them told me that, well, they were happy with
Everyday math, what they were doing, but they also felt something was missing and they didn't quite get to the bottom of things. So they told me that they were very happy. Now they finally seemed to get it.

And so my question to you, after this long winded opening, is, “Are there teachers in the Boston District that you have talked to who eventually learned, became knowledgeable in mathematics, and

they could go beyond, a level beyond that and share that experience with you?"

MS. CONCANNON: I think that's one of the greatest things that is happening in our district. Along with the early stages of the professional development that has been offered in Boston has come a group of teacher leaders that have come out of that. We have also had the great fortune, many Boston teachers, of traveling to different universities and colleges and enrolling in classes to further our own knowledge. With that, we've come back to our district and we have offered professional development to our colleagues. So, not only are we receiving professional development from outside of our district but also then coming back and sharing everything we know with our colleagues in Boston.

And you can see professional development. It looks so different across Boston because we have so much to offer within schools, district-wide, and through being able to have the opportunity to travel outside of our district to learn more.

MR. FAULKNER: Diane, is it extremely pressing?

MS. JONES: I just have a quick question.

MR. FAULKNER: Okay.

MS. JONES: It sounds to me like you are

the kind of teacher that all of us wish our children had and you've done a lot in your own professional development. I just have a quick question. One of the things we are thinking about is teacher professional development, pre-service. Do you have any recommendations based on your own journey that would be helpful to us and how pre-service may have been different for you, based on what you've learned through in-service?

MS. CONCANNON: Yes, and I will admit that my education in undergraduate math was not stressed at all. I really depended on the professional development I received after college and after graduate school. I do believe that, as part of every teacher prep class, there needs to be more emphasis on math and math understanding. Many people my age weren't asked to think about numbers and how they work. They were told what to do. We did it and many of us who memorized the theory back then don't remember it now because we haven't applied it in a way that made sense to us. I do believe there needs to be more emphasis on math education in undergraduate programs.

MR. FAULKNER: Thank you, Ms. Concannon.

I think we need to move on.

I would like to point out to the panel

that our time for doing public comment is now up and we are halfway through. We are going to go without a break until we get all the way through. So we are going to move on and that will mean that we move to Karen Wonton.

MS. WONTON: Good morning. My name is Karen Wonton. I'm a parent of a one-year-old daughter and my son is a sixth grade student at the Murphy K through 8 School here in Boston. I'm here today as an advocate for my son's math learning and an advocate for schools partnering with families to raise academic achievement. I hope the panel will be able to examine districts that are building these partnerships and the impact they are having on student learning. I know that my experience with the parent leadership team in Boston has made a huge difference for me and my son, as well as many other families in the district.

I first became involved with the team two years ago because I wanted to help my son with his math homework. Now I had been a math major at MIT myself, and I had always done well in math when I was in school at my son's age. But frankly, I was perplexed by what he was bringing home, so I had to get involved as a parent. Fortunately, through parent workshops, Boston gave me a chance to find out

more about what he was learning and the way he was being taught. The workshops were a real eye opener for me. I got to see how children were being challenged in class, because I was challenged to think about the math they were learning.

In addition to information about the goals and approach of the curriculum, the workshops give parents a chance to do the math their children are doing. Parents are asked to solve problems and think about how they got their answers. I have to say that when I had to go back and start thinking about what was really going on, for example, when I was carrying that one while adding a column of numbers, I began to see what the teachers meant by the words developing computational skills with understanding. The workshops convinced me that children understand the math better when they can explain how they got the answer.

When parents are asked to solve a problem in their heads without paper and pencil and then describe how they figured it out, they are surprised by all the different ways people worked the problem. This is just one example that demonstrates to parents why teachers want students to learn different approaches to a problem so that they can solve them efficiently. In learning how to approach a problem

in several different ways, the children develop real life skills and are more valuable to their future employers, where flexibility and creativity are a plus.

My experience is not unique. I lead parent workshops, and it is so gratifying when parents come back and tell me about the progress their children are making. These workshops would not be possible without the commitment of the administration and teaching staff here in Boston. I am glad I decided to get involved and learn more about my son's math program. I love helping him with his homework. He is excelling in math and recently he confessed to me that he likes solving those math problems. I believe that this school/family partnership is a critical component of Boston's math program and has contributed to the increase in student achievement that we are seeing here.

I am eager to continue my work with the parent leadership team so that more parents can be advocates for their children's learning. I also want my daughter, who will be starting school in a few years, to have as much success in math as my son is now having.

I would like to thank the panel for this opportunity to address you today and hope, in all

your work, you will be able to examine the impact of parental programs like the one that is happening here in Boston. Thank you very much.

MR. FAULKNER: Thank you, Ms. Wonton.

Are there questions from the panel?

Deborah?

MS. BALL: We are getting a very strong message this morning about the importance of both teacher development and as you've just been describing, the partnerships with parents. Could you just describe briefly for us what the nature is of the opportunities for parent learning that Boston provides and that you've been involved in?

MS. WONTON: The parent workshops that I've been involved in, as part of the actual training for the facilitators, we actually were getting to go to training where we were shown how the math was done throughout the grades from kindergarten through fifth grade. Then we were actually trained in how to be able to facilitate workshops for parents. And so, through a series of four workshops, parents were able to come and actually see what the math was that was happening in class and actually practice doing the math. So we first got trained, as parents, and then we would go out, partner with teachers and actually do trainings for parents in parent workshops.

MR. LOVELESS: Do you know how many parents have taken part in this?

MS. WONTON: In the past two years, I've seen several parents, over 20 plus parents, taking participation. I know even more parents are participating this year.

MR. LOVELESS: How about across the city?

MS. WONTON: I've just been involved with the Boston workshops myself, so those are the only ones that I am aware of.

MR. FAULKNER: Thank you very much, we appreciate your being here.

The next commentator, number ten, is Dr. Daryao Khatri.

MR. KHATRI: Good morning. I'm Daryao Khatri, a professor of physics, with a Ph.D in physics. My colleague, Dr. Anne Hughes, has a Ph.D from the University of Chicago. We are neighbors of Mr. Ron Williams and Dr. Borga, NSF and Department of Education. We are from the University of the District of Columbia in Washington, D.C.

Don't give up yet, please. As a professor of physics, I have a retention rate of 100 percent. I do not require books in my classes. We take the approach that it's not the book that teaches. It is the teacher who does the teaching, and

let's see what Dr. Hughes has to say now.

Dr. Hughes?

MS. HUGHES: We are going to report on a research study, a small one, a pilot one, but let me give you the background first. We begin by stating to keep using the current methods in math will only produce the same old results of failing and drop out students at the college level. We call this staying inside the box. So we looked outside the box, and how we climb out of it. The answer is students will basically stay the same, at least for a while. We cannot provide for a missing father or mother in the home. The answer must be we must change ourselves, as teachers.

To make this change, three things must happen. First, we must know the discipline. All too often, at the high school and elementary levels, the discipline of math is not known.

Second, we must know the universal principles of pedagogy. At the college level, some people can hardly spell the word.

Third, both the discipline and the pedagogy must be fused into one person. We tested this proposed answer in the six-week summer math program with 12 District of Columbia public school graduates who had been admitted to the University of the District of

Columbia as freshmen for this fall semester.

I might add that UDC is an open admissions institution, so there is no, while, we require the SAT, it is not a consideration for the students to be admitted. They were admitted to the project on a first come/first serve basis, without any screening. The problem, basically, for this exploratory study was to ascertain if a short, intensive, six week project in basic math and introductory algebra would produce a recognizable improvement in the math performance of entering UDC students, as measured by the UDC placement test. I might add that UDC requires approximately 85 percent of its freshmen students to take two remedial math courses, basic math and introductory algebra.

We have two exceptions. The pretest results showed all of these students, with two exceptions, would be required to enroll in basic math, and their mean score was 35 and the passing score for basic math was 70. The results showed a 78 percent improvement for basic math and a 44 percent improvement for introductory algebra.

The differences between the pre and post test means for both courses were statistically significant. 3 of the 12 students tested out of both courses. Another 3 tested out of the basic math, and

the remaining 6 showed a marked improvement in knowledge required in the basic course.

The project was funded for the magnificent amount of $8,000. No calculators were allowed and no pictures were used in the handouts. It was all math, and it was also all readiness for college, which these students had very little readiness for. We are now absolutely convinced that an intensive, eight-week program will probably ensure the exemption of similar students, such as the ones we had, from both remedial courses. The implications for expenses of remedial courses at the college level are enormous.

MR. FAULKNER: Your time is up. I need to get you to wrap up.

MS. HUGHES: I'll just quickly add the pedagogy we used in the project is present in two books and they formed the basis for the teaching.

MR. FAULKNER: We have been provided with copies of those books and we thank you.

Are there questions?

MS. HUGHES: Thank you for the opportunity.

MR. FAULKNER: Well thank you. We appreciate your being here, Dr. Hughes and Dr. Khatri.

Questions from the panel?

MR. KHATRI: Let me add that anyone who is interested is invited to see us in action at any time.

MR. FAULKNER: Thank you very much.

The 11th commentator is Stanley Ocken.

MR. OCKEN: Good morning. My name is Stanley Ocken and I thank you for the opportunity to speak. I'm a professor of mathematics at CCNY, the City College of New York. CCNY is the original branch of the City University of New York, whose undergraduate colleges, together, have graduated 12 Nobel Prize winners including, I'm happy to say, three who began their careers as City College math majors. Extending that record of accomplishment has proven to be a challenge for reasons that connect directly with the work of your panel.

There is cause for real concern about whether American high schools are graduating the critical mass of mathematically competent students needed to sustain science, engineering and other mathematics-based programs in our colleges and universities. Addressing that concern is a long-range goal of your first charge, which is to describe what students should know if they are to be ready for algebra and for higher levels of mathematics.

Of course this panel knows well what constitutes higher mathematics, but many people do not. It is crucial to inform as many stakeholders as possible about the content of and prerequisites for success in college mathematics. We need to do that now, as more and more undergraduate math departments are being pressured by administrators to do something about low pass rates in pre-calculus and calculus courses.

Well, what is to be done? Part of the problem is lack of communication. K to 12 teachers, parents, students, board of education and schools of education all need access to something that is not easily available, a clear portrait of college mathematics. My first suggestion is that you paint and publicize such a portrait. Start by asking a representative group of high school and college mathematics faculty to assemble a college math guide. That document should contain generic final exams in pre-calculus and freshman calculus with the solution to each problem accompanied by a concise list of prerequisite topics and relevant examples from high school mathematics.

Send that math guide to state education departments with the strongly worded suggestion that they use it to calibrate the content and emphasis of

standards and assessments. Offer it to parents' organizations so that they can demand from local school boards a content rich mathematics curriculum for their children. Send it to schools of education so that degree candidates and faculty in mathematics education, as well as K to 12 teachers in training, understand clearly the eventual focus of mathematics instruction for a large cohort of American K to 12 students. Finally, distribute the math guide to curriculum and textbook publishers with a request that they undertake item by item valuation of whether their K to 12 products provide grade appropriate preparation for problems on college math exams.

My second suggestion is that you investigate and make recommendations regarding common sense issues of pedagogy. It's important to think about the sequence of tasks and knowledge that lead to success in algebra, but it is critical and possibly easier to find out why so many entering college students seem to have forgotten the algebra they learned in school. You could begin by stripping away the obfuscating rhetoric of blind rote and drill and kill. Then you might examine the proposition that repetition and practice, properly implemented, are essential to success in mathematics, just as repetition and practice, properly implemented, are

essential to success in music, sports and the study of foreign languages. You could conclude by identifying prior indicators of successful college math students.

Before they got to college, did they experience rigorous and frequent in-class assessments? Were they required, for example, to master the multiplication facts by the end of third or fourth grade, or were their programs grounded in the principle that it doesn't matter if children master the material this year, since they are going to relearn and re-relearn the same elementary material in later grades? In other words, please investigate the role of basic interventions that clarify the scheduling and rigor of learning goals, these may be more effective and easier to implement than complex manipulations of curriculum and pedagogy.

Here's my third and final suggestion. Annunciate the importance of a coherent K to 16 mathematics curriculum, one grounded in the principle that K to 12 math instruction must permit and encourage students to prepare for the rigors of calculus. To bring that principle to life, we'll need to see fundamental changes in the dynamics of K to 12 curriculum design. Groups that develop

standards, programmatic materials, assessments and textbooks should include math teachers at all four K to 16 grade bands. The college contingent should include math professors who teach calculus as well as representatives of engineering and science departments who would provide valuable insights about applications of mathematics in their disciplines.

I think that your panel has sufficient latitude in its charge to address and encourage the structural changes that I have discussed. Our nation's security and technological leadership require quick and decisive action. All of our children deserve a chance to pursue mathematics related careers. On behalf of math chairs at the City University, and at New York University and Karant Institute of Mathematical Sciences, who have endorsed this message,

I thank you for your attention and I wish you much success.

MR. FAULKNER: Thank you, Professor Ocken. I appreciate your comments.

Are there questions from the panel?

We thank you one more time.

Let me go to the 12th commentator, James Wendorf.

MR. WENDORF: Good morning. My name is

James Wendorf and I am Executive Director of the National Center for Learning Disabilities (NCLD). NCLD is a not for profit organization founded in 1977 that helps children, adolescents and adults with learning disabilities succeed in school, at work and in life. We work with a national network of approximately 30,000 parents, teachers and others, including individuals with learning disabilities.

My hope in speaking to you today is that your work will result in a rigorous research and policy agenda that will enhance our knowledge of the essential foundational math skills not only for algebra learning, but also skill development for the K to 12 curriculum. I also hope your work will contribute to the development of effective models for screening and assessment, much along the lines that we heard about earlier from Dr. Ginsburg. And I hope that you'll pay particular attention to children who struggle to learn, especially in the early grades. Children with learning disabilities comprise 50 percent of the special education population. We are looking at almost three million students.

I have three recommendations to present this morning and they are developed in greater detail in the written comments.

The first is that we recommend that you

establish a priority for math disability research. We already know that, in math, 44 percent of secondary students with learning disabilities are working three to five grade levels behind their peers. Nearly 40 percent of students with learning disabilities drop out of high school. Those who manage to get through high school have a 50-50 shot at a standard diploma. Two thirds of high school graduates with learning disabilities are rated entirely unqualified to enter a four-year college.

These data highlight the critical need to invest in math disability research. I would also point out that the success of Reading Forum in the United States is a direct result of the investment in reading disability research, primarily at the National Institute of Child Health and Human Development (NICHD), and we are happy to see that math research in disability is proceeding at NICHD. We encourage a greater investment there.

The second recommendation is to promote an explicitly inclusive approach to research-based instruction. Instruction should support all students learning and achieving grade level math skills, including struggling learners who require more intensive instruction and appropriate intervention. We would want to see institutionalized use of

research-based screening methods, tools, curricula and assessments, the use of scientifically research-based interventions, targeted interventions and progress monitoring.

If this sounds like an application of some of the key components of response to intervention that's been written into the Individuals with Disabilities Education Act, it's not surprising. We want to see the same things come out through a "Math First" initiative out of the Department of Education.

And the third recommendation is to define and delineate critical math skills at each grade level. Current research suggests that the learning of foundational skills in core areas of math lays the foundation for more advanced mathematical knowledge. Students with mathematics learning disabilities absolutely need more intensive and focused instruction centered on critical mathematics content. It needs to be there. We also know, from research in other subject areas, especially reading, that that approach with foundational skill development, step by step, and the teaching in explicit and systematic ways, benefits all students, not just those who may have a neurobiological disorder that limits their access to this information.

I would point out that the National Center for Learning Disabilities is keenly interested in this issue. We have put together and initiated a mathematics disabilities roundtable, including leading researchers, and we are preparing two papers which will be published shortly. One of them focused on skill development, the foundational skills that children need in order to achieve success in mathematics, and the second and much more difficult paper is focused on effective interventions. And of course one of the problems that we are encountering, our researchers are encountering, is that there is a paucity of evidence for effective intervention. Nevertheless, we will proceed and we will share those with you when they are published.

Thank you very much for the opportunity to present.

MR. FAULKNER: Thank you, Mr. Wendorf.

Are there questions or comments from the panel? None?

Then we go to the 13th commentator, Sally Mitchell.

MS. MITCHELL: Ladies and gentlemen, I am very excited to be here today because mathematics education has a vital role in science education. My name is Sally Mitchell, and I'm a chemistry and

physics teacher in East Syracuse, New York. I'm also a Ph.D candidate in science education at Syracuse University.

I've been studying the correlation between mathematics and science education for the past five years, and I have several points I would like to address. I left teaching to start my family in 1987 but, when I returned ten years later, I was shocked at what I found in the chemistry classroom.

At first, I couldn't put my finger on the problem, but then, when I started to teach physics again the following year, I knew immediately what was wrong with science. The answer was mathematics. My students could not measure properly. They were calculator dependent. They could not and were never taught to estimate and they did not use or speak the universal language of measurement, also known as the metric system. I remember entering sixth grade during the 1970s and my science teacher told me by the time I graduated from high school, the United States would be using the metric system.

(Laughter)

MS. MITCHELL: I believed my teacher and I didn't even give it a second thought. I converted right over to the metric system, went on to college, majored in chemistry and biology, and I never once

had a problem with measurement or estimation. The entire world went to the metric system, and in 1976 the Olympics went metric. There was national pride in the metric system. My estimation skills were excellent. I had points of references and the prefixes made calculations and data collection a breeze. Money was metric, so it seemed a logical choice to standardize measurement throughout the world. Everyone was on board, but something happened here in the United States.

(Laughter)

MS. MITCHELL: A swipe of the pen by the national government and all of a sudden, the inch/pound system was back in full force. I first realized that the United States was at a disadvantage using this inch/pound system five years ago when I was judging a science olympiad event called Metric Estimation. The students had no clue to what a kilogram of math was or distances measured in millimeters. The winner of the competition was not a United States citizen, but a boy from a foreign country. This boy had an excellent ability to estimate and he had a grasp of using the metric system.

I then went back and pretested my students on their abilities to estimate, and I was

shocked at the results. They had no clue of what a point of reference was or using the metric system, the system that's used extensively in science and in medicine. I then pretested my students on their ability using the inch/pound system and the results were even worse.

(Laughter)

MS. MITCHELL: I found that students knew more metric measurements than the inch/pound units, but using both systems confused them and they just gave up. When quizzed on simple questions like this, and I challenge you, how many cubic inches are in a gallon? How much does a gallon of water weigh? Or, better yet, what is the mass, in slugs, of a gallon of milk? Then I remembered my confusion when I was five years old. I had the mumps and with it, I had a very high temperature. When my mother took the thermometer out and read it to me, it was 105. I was delirious, and she went out and got a washcloth with water on it to place it on my head.

I thought, since the boiling point of water was 100--

(Laughter)

MS. MITCHELL: --that the water on the cloth would just sizzle.

(Laughter)

MS. MITCHELL: I didn't understand why it didn't. I was confused because I was taught two different systems of measurement. The problem is still here today in the United States. When I pretested my students this year in chemistry, I asked what is the normal boiling point of water and what is the normal freezing point of water? I was shocked when all of the students wrote 32 for the freezing point but 100 for the boiling point. I went, and I investigated and interviewed these students and it turned out that the weather stations are refusing to place units on numbers now on the Weather Channel and students only get measurements around room temperatures. They see 32 but no units associated with them, then they come to my science class, put a thermometer in the boiling water and they see 100.

During my dissertation work, I designed an instrument to measure a student's ability to measure and estimate. I held up a two-liter bottle of soda that was half filled. I asked them to estimate the liquid, and 100 percent of the students wrote one liter. Then I held up a gallon container containing one liter of soda. I then asked them how much liquid was in the bottle, and 80 percent of the students wrote a fourth of a gallon. Both contained the same amount of liquid--

MR. FAULKNER: You need to wrap it up, please.

MS. MITCHELL: We have conditioned our children to two sets of measurement for volume. Students will listen to their teachers, and children follow in their parents' footsteps. It is up to us, as educators, to look at the problems associated with the fact that the United States of America is the last, and I don't like coming in last, of the industrialized nations to totally convert over to the metric system. It is up to us, as educators, to realize that the United States is falling behind other countries in math and science and just one of the pieces of the puzzle is so simple to fix, we need to be metric.

Congress authorized the use of this metric system for use in the United States in 1866. At this time, each state was supplied with a set of standard metric units and measures. In 1875, the United States became one of 17 nations to sign the Treaty of the Meter, an international agreement of refining accuracy in standards.

MR. FAULKNER: Ms. Mitchell, your time has been up for about a minute.

MS. MITCHELL: All right, can I just finish?

(Laughter)

MS. MITCHELL: As an aside, just real quick. My son was a foreign exchange student this year in Switzerland. He has grown up metrically, he only knows the metric system. When he was asked to travel 30 kilometers, he didn't wince, he knew what it meant, and all the other students said how far is that in miles? It doesn't do us well not to use the system of measurement that's the universal standard. Just remember, students will learn what we teach them. If students learn only the metric system and live metrically at home, it will make our jobs as educators easier. I've done my job in chemistry, living the universal system of measurement, leave no child behind, I have done my part, now it's time to do yours, thank you.

MR. FAULKNER: Thank you, Ms. Mitchell.

Is there a question or comment from the panel?

MS. MITCHELL: Come on.

(Laughter)

MR. FAULKNER: Thank you. Maybe everyone agrees.

Nancy Buell, number 14.

MS. BUELL: My name is Nancy Buell, and I am President of the Association of Teachers of

Mathematics in Massachusetts.

Mr. Chairman and members of the panel, I thank you for this opportunity to speak to you. I am not a researcher. I have never conducted nor never expect to conduct randomized trials, nor a scientifically-based research study. However, I bring to you my observations from 34 years as an elementary classroom teacher and over ten years as an elementary mathematics consultant assisting school districts and teachers in over a dozen states in their efforts to improve the mathematics learning of their students.

I applaud you for considering what happens in elementary classrooms as you focus on the mathematics that leads to success in algebra. I believe much more could be going on in elementary classrooms to lay the foundations for algebra but that most elementary teachers are unaware of the opportunities to explore such ideas and do not see them as important for their students.

When an elementary teacher is confronted with over 700 pages of text or ten curriculum units to teach in the course of a year, she knows she can't do it all. It is the classroom teacher who makes the subtle choices about what gets taught and what gets skipped. She does this based on her sense of what is

most important for her students this year, not for building a foundation for future years.

If she doesn't think that preparing her students for algebra is part of a second grade teacher's job, if she doesn't even see the opportunities for her students to explore early algebraic ideas, her students will not have a rigorous mathematics program.

Let me give you a simple example. A teacher might ask second graders to make a list of equations that equal 14. She might let the students share some of their examples and then move on to a different part of her lesson, or a teacher might take one of those shared examples. Let's say 10 plus 4 equals 14, and ask what would happen if I changed the 10 to an 11?

The class could generate a list of related equations for 14, 10 plus 4, 11 plus 3, 12 plus 2 and so forth, and the teacher might ask them to think about how the second addend is changing, as the first addend goes up by one. As students, even very young students, pay attention to how numbers behave and make rules about what they see happening, they are beginning the work of early algebraic thinking.

Two observations I would make about this

particular example, even if the teacher's guide suggests having this discussion, teachers will only do so if they see it as a valuable use of their limited time. If they don't understand the underlying mathematics that the children are exploring, they are likely to skip the part of the lesson that highlights that mathematics.

Secondly, you will notice that the example used small numbers, numbers that are not particularly challenging for second graders. Indeed it is the familiarity and understanding students have with these small numbers that allows them to pay attention to the mathematical ideas related to how the numbers behave. Again, if the teacher doesn't understand the purpose of working with the small numbers, she is likely to view the activity as too easy and move on to other work with larger numbers. Let me be clear, we want second graders to work with larger numbers as well. However, working with small numbers allows them to focus on how the numbers behave, rather than on how to fund the sum of two large numbers, students need to work with different sized numbers for different purposes.

I have worked, as a math consultant, with teachers who use investigations and number data and space, as well as teachers using every day

mathematics, and both of these curricula provide many opportunities for students to explore algebraic ideas as they develop fluency with basic facts and operations. However, if the teacher doesn't understand the mathematics or doesn't think the explorations further her goals for her students, the opportunities will be missed. The enacted curriculum is not necessarily the intended curriculum.

How do we deepen elementary teachers mathematical understandings and broaden their vision of what is important for their students to learn and explore? Clearly more mathematics in the preservice program is important, but I believe we also need in-service programs that help teachers develop their own mathematical understandings at the same time that it helps them see the connections between those understandings and the mathematics they teach at their own grade level.

MR. FAULKNER: You need to wrap up.

MS. BUELL: If we are going to change what students know and are able to do, we must change what teachers know and what they do.

Thank you for the opportunity to address the panel.

MR. FAULKNER: Thank you, Ms. Buell.

Any questions for Ms. Buell?

Thank you.

Our last commentator is Anne Collins.

MS. COLLINS: Good morning. I'm the President of the Association of Teachers of Mathematics in New England, and also the Director of Mathematics Programs at Lesley University. The Association of Teachers of Mathematics in New England and Lesley University are both organizations committed to improving the teaching and learning of mathematics for all students.

Focal areas that we believe will help us reach our goal include mandating a minimum of 60 minutes a day for mathematics instruction. Although No Child Left Behind requires about an hour per day be spent on mathematics in Title I schools, many teachers report spending much less than an hour per day on math, some as little as 30 minutes, three days a week.

We also believe that we need to be providing quality professional development in mathematics content for elementary and middle school teachers. If a greater emphasis is going to be placed on advanced placement courses, as directed by the President, we need to be sure that all students recognize or have an opportunity to develop a strong understanding of the fundamental concepts of

mathematics in the elementary and the middle school grades. We also need to ensure that all students recognize and appreciate the need to engage in doing mathematics while in elementary and middle grades.

Too many of our students are still sitting in classroom rows where there are 30 students watching one teacher working hard, instead of a teacher working differently and watching 30 students working hard. The way in which students are taught mathematics is as crucial as the mathematical content they are taught. Students who engage in solving interesting problems rich in mathematical content are more likely to enjoy doing mathematics and are more likely to consider pursuing careers that rely heavily on mathematics. This means that elementary and middle school teachers must have a deep understanding of mathematics content.

An implication for elementary schools is the need for mathematics specialists who teach mathematics, just as an art specialist teaches art. For districts, the implication is a major investment in professional development. Positioning the mathematics that students need to know and be able to do in contextual situations requires a deep understanding of mathematics content for teachers. The implication for colleges, universities and

professional development providers is to look beyond traditional sequences of courses, the Calculus I, II, II, IV and differential equations, and to engage prospective and in-service teachers in exploring and unpacking the fundamental concepts underlying procedures or algorithms in algebra and geometry.

Teachers of arithmetic concepts need to deeply understand how those concepts play out in algebraic concept. In algebra, there are no putdowns or carrying. When arithmetic is taught with an eye towards algebra, the transitional process for students going between arithmetic and mathematics is seamless and makes sense.

The following data is from a recent survey of middle school students conducted on behalf of Raytheon Company. 84 percent of students surveyed would rather do one of the following than their math homework: clean their room, take out the garbage or go to the dentist.

(Laughter)

MS. COLLINS: Only one third of students surveyed reported liking math a great deal. 43 percent of students reported having a difficult time understanding the mathematics they are taught in school. 34 percent of students think mathematics is boring; and by eighth grade, as many as 45 percent

are turned off to math, describing it as boring. To many classroom teachers, it has become increasingly clear that the learning style of students today is greatly different from students in the pre-computer electronic era.

Many children, even those in underprivileged areas, are entering school proficient with electronic gadgets such as Game Boys, Play Stations and X Boxes. They are accustomed to quickly changing graphics, animation and fast paced games which require them to react and respond as quickly as possible. They are constantly problem solving and challenging themselves as they strive to earn the most points in their games or to beat their previous scores. Most of these same children are not content to sit passively in a classroom watching demonstrations or listening to lectures, rather, they want to be part of the action.

One student, when he was seven years old, went home from school one day and told his mother that he was lucky he had little leakage. When his mother asked him what he meant, he said when the teacher says something, it goes in one ear, and most of it gets absorbed by my brain and only a little leaks out the other side.

(Laughter)

MS. COLLINS: He continued, but when I look around the room, there are a lot of kids with a lot of leakage.

(Laughter)

MS. COLLINS: What she says goes in one ear and out the other. Now it turned out, at seven years old, Steven had identified himself as being an auditory learner, and he recognized at the tender age of seven, that he was only one of a few who learned well that way. Directed instruction worked for him when it came to test taking scores. However, he did go on to become a National Merit Semi-Finalist, but he refused to take a mathematics course in college--

MR. FAULKNER: You need to wrap up, please.

MS. COLLINS: --because he said he knows how to do all the procedures, he knows all the algorithms. He can get all the right answers, but he doesn't understand why he is doing any of it. And we need to change that for bright students like Steven so that we have more folks going into careers that really depend on mathematics and mathematical reasoning.

Thank you so much.

MR. FAULKNER: Thank you very much. Are there questions from the panel?

MR. FAULKNER: Yes, Tom? And you also.

MR. LOVELESS: I'm interested in this topic of joy and how much children enjoy mathematics and I have been doing some of my own research on it. I wonder if you would just comment on two trends. One trend is, since 1990, the percentage of kids in the United States on NAEP who said they enjoy mathematics has been declining, and I'm wondering if you would speculate as to what's going on there.

MS. COLLINS: Well in the work that I--

MR. LOVELESS: Let me, and then let me ask you the second question and then you can take them both. The second thing is if you look at the TIMSS, Trends in International Mathematics and Science Study, scores around the world, the nations with the highest mean scores in mathematics tend to be those where the smallest numbers of kids say they enjoy math. And the reverse is also true, the nations where kids say they enjoy math a great deal tend to have the lowest test scores. And I just wonder if you would comment on both those phenomena. In fact the correlation coefficient on mean test score and enjoyment of math is around negative .60, it's rather significant. So I wonder if you would comment on both those and just speculate as to what may be going on.

MS. COLLINS: In the work that I do as a professional development provider, I'm in hundreds of classrooms every year, and I haven't seen the majority of classrooms transforming or transitioning from the way in which they were teaching in 1990. So it doesn't surprise me that in so many classrooms students are not really excited about mathematics. I was in one classroom, which is typical of many that I see, unfortunately, where students had a packet of work sheets, and they were in grade seven, where they were doing 25 problems per page, reviewing for tests, doing all kinds of addition, subtraction, multiplication and division that would be of what I would consider a fourth grade level. These were seventh graders, and they spent day after day doing those kinds of things.

I was also in another school in that same district, an urban district, and students were investigating the handshake problem, and they were graphing solutions. They were acting it out, modeling it. They were not only showing an excitement about the problem but they were really doing some mathematics that was grade appropriate. So I think that we have to be careful with saying that the scores on NAEP aren't showing significant gains, although we are showing some, when we haven't been

able to document that a majority of classrooms that have changed what they are doing in the past 16 years.

And in terms of the TIMSS report or the trends in the international studies, I wish I had a comment for that, I just know, as a lover of mathematics, I just couldn't imagine having to sit and do tedium work sheets and be excited about mathematics. What excites me and what I see exciting most middle school students are those interesting, rich problems that they are able to sink their teeth into and find solutions to.

MR. FAULKNER: Sandra?

MS. STOTSKY: Yes, thank you.

You mentioned in your talk that you were interested in or saw the need for full-time elementary teachers of mathematics. I believe that's what you mentioned. And as you obviously know, the current Massachusetts regulations allow and encourage the use of that kind of a position. Have you been preparing students at Lesley for this kind of position? Do you have any research information or follow-up information on how successfully schools are implementing, in the upper elementary grades in particular, the full-time mathematics teacher, in terms of reorganizing the school and using such a

position?

MS. COLLINS: What we have been doing at Lesley, in the mathematics, has been going out into districts and providing math content courses for elementary and middle school teachers where they are coming in and they are taking 27 math content courses ranging from Math as a Second Language, all the way up through Conceptual Calculus II. These teachers are then going on and taking the math section of the Massachusetts Tests for Educator Licensure (MTEL) so they can go back into their districts and become the math specialists in their classrooms.

Now whether or not the districts actually use them to teach all of mathematics or use them as coaches, I'm not sure about that, but Lesley has been making a commitment to upgrading the level of skills for the teachers to become math specialists.

MR. FAULKNER: Thank you, Dr. Collins, we appreciate you being with us.

Let me say, as we close this public comment session, that the panel has received a great deal of valuable comment here and we are grateful for those who took time to be with us. Many of you traveled appreciable distances and have spoken about things you care deeply about. And we are grateful for those who asked for time and were not able to get

it. I can only express regrets. You can see that we struggled to accommodate what we did accommodate.

But we now need to move into a session where we will review progress reports from the task groups. In order to get this done, I think, at a reasonable hour, we are going to move without a break. If you need a break, you are just going to have to take it on your own. But I think we need to go ahead, and move forward and get the task groups reporting.

We actually have a subcommittee on methodology or on standards of evidence. Valerie Reyna is the chair of that group and I think Valerie, you may want to kick this off.

MS. REYNA: Certainly. Thank you, Mr. Chairman.

And we have discussed this at our first meeting, open meeting. We initiated a draft of the methodology guidelines for this group after that. We incorporated additional feedback from the members, from the methodology subcommittee and from the chairs of all the subcommittees. And our most recent step in the revision process is to send it out to all members of this committee for feedback. Most of the feedback I received, prior to this meeting via e-mail has been positive, but I would like to now take the

opportunity to incorporate any additional comments people may have or any additional discussion people may have about these issues.

MR. GERSTEN: Valerie, as I mentioned in the e-mail to the group several days ago, I think it's an excellent document but it needs to go further, especially in those mid range areas. We'll be dealing, as the contractor and us as a panel, with various evaluations that use quasi-experimental designs, very, very weak designs, interrupted time series designs. There will be some that have major confounds that the teacher, the experimental teachers might be volunteers, the control teachers not.

There needs to be some more specificity in the guidelines, I would suggest, as much as possible, using something in existence, and having the committee review it and then running by the whole panel to guide the work of Abt Associates in their search through the literature and how they sort out the evidence. Because once you start doing this kind of thing, there are these gray areas, and rules need to be made and sometimes you need another iteration based on the real issues you see because there are things that we'll see, as Panelists, or the researchers at Abt that they'll feel this study isn't valid. We need to articulate and make those reasons

public, so I think more needs to be done along those lines.

MS. REYNA: That's an excellent point. One of the strategies we talked about for doing that is that we have a document at the moment that captures certain principles I think that are probably compatible with the particular examples you just gave about quasi experiments and so on. We discussed the possibility of perhaps agreeing to the principles document and then creating an additional document that would be a procedural, much more concrete document that would instantiate the principles of the more general document, so it would be more at the level of instructions to the contractor. Would that make sense, given your feedback?

MR. GERSTEN: Absolutely, yes, and with the idea that it will probably need a pilot run or a dry run with perhaps a dozen studies and then they can come back with areas that are still unclear.

MR. FAULKNER: Deborah?

MS. BALL: I think I mentioned this at the meeting at Chapel Hill, but I still would like us to be sure that we are being careful about another aspect of validity which is construct validity. I don't see as much in here as I would like and since many of the things that, in which we have a strong

interest have been difficult to measure in a valid way from a construct validity perspective, I would like to see more emphasis on our ability to be skeptical and careful about that.

MS. REYNA: We have certainly mentioned the validity and reliability of measures as being key points, repeatedly, in the document but, as you note, we don't go into the different kinds of validity and in particular, into the nature of construct validity. I think construct validity is often at the heart of much research, but it's a very difficult thing to define a priority. It's a question of what do you think the nature of the outcome is at its core and its essence, and then do you have an operational definition to in fact measure that in a scientific way?

If there is any language that you would like to add to define that, I think that would be marvelous, and we could circulate that language to define what we mean by construct validity and add that to the document. I see it as compatible with what we currently have.

MR. FAULKNER: Are you finished, Deborah?

MR. SIEGLER: I also thought this was a very good beginning on standards but I think, in the coding, it's going to be very important to specify

some intermediate cases in the top tier area. So the way it's written now, it requires not only a number of randomized clinical trials but also a large and diverse subject population from around the country, representative of the U.S. population. In most areas, this is either going to be unpopulated or minimally populated, and as far as studies go, it's too high a standard for us to have as the only sort of tier A case. But I think we need to differentiate a few standards that are still very good but maybe not quite as good.

For example, ones where there are multiple randomized clinical trials but where it's not necessarily a representative population through the entire U.S., or even necessarily as anyone from all areas of the country.

MS. REYNA: Since I'm going to have to put all the comments together, I want to make sure I understand what you are saying. Now I think I understand better your remarks earlier to me. So we now distinguish, I think we would, and please correct me if I'm wrong, we would all agree that the ideal study would have all of these things, but what we want to call top or high evidence so, in a rank, ordering sense, we are all in agreement. So the top study would have diverse samples, multi-center trials

and so on.

And I want to mention again, particularly to the audience, we are not requiring that evidence be at this ideal level to be considered or included in our deliberations, we are distinguishing evidence at different levels, and what we are talking about now, I think, is whether we call this a high level of evidence, even though it is not the top ideal level of evidence. Do I understand you?

MR. SIEGLER: Yes.

MR. FAULKNER: I think Camilla, Camilla wants to add to that.

MS. BENBOW: Add to that, but this is a copy. We have in that table the way we classify them, and I think what we have to make very clear is that it's classified in terms of inferences that we can draw, and clearly the top category allows us to draw much stronger inferences and talk about causality. It doesn't mean necessarily that somebody in the second category, that's less of an excellent research design. It's just that you can't draw as strong conclusions from that theme. And I think when we come back and we want to revise the paper, we want to make clear what we mean by those categories, that it refers to not quality of research but in terms of the interpretations we can do.

MR. SIEGLER: Yeah. Actually, the case that I'm most concerned with, because I think it's going to be the top quality of evidence that we actually encounter in most areas, is one where there are a few good quality studies. They don't naturally fit into either the top tier, as currently defined, or the second tier, as currently defined, and I'm saying we should make it like a 1(a) kind of category.

MR. FAULKNER: As a casual commentator on this, in this area I'm not an expert, as people know, it strikes me that we may have a middle category that is too wide. We have a highly exclusive top category and we have of course an encompassing bottom category, but the middle there may be covering too many types of studies that, I mean we may not be differentiating enough and that's essentially what Bob is saying.

Deborah, do you want to add to the same subject?

MS. BALL: I just wanted to say at some point I would like us to talk about how we enact norms around this set of principles. So this is a set of principles we are developing to guide the research reviews. However, in our discussions, both in the testimony we have received or the comments we

have received this morning and our own interaction with those, and in discussions we are having, I see a looseness across these categories. I would like to urge us, as Panelists, to be using these principles to qualify things we are saying as we are talking about things because our thinking is being shaped without reference to saying. Right now I'm saying this but actually the thing I have something to say about is in the lowest category of evidence, but I still want to put it on the table.

So I think, in our own patterns of deliberation, I think we need to use these to guide our discussion, which I do not see us doing that, nor did I hear that in some of what we heard this morning.

MR. FAULKNER: Sandra, are you on this topic or did you want to go to a different topic?

MS. STOTSKY: It's in relation to what Valerie, what we've been talking about, the research.

MR. FAULKNER: Okay, well, then you're next.

MS. STOTSKY: Okay, a general topic, yes.

I just wanted to add that we, and I mentioned this earlier or yesterday, Valerie, that we need to think about what are the specific questions that each task force may be addressing and in some

cases, a question may need just descriptive data. There may be different kinds of data from different kinds of studies. They won't be experimental data, so we have to allow for a broad range of different types of studies that can inform a particular question, depending upon the question of the task force. And I don't think, at this point, we should be seeing ourselves restricted to mainly what seems to be experimental studies that have been given to us in this hierarchy. We just have to think about what are the qualities of the different studies, as far as the different groups that statistics have been compiled on and how they might best inform whatever the question is.

MS. REYNA: I took some pains to, and I think Camilla reiterated it here, to make the connection between design and inference and I think that's what you are getting at. If your claim is about description, then descriptive study is apropos. If your claim is about causation, then you need a different kind of study, so it really is very much tied up with the kind of claims. I think the document, as it's currently written, speaks to that but, if there is any additional verbiage you would like me to add, I would be glad to.

MR. FAULKNER: Russell?

MR. GERSTEN: I would like to reinforce two points, the one that Deborah made about construct validity is crucial to our work. Many meta analyses just basically say if you have a reliable measure of math, we put it in the hopper. It's very important for us to think about, and this is beyond what the contractor could do, the nature of the dependent measures, and to be clear and explicit about that and not to get, you know, the simple level that standardized tests are good or bad. There are richer levels, and I think we do need to do that.

The second thing is what I think needs to be more explicit is that there are this wide, as Larry said, wide group of studies in the middle. People cannot get confused about the fact that there are also studies that are invalid from which inferences cannot be drawn. So you can say the six correlational studies keep suggesting the same thing, clear about the evidence. This is this middle level. If there are studies that are not valid, and those are the decision rules, then those are not considered evidence. So expert opinion might be, for some of the key points we want to make, the low level, but in valid studies, that is going to be a crucial decision for which studies just are too confounded or flawed. That is hard work but I think we have to all adhere

to that in this process.

MR. FAULKNER: So you are saying there is a category below the bottom.

(Laughter)

MR. FAULKNER: Wade, do you have a question?

Okay, Tom is next.

MR. LOVELESS: I like the document, and I think it's great and it is. I think you've really taken a nice stab at things like inferencing, and causality and the way we'll approach that. However, in terms of our policy guidance that we give to people, we are going to need more than that. We are going to need, for instance, questions about if anyone out there is going to do any kind of cost/benefit analysis. A great study on an intervention where the intervention happens to cost so much money that no one can do it still is of little value so, in terms of the direction that we give to our contractors. We want to know some basic facts, if they have evaluation evidence on an intervention, things like how much time does it take? How much teacher preparation is required for the success of the intervention? And then, financially, how much simply does it cost?

Can we build that anywhere in here?

MS. REYNA: There is actually good work on this in the area of things like medical decision making and quality of care in which cost effectiveness has been the subject of a consensus committee document and so on. Again, I think you know this document was aimed at the effectiveness side of the cost effectiveness question, as well as the mechanism side. Cost is a separate consideration and you point out a case in which you might have a very effective intervention but its cost makes it prohibitive. I think it's possible and the consensus documents on these issues agree that it's possible to separate the issue of effectiveness or quality from cost. But I do agree that they are both important, and I don't know if we would want to put them in the same document.

MR. LOVELESS: And then, related to that, there may be contingencies for the success, right? So the intervention may only be successful if you train the teachers for a year prior to the intervention, or something like that, and those are the kinds of things that, in terms of any recommendations we make as a panel, we have to be aware of.

MR. FAULKNER: Anything else on Valerie's report? All right, let's go to the task groups.

MS. REYNA: Although I did put all the documents together, I do want to thank everyone who contributed, this was a multi-authored document.

MR. FAULKNER: Okay, thank you, Valerie, and we thank you for the work on it. Let's go to the task group reports, and we'll start with the one on conceptual knowledge and skills, which is being chaired by Skip Fennell.

Skip?

MR. FENNELL: I think, given our prior work and given some of the testimony certainly yesterday, we are close to coming to consensus on what might be essential concepts and skills pre-K through 8. We are continuing our analysis and work in attempting to define algebra. And I'll qualify this, my hope is that at a meeting not too very far distant from this one that we are able to put out a template for a national curriculum in these areas.

MR. FAULKNER: Is there, are there any questions or comments about the work of task group one, conceptual knowledge and skills?

MR. WU: So in a sense you are coming close to a national curriculum?

(Laughter)

MR. FENNELL: So I guess I achieved my objective, Wu, to see if you are still alert at the

meeting.

(Laughter)

MR. FENNELL: We think it's time to at least begin that conversation, even if it's pushed back in our face a little bit. Again, this is tentative and I am therefore allowed some latitude.

MR. WU: I'm more interested in the details. I mean what do you mean by having a national curriculum? Are you just defining algebra, which is a very intellectual thing, or are you prescribing step by step, grade five, grade six, grade seven, and grade eight?

MR. FENNELL: Well we would probably provide a document that might be built off of and Wilfried, you are going to need to step in here, as you typically do.

(Laughter)

MR. FENNELL: In terms of what's essential mathematics, pre-K through 8, we will probably work off the focal points document in that arena, and then we are looking, Wu, in a variety of ways in terms of what is algebra which, in some sense, is more complex, given what I just said relative to the prior document. We are undertaking an analysis of the 19, actually, it's now I guess grown to 22 or 23 states that define this. We are

looking at how algebra is defined in countries other than this one. We are looking at algebra as it is described in integrated curricula in states where they are beginning to do that to get a sense of what these are, and then we are frankly going to assemble a topic list for this panel to take a look at.

MR. FAULKNER: Tom?

MR. LOVELESS: I don't have any problem at all with the idea of a curriculum that defines what kids need to know up through algebra, but the word national I do have a problem with, because it's politically loaded and that's where I think we may run into problems. This is still a system where 92 percent of the finance comes from state and local sources and they think that they have some say in what is taught. So you are running not only into an historical tradition in the country but also a deeply entrenched governance system that I think, if there is an attempt to reform it, goes way beyond the scope of this panel. And I just think we have to be cautious in biting off things that we don't need to be biting off.

MR. FAULKNER: Skip?

MR. FENNELL: Of course I expected that response, Tom, which is why I was somewhat quiet, never mentioning any of this the entire morning to

you when I could have.

(Laughter)

MR. LOVELESS: Not to mention that you never mentioned it in the task group meeting either.

(Laughter)

MR. FENNELL: I figured it was time the panel talked about serious stuff. Seriously, Russell of course gets the entire blame for this because in fact we think, now being serious, that it's time to have a conversation about a template for a national curriculum, about something that would even perhaps be voluntary in nature and again, going back to what I presented just a few moments ago. It could be that we decide not to do this. To not even wander in the direction of the conversation, I believe, speaking solely for myself would be a mistake.

MR. FAULKNER: Wilfried, then Deborah.

MR. SCHMID: Yeah, I'm perfectly comfortable when you talk about a template, I think the focal points are a template, and certainly we can not ask for more than a template when we talk about algebra and the prerequisites for algebra. I think that if we go beyond that, we will be in trouble.

MR. FAULKNER: Deborah?

MS. BALL: I think that if this panel takes its charge seriously, however, we've got to

point at those aspects of our system that are creating the situation that prompted the panel in the first place. And in our subgroup, there is at least one thing on our list that I think is of that same order which violates a lot of the customs and norms of American education. We have the system we have because we've decided that certain things can't be done, and I think if we are not courageous enough to, once we've considered and deliberated about certain things, we are going to have to include some things in this report that go against normal practice or all we are going to see is exactly what we've seen for the last 20, 50, whatever number of years you want.

I really would like to see us have some serious discussion about what the issues are, rather than simply hearing that it's a political issue. There are a lot of things on our list that are political issues. I think it's possible to consider evidence, and I don't want us to talk about it right now, but I would like to propose that we organize to find a way to consider what could be meant by a national curriculum, by a template, what the arguments are for and against. I would like to propose that we have some serious consideration of this because it's quite clearly one that comes up regularly as the source of our, you know, chaotic

teacher education system, our lack of system for professional development, our lack of common assessments. So I don't think it's something that we can simply decide in this conversation right now but, rather, we should find a disciplined way to talk about it.

MR. FAULKNER: Diane, then Wu.

MS. JONES: I guess I want to echo what Deborah said. I think that we have to have a discussion about what we mean by a national curriculum. I mean if we mean amending the Constitution of the United States that's a pretty big undertaking, and it requires participation by many, many people. If we are talking about guidelines, if we are talking about templates, if we are talking about standards, I think that we do need to have a conversation about what is meant by that term. Given my own experience, if we are talking about amending the constitution and reestablishing how the education system in this country was established, that might go a little bit beyond the two years that we have, so I just thought I'd mention that.

MR. FAULKNER: Wu is up and then you, Tom.

MR. WU: I'm not too worried about the term you use, but I'm trying to concentrate on what

we are supposed to do. The charge here is to define algebra and that's something that we can certainly, we are competent to do, but it's not a matter of surveying what other countries do, what other states do. Certainly, we should take that into account. That's a small part of it. There is a purely intellectual problem involved. Algebra, as it's situated in school mathematics, has sort of natural limitations. You cannot talk about real numbers. You cannot talk about rational numbers. You can say explicitly that algebra is the mathematics of rational numbers with some peculiar rules about what to do with irrationalities.

And you can also describe quite clearly what lies behind this. I mean you have steps. This is why the mathematics for grade five, six, seven is so important because that's strictly the arena of rational numbers and therefore, all that matters in that situation is that you have more intensive symbolic use in dealing with rational numbers. That's certainly one of the main characteristics of school algebra.

People should be gradually learning how to use mathematical proofs. In algebra, when you are talking about it in total generality, you must have general reasoning and therefore, these are the

characteristics we have to define.

But I think we can say it is what it is and what needs to be done. Of course I should say the way we are teaching algebra is really completely wrong because the element of geometry is completely missing, at the moment, in school mathematics. We need to have similarities. Without similarities, for example, people in the audience here, why is the graph of a linear equation a straight line is almost never answered in school mathematics. And that's what about 60 percent of algebra, as it's taught today, I mean Algebra I is about linear equations and linear graphs, and there's a whole black box for them because they don't know what's a similarity.

Therefore, the equations should have four forms of linear equation for a straight line, and people who memorize them have no idea what they are all about. And these I think we must go into. That's our charge, and we can define that very precisely. Then you can leap through every state and every school district, every other nation to decide how you want to structure your classes to live up to this one goal, and I think that's within our confine.

MR. FAULKNER: Tom, then Sandra.

MR. LOVELESS: Just to respond to Deborah, the point I was making, I am agnostic on the

issue of a national curriculum. The point I was making is we need to bring to bear the same scrutiny of evidence on the question of political feasibility, if we are going to consider that recommendation, as we do on anything else. And there is a body of evidence that suggests that that's a very difficult task, to implement a national curriculum in the United States. So we could gather polling data, we could gather past efforts to establish national curricula, all of that we would need to consider before we would make such a recommendation.

MR. FAULKNER: Sandra?

MS. STOTSKY: Sort of continuing that line of thinking, I think the language we use is very important and a word like template at least might be more neutral, at this point. But I would want to be sure that the panel doesn't attract any kind of negative attitude or criticism for something that does go beyond its charge or might land it in a political thicket that it didn't need to be in.

But I also would like to say that there may be other ways to pursue some of the ideas of how broadly our recommendations might go in areas where it's possible, legally, within the constitution, without amending it, to go. And I'm thinking in areas like teacher education, we already have Title

II in the Higher Education Act. There are precedents already for the federal government to ask for certain things, to do certain things.

It's very possible that the panel, in the area of teacher education, could come up with some kinds of recommendations on the training teachers need for pre-service, or whatever the number, course hours, things like that, that would not violate, at this point, what we know about the federal responsibilities in the area of education, as opposed to state and local, as well as how strings can be attached to federal money that goes to states that do the things that one would want them to do for the kind of money that the federal government does offer.

So that's a conversation I would like to see the panel at some point have, that talks about what areas will not get us into any hot water right now but actually might be very fruitful for us to explore for part of our task force work and ultimate recommendation.

MR. FAULKNER: All right, thank you.

Are there further comments on Skip's group?

Since I think there are reporters dealing with this, I would like to speak a little bit toward what we've been discussing. This panel is not

charged with recommending political courses, it's charged with recommending educational interventions and educational policies that can lead to success in algebra and we need to respond to that.

For the most part, your Chair will take the position that political action that might follow these recommendations is up to the people we are advising and that might consist of some of the steps that have been talked about today. But what we need to focus on really is what the evidence says is the best thing to do in curriculum and practice to get children ready and that's what we need to say in our report.

Implementing that may have political consequences but those, for the most part, are not for us to develop.

Deborah?

MS. BALL: Can I ask a question about that?

MR. FAULKNER: Pardon?

MS. BALL: I'd just like to ask you a question about that.

MR. FAULKNER: Sure.

MS. BALL: I want to understand better. We certainly are making recommendations that may influence policy. We are not setting policy.

However, for instance, yesterday we heard repeated evidence, that we'll have to talk about and figure out how to gather more, that one of the reasons for the so-called bloated textbooks is the fact that curriculum is produced in such a way that it's responsive to the myriad of curricula and standards out there. So that might lead us to be asking what it would take for there to be much more coherent guidance, instructionally, for teachers and for students and for parents which, therefore, I think is what has led to Skip's group exploring the question of how to reduce that incoherence that we currently face.

So I think we may need your help in figuring out how to organize the things we are hearing. What I'm arguing for is that we remember to consider the context in which success in algebra is occurring and--

MR. FAULKNER: And I'm not--

MS. BALL: --I assume you are not arguing with that.

MR. FAULKNER: And I'm not dissuading you in the least from raising those questions, I think that those are questions that have consequence, educational consequence, and we will need to find a way to express what we think is a wise course for the

nation.

What I'm saying is that how that ends up being worked out inside the political structure is not for us to specify in detail. What we need to say is what we think is best for children and for the nation as we seek to gain greater effectiveness in our preparation of children for high school mathematics. That's probably the best we can say, at this moment.

Let's go to task group number two, which is learning processes, Dave Geary.

MR. GEARY: All right, thanks, Larry.

Over the last several meetings, we've been working on an outline for what we hope to achieve as a group and as related to the charge of the other groups. At this point, I believe we have goals for what we would like to achieve by the end of January and what we would like to contribute overall. We will be looking to provide information on what children will bring to school and up through kindergarten, so their basic understanding of number, counting, arithmetic.

We'll explore differences across diverse groups in what kids bring to school because, as we've heard over the last, or at least yesterday, we heard that the gap that is there at the beginning of school

tends to remain. So we'll explore those areas in which that kind of preschool mathematics and where those, where important differences might be found.

We will also provide a little bit of information, kind of basic information on what we understand about human memory, development of children's memory, development of procedural competencies, conceptual competencies. We know that they are interrelated in important ways and we also know that different types of experiences may affect procedural competency development versus conceptual competency development, and so we will provide a background in that.

This background will then be applied to a number of the content areas that we are working with Skip's group to identify, and these will be the basic pre-algebra and algebra content that the panel will ultimately flesh out by the end of our charge. By January, we hope to have draft reports of children's perceptual understanding or perceptual skills, conceptual development, difficulties in learning and so forth, in the area of fractions, decimals, and rational numbers. I don't know that we will have that completed by January, but certainly that is one of our goals.

We also will begin work on the topic of

whole number arithmetic, looking at not only development of basic facts and algorithms but also relationships between conceptual understanding, and procedural understanding and so forth in those domains. We hope to have that covered. We also hope to cover non-cognitive factors that might influence learning and learning processes; this would be student motivation, cultural evaluation of learning in different areas, affective factors, anxiety and so forth. And that will be covered in a general basis and then discussed within each of the content areas, as that research is available.

MR. FAULKNER: Okay. Comments? Anybody have questions of Dave?

Dan?

MR. BERCH: Dave, I wonder, you used the word memory and some people might take that to mean that just the fact that we are looking at that suggests that we are endorsing rote memorization, and I'm not saying we are or aren't, but maybe you could just say a little bit more about the nature of that in the way that we are exploring it.

MR. GEARY: Yeah, certainly. There are several different forms of memory and one form is you know the facts. It would be long term memory and then there are different components of working memory,

your ability to kind of deal with information simultaneously online. And so competency at solving multi-step arithmetical or algebraic word problems seems to be related to skill, from some of my own work, in executing algorithms, retrieving information from long term memory, but also working memory. So competency in that particular area involves multiple types of memory and multiple types of mathematical skills.

And we hope to separate out the different types of memories, provide operational definitions of those and then identify how they might be involved in the different types of learning and how they may facilitate or interfere with mastery of those skills.

MR. FAULKNER: Anyone else?

Okay, task group three on instructional practices, Russell?

MR. GERSTEN: I want to start off by thanking the speakers this morning because I just learned a lot and I got so much, so much to think about from the various remarks and the different perspectives and how articulate folks were.

Our group yesterday I think was a little bit like a long day's journey into night. I guess it was only three and a half hours but it felt like 12.

(Laughter)

MR. GERSTEN: There was conflict, tension, resolution, but it was certainly not boring, and I think everybody was weary. What? No fist fights, no fist fights, verbal, verbal.

I think we came up with some reasonable synthesis. We decided, that we are not going to come up with one quick turnaround task for the contractor because there is such interrelationship between the various things. In Chapel Hill, we came up with a laundry list, and I remember I just didn't want to read it because it was so tedious. I mean it went from calculators, real world problems, what are real world problems, what kind of problems makes sense to teach.

So our focus is really going to be on, a term which still really hasn't been defined, but it's essentially what is explicit instruction? What is effective instruction? What are the kinds of activity-based or inquiry-based activities that make sense in math curriculum? And just looking at what evidence there is, and trying to break it into facets, and look at pockets of evidence and to build as best a picture we can. And that can and probably will also include talks with some experts about their thinking and ideas that are emerging, as well as a careful review of the research using a lot of our

laundry list topics, formative assessment and all, to help build this picture.

And so we see this as a goal for the final report and the interim report will just be an update, it will be a little bit like what the National Reading Panel did in terms of instructional issues, they deferred that strand until up the road.

So that's where we stand now.

MR. FAULKNER: Any questions about Russell's panel's activities or plans?

Valerie?

MS. RENYNA: Russell, I know you have a lot on your plate in your committee. There are a number of areas in which one might say there actually is evidence. There is some data, and not necessarily in some of the areas you mentioned. But are you going to be examining, as a committee, things that might prove effective practices and for which there is a copious amount of data? Are those things going to make it into your final set of high priority items?

MR. GERSTEN: That is absolutely correct. Our report will not be only debunking things, but if there are areas where simply we could locate no research or areas where some research suggests overuse of this kind of thing creates problems. For an area like calculators, Tom mentioned there are

three meta analyses there, so that will be part of our report. But we don't want to just have a list of things, so we definitely will review evidence in all those areas. Abt has made that commitment. If we get them off the hook early on, then they can really search pretty thoroughly through these areas, and so the answer is yes.

MS. BENBOW: The five top ones?

MR. GERSTEN: Oh, the five top ones. So one was this whole idea of explicit instruction, calculators, formative assessment came out high, individual differences did but we thought we would let that infuse the report. And we heard some eloquent talk about that this morning, both for the kids who need acceleration and for the kids with learning disabilities who really might be four years below their peers, and what makes sense for teaching. Other ones are real world problem solving, which we also have to talk about, activity-based, real world in science, and manipulatives.

MR. FENNELL: Did you include review, practice, and homework? These are kind of connected in there somewhere, right?

MR. GERSTEN: Yes, absolutely, homework is connected. Some of these topics I find fascinating, others I'm profoundly indifferent to,

but that's me. That's why we have a group.

Any other questions?

MR. FAULKNER: Anything else on Russell's committee? Okay and--

MS. STOTSKY: Are you in any way looking at the role of research on instructional leadership, principals, and school administrators? Where does that fit in? Where does that go at all, if it goes anywhere?

MR. GERSTEN: I did not see it as fitting into our subgroup. It's certainly important, but I didn't see it fitting into our charge.

MR. FAULKNER: Wilfried?

MR. SCHMID: Well this is really a question for you, Larry. So what Sandy said brings up the point that there will be some issues that don't neatly fit into any one of these four subpanels, and there should be some occasion, some time before our final report, for the entire panel to sort of collect items of this sort that we might want to say something about, even if they have not been covered by one of the four subgroups.

MR. FAULKNER: Well I think that's entirely possible, and my sense is that probably we've got enough on the plate before our interim report is due. When we meet after the interim report

is issued maybe what we should do is review whether there are issues that aren't being picked up in the structure we have and whether we ought to invent a structure that can do that.

MR. SCHMID: Well, absolutely, I mean I did not mean to suggest this be done before the interim report.

MR. FAULKNER: No, I think it's a good comment, Wilfried.

I've got Tom and then, Russell. Did you want to comment on that thing?

MR. GERSTEN: Yeah, on that specific point, I think we don't necessarily want to be so comprehensive and throw things in at the last minute. When I've read national reports and in the last minute, they put in an area where there isn't much evidence, I think they wish they had not thrown some of these things in. It's not like leadership isn't important, but maybe that should come in some other document, so we want to think about throwing a lot of other things in.

MR. FAULKNER: Well there is certainly a leadership interface with the teacher panel, which we are about to go to anyway. Tom, are you--

MR. LOVELESS: Well, this follows up on Wilfried's point. The one area that I think is

missing from our subpanel discussions is the area of current federal policy. I mean we heard testimony yesterday from National Science Foundation and also from Tom Luce on just examining current federal programs on mathematics and their effectiveness. And it seems to me, at least with the National Science Foundation and with NAEP, those are the two main drivers of math in the United States from the federal level, and we are a federal panel.

If we are going to issue a report, even our interim report, that essentially says to teachers, and to schools and to parents, here is what we want you to do, there's a little bit of, you know, physician heal thyself that needs to be going on. The one area where we truly can have an impact immediately is on federal policy. So maybe we can't give substantive, concrete recommendations in our interim report but, boy, we should at least be saying, look, the NSF and NAEP both have a huge impact on mathematics in the United States and given our findings, here are some things we are going to do, at least in the next year, that examines whether or not they are going in the right direction, the wrong direction or whatever.

MR. FAULKNER: Okay.

Wade?

MR. BOYKIN: I brought this up in North Carolina and I just want to bring up again, with the particular subcommittee, the focus is supposed to, at least the charge says it's supposed to be on instructional practices, materials and programs. And the issues that I heard raised more so in Russell's comment were around what I would consider to be practices, as opposed to "programs". You know, you have a lot of sort of brand name programs out there trying to raise math scores, whatever, and would that be in the long term purview if not in the short term purview of this particular subcommittee?

MR. GERSTEN: That's an excellent point, and I think there will be some reports from the What Works Clearinghouse. In fact, I got an e-mail early this morning, the first one or first couple in elementary math are on the website, posted this morning, we will look at curricula issues as well. There is a recent National Research Council (NRC) volume, which kind of is a nice source for us, but then we will update that and we will talk about curriculum as well, that was an omission.

MS. JONES: I think our discussions haven't included a discussion of, you know, as you said, sort of named and branded curricula. I don't see the usefulness of the Panel blessing one

curriculum over another. I think there are other bodies that look at curricula and give information about if a name brand curriculum works, doesn't work, has evidence or doesn't. I think what we talked about is dissecting out that almost every curricula includes lots and lots of methodologies and that our role was to sort of look at the research to find out if there is evidence that particular methodologies are best used in a particular place and a particular time.

I think what we talked about yesterday is that most classrooms and most curricula combine lots of methodologies. So we are looking for evidence that says which methodologies may work best, as opposed to saying this particular package of methodologies is good, or bad or indifferent. We won't be looking at name brand curricula, so much as looking at the educational components that are in many different curricula.

MR. BOYKIN: Well that's fine and I think that's an important place to take that particular discussion. I don't think our responsibility is to come out endorsing, you know, Go For Math versus Math Gymnastics, whatever the case might be. However, we ought to be able to unpack some of these kinds of programs, extract from them what are the effective

practices that we can endorse in more generic ways. You still need to look at these kinds of programs to see what you can extract from those that are proven to be effective and there is good data to support that.

MR. GERSTEN: We should just, as a group, discuss the curriculum issue , which has not been on the front burner in our first two discussions.

MR. FAULKNER: Okay, can we go on to task group four, which is chaired by Deborah Ball? The task group covers teachers and related matters.

MS. BALL: So I think we made some progress yesterday in focusing, although we are not done. I would say I could organize what our group will be addressing under the heading of the problem of creating a mathematically qualified professional work force. There are sort of three big clusters within that, but I'll name them. They are really organized in five or six areas right now. I hopefully will be able to organize them still in a more focused way.

But the three large topics within the question of how to build, recruit, retain, maintain, and reward and so on a mathematically qualified professional work force centered on reviewing the research on teachers' mathematical knowledge,

reviewing research on programs related to the pipeline retention and rewards issues. In other words, getting people into teaching, retaining and rewarding them once they are there. And third, clearly professional training of all kinds, both pre-service and in-service, and the licensure exams associated with those and perhaps other kinds of exams.

But all of these that I've just mentioned around the question of a mathematically qualified professional work force, we would be seeking evidence for how to tie those more closely to performance and effectiveness with students. So the five problem areas you can see perhaps growing out of that are, the questions would be what's the kind and level of mathematics knowledge needed for teaching? And we have a bunch of subquestions related to that. The second one would be what's known about recruiting and retaining mathematically qualified people into teaching? We have a whole bunch of hypotheses about things that are often said to be related to that, recruiting and retaining such individuals into teaching, including conditions of the school, and salary incentives, and training programs and all kinds of things under that.

The third area would be investigating the

question of differential staffing at the elementary level, which is to investigate what it might look like to have teachers who are responsible for teaching only mathematics. We are particularly interested, in our group, not in the specialist model where teachers are outside the classroom but rather a subject-divided day, although we will investigate different models for what are sometimes referred to as math specialists.

It's, just to be clear, our hypothesis is centered, for feasibility reasons, more on questions that would reduce the number of people who need to be qualified to teach math, and center on those and offer, also built into their work, the opportunity to learn.

But we are not predetermining that, it's just that we are trying to focus the math specialist question, which has come up in many different panels, in a way that would allow us to perhaps get some leverage on whether there is something to say about that. The fourth one, which we haven't worked on yet really well at all, we did at Chapel Hill but we didn't get to complete our work on it yesterday. This would be what can we say about investments in and the quality and nature of effective pre-service teacher education and continuing education? And clearly that

was a big theme this morning, so it's something our group is going to have to figure out how to focus. What we can learn about the nature of effective professional training, both initially and continuing?

And the final topic, which you may think I've already mentioned but I'm separating it right now, is teacher evaluation and compensation and what's known about how to tie that more closely to teachers' performance and effectiveness. We worry that, in a couple of these areas, the recruitment one and the evaluation one, that there may be research that's more general and not always related specifically to math, so we'll have to deal with that as the contractor and we try to review the evidence that's out there about how to consider the question of the special nature of the teaching of math. We will also take advantage of research that's more general that might help us.

So, again, going back, the main theme you should take away is that there is an overarching focus on the building of a mathematically qualified professional work force with an emphasis on the mathematical knowledge needed, the recruitment, retention, reward structure, as tied to practice and performance, and professional training itself.

MR. FAULKNER: Thank you, Deborah.

Are there questions or comments about this?

Vern?

MR. WILLIAMS: Sandra mentioned a few minutes ago about the effect of administrators on teachers, math teachers in particular, and I have my own theories about that. I think the intellectual flavor of the school is sometimes set by the principal and math teachers tend not to stick around in anti-intellectual places. So I do think administrators have quite an effect on the retention of math teachers, and I assume that that will be part of the research.

MS. BALL: That's true. I didn't go into the details, but under the heading of the recruitment and retention question, we have an investigation of factors that affect the retention of teachers and one explicitly listed is school leadership and features of the school leader and the principal.

MR. FAULKNER: Any other questions?

Wade?

MR. BOYKIN: Deborah, has your group considered or will it consider examining the effectiveness of, well I guess what's called alternate routes to the teaching profession?

MS. BALL: Yes. So, when we say pathways

of recruitment and retaining teachers, among those will be investigations of what are sometimes referred to as alternative pathways, as well as special programs and so on. Initially, we were separating those and then yesterday it became clear to us that, in reviewing this, we can group them together in the question but, yes, explicitly, we will be.

MR. FAULKNER: Other comments or questions? If not, then we seem to have come to the end of the morning session. This has been a long session and I want to thank the panel and the audience for its patience.

And I do want to say that I believe that the National Math Panel made substantial progress in this day and half period, up to this point, we are not finished yet. I would like to remind the audience that the next meeting of the Math Panel is in Palo Alto on November 6 and 7. I would like to let both the audience and the panel know that the January meeting will not be in Washington, as was originally designated, because we have not been able to find a location that can accommodate the Math Panel. We will be meeting instead in New Orleans on January 10 and 11.

Thank you all. We are adjourned from this session. The panel members need to go immediately to

the bus.

(Whereupon, at 12:28 p.m., the session was adjourned.)