U.S. DEPARTMENT OF EDUCATION
NATIONAL MATHEMATICS ADVISORY PANEL

November 28, 2007

The meeting of the National Mathematics Advisory Panel convened in Salon ABCD, BWI Airport Marriott, 1743 West Nursery Road, Baltimore, MD, at 8:30 a.m.

PANEL AND EX OFFICIO MEMBERS PRESENT:

DR. LARRY FAULKNER	Chair
DR. CAMILLA PERSSON BENBOW	Vice Chair
DR. DEBORAH LOEWENBERG BALL	Member
DR. A. WADE BOYKIN	Member
DR. DOUGLAS CLEMENTS	Member
DR. SUSAN EMBRETSON	Member
DR. FRANCIS "SKIP" FENNELL	Member
DR. BERT FRISTEDT	Member
DR. DAVID GEARY	Member
DR. RUSSELL GERSTEN	Member
DR. TOM LOVELESS	Member
DR. LIPING MA	Member
DR. VALERIE REYNA	Member
DR. WILFRIED SCHMID	Member
DR. ROBERT SIEGLER	Member
DR. SANDRA STOTSKY	Member
MR. VERN WILLIAMS	Member
DR. HUNG-HSI WU	Member
DR. IRMA ARISPE	Ex Officio
DR. DANIEL BERCH	Ex Officio
DR. JOAN FERRINI-MUNDY	Ex Officio
MR. RAYMOND SIMON	Ex Officio

PANEL AND EX OFFICIO MEMBERS NOT PRESENT:

MR. JAMES H. SIMONS	Member
DR. GROVER “RUSS” WHITEHURST	Ex Officio

U.S. DEPARTMENT OF EDUCATION STAFF PRESENT:

MS. TYRRELL FLAWN	Executive Director
MS. MARIAN BANFIELD	
MS. HOLLY CLARK	
MS. IDA EBLINGER KELLEY	
MS. JENNIFER GRABAN	
MR. JIM YUN	

CALL TO ORDER

Chair Faulkner welcomed the public to the tenth working meeting of the National Mathematics Advisory Panel. He alerted the audience to the availability of signing services. Services were discontinued as no one had a need for them. He also pointed out that the meeting was being videotaped and photographed. Chair Faulkner noted that while they will be discussing the contents of the Final Report, the document is still being worked on and the points are still being debated.

Chair Faulkner stated that before the discussion of the Final Report, the Panel would hear brief presentations on the current status of particular task groups that remain active on their own reports. These groups are Assessment and Instructional Practices.

OPEN SESSION

TASK GROUP AND SUBCOMMITTEE REPORTS: TASK GROUP ON INSTRUCTIONAL PRACTICES

Joan Ferrini-Mundy, Co-Chair; Camilla Benbow; Doug Clements; Bert Fristedt; Russell Gersten, Co-Chair; Tom Loveless; Vern Williams.

Dr. Ferrini-Mundy gave a brief report on the progress of the Instructional Practices Task Group and outlined the changes since the last meeting. “Effective Instruction for Students with Learning Challenges” is a new title and a combination of two pieces -- the section on learning disabled students and low-achieving students. The section is also being rewritten. The section on teacher-directed and student- centered instruction in mathematics is undergoing some revisions, as well. The other chapters have been edited and finalized based on comments from the Panel and other informal reviews. They expect to complete the report in the next couple of weeks.

The Task Group is also working on a new section, “From Teachers for Teachers,” that will provide mathematical examples relative to the Critical Foundations that are proposed in the Conceptual Knowledge and Skills Task Group report.

Dr. Ferrini-Mundy then stated that the rest of the presentation would focus largely on the report that has had the most revision -- the role of technology in mathematics instruction.

Dr. Clements stated that the report looks at computer software and technology in general, but also at calculators as a special kind of tool. They conducted a synthesis of previous meta-analyses and reviews, and found that it was clear that there was a substantive amount of rigorous research only in three categories of software. So, the Task Group conducted its own meta-analysis of those three categories.

One of those categories was tutorials, drill, and practice, and what they found was that drill and practice of high quality can improve student's performance compared to conventional instruction. There are some hints from previous reviews that the improvement is higher in computational areas than in concepts or applications, particularly in generating automaticity and basic fact knowledge. When the software is well designed and implemented, it may be useful and show statistically significant results on math achievement, especially at the junior and senior high level. There were stronger effects with the older students. Some software was also shown to be useful to introduce and teach new subject matter content and to develop specific educational

goals for specific populations. The report will summarize the useful types of applications, for specific goals, and for particular groups of children.

A couple of studies in this category of software applications that provide tutorials, and drill and practice, especially a recent large scale study by Dynarske et al., funded by the Institute for Educational Studies (IES), found virtually no effects. These studies showing no effects, both in the meta-analysis and in the discussion afterwards, lead the Task Group to say that there are important caveats, and care must be taken to accurately state what the research says about how the software impacts learning. Before one adopts any kind of software, it should be recognized that all software is not equal. General statements about any of these categories do not guarantee that any piece of software is going to be effective. Requisite support conditions for effective use have to be in place, teachers have to be trained, and the software has to be integrated with the curriculum, among other factors. All of this is included in the Task Group report.

The second category was computer programming, the only one where a review of rigorous studies actually led to a higher effect size than previous reviews. Computer programming is shown to develop mathematical concepts, particularly geometric concepts and problem solving abilities. It did not show strong effects on developing calculation abilities, which is not surprising, especially for elementary students. The effects are larger if the environment and the computer software are designed for learning, for instance, Logo versus BASIC or other languages. The effect sizes tend to be larger if student's programming is mediated and guided by teachers to help students achieve particular mathematical goals.

There was an insufficient number of rigorous studies to make recommendations on other categories of software. The Task Group cannot say anything about problem solving software, as there were a few studies that seemed to show very small effect sizes, but not enough to conduct a meta-analysis. They recommend further research on the issue.

Third, tools other than calculators, including clickers, handheld technologies, simulations, games and various Internet applications, have not been rigorously researched. Therefore, the Task Group cannot say anything about that category.

Fourth, for calculators, Dr. Clements presented a new analysis covering more literature than at the last meeting. The Task Group can say that in a review of 12 studies that met the Panel's rigorous criteria, only one less than 20 years old, calculators have shown limited to no impact on calculation skills, problem solving competencies, or conceptual development. The review of reviews the Task Group conducted contained hundreds of studies, many of which are more recent. Using the Task Group’s rigorous criteria, the only one after 1987 was a single study at ninth and tenth grade.

Long-term effects of calculators, which many people on the Panel think is very important to point out, have not been studied. The Task Group cannot say from rigorous studies anything about possible negative effects of over-reliance or inadequate use of calculators.

Given the limited positive impact in the focal research and considering the Panel's work as a whole, there are strong arguments for caution in the use of calculators, and especially for more targeted and thoughtful use. Specifically, calculators should not be used in situations where they may impede the acquisition of basic facts and computational procedures. As substitutes for mental or paper and pencil calculations, they may have long-term harmful effects, but the Task Group does not know that. Conversely, if calculators are used, even in the early years, to verify answers and ensure accurate computations, they could lead to correct association. Further research is needed. The studies are frustratingly inadequate in reporting exactly how long students use calculators and exactly what they were doing with those calculators.

Similarly, calculators should not be used in situations in which they may interfere with student's understanding of the meaning of fractions and their ability to compute in fractions. Limited and targeted use of calculators may enhance student's problem solving ability and their understanding of functions, but students should develop a sound idea of what graphs are and how to use them independently.

TASK GROUP ON INSTRUCTIONAL PRACTICES: QUESTION AND ANSWER PERIOD

Dr. Schmid stated that in the sentence, "Given the limited positive impact and focus of the research," the word positive seems out of place. Instead they should say “limited evidence.” Dr. Clements agreed.

Dr. Stotsky asked if almost all of these studies are pre-1990, why they simply shouldn't say these studies are too old to draw any conclusions. She also asked why is it that there have been no high-quality studies done since 1990, as the major use of calculators became an issue in the schools after that. Dr. Clements stated that they are reporting it because it's not always true that just because research is older, it has no implications in the present day. They give direction to the field to ask for good causal studies, and to ameliorate some of the weaknesses and disadvantages of the earlier studies. But it is interesting that most of the rigorous studies, even though they are old, were substantially in agreement with more recent studies that were covered in other meta-analyses.

Dr. Wu stated that it’s not a question of age of the study, but rather the issue is about the long-term effects. There should be a qualification about the fact that these are pre-1990 studies and not indicative of all the problems that arose from the long-term use. Dr. Clements agreed and stated that they have the caveats in the report. But while there are claims about long-term calculator use, he would claim that they just need better science to know how much they can attribute those problems to specific calculator use. For example, the reason for a high school student needing a calculator for what should be simple arithmetic may not be directly related to long-term inappropriate calculator use. There could be several other causes such as lack of dedicated teachers and not enough time spent on basic skills.

Dr. Loveless added that he also would like to see the point made that most of these studies are with older students. There are very few of the 12 calculator studies, especially the high-quality ones that are before third grade. Dr. Clements stated that only one had second graders, and that showed a negative effect. Dr. Loveless stated that he would rather have the task group say that for those who are concerned that calculators may interfere with the acquisition of basic skills, most of which occur in Grades K through 3, but the research just can't answer that question. Dr. Clements agreed and stated that that is in the report.

Mr. Williams stated that some of the studies actually involved having students check their calculations. So, if students are asked to calculate and then use the calculator to check those calculations, that's not going to have an effect on calculation skills. But yet, in the first sentence of what the task group presented, it's implied when they just say calculator use. Mr. Williams also stated that these studies were done prior to 1990; yet in 1990, there was a sea change in the mathematics world with the National Council of Teachers of Mathematics (NCTM) standards. With these, computation was de-emphasized.

Dr. Gersten stated that one of the most rigorous studies was completed within the last six to nine months, with the year-two results coming out soon. They are facing, at least in terms of

studies of software use and their impact on student math achievement, a change to more rigorous research on a much larger scale than any of those calculator studies. So, the two areas are different.

Dr. Fristedt stated that he was concerned about how parents and teachers would read this. The issue for them is that it is important that students learn how to do addition, subtraction, multiplication and division of three-digit numbers and two-digit numbers. Reading about the calculator, the parent will think how the calculator interferes with the ability to do that with pencil and paper. The research questions that were asked in these studies are much narrower than that. He asked if that should be the very first thing mentioned here.

Dr. Boykin stated that the time dimension might also come into play as what a calculator can do has changed greatly across time and become more sophisticated. Dr. Clements stated that the synthesis of other meta-analyses and reviews discusses that to a limited degree. But there just hasn't been enough research on computers or on calculators that look at specific features of the hardware or software environments and what they do or do not contribute. It's another thing that is in the recommendations.

TASK GROUP AND SUBCOMMITTEE REPORTS:
TASK GROUP ON ASSESSMENT

Camilla Benbow, Chair; Irma Arispe; Susan Embretson; Francis "Skip" Fennell; Bert Fristedt; Tom Loveless; Wilfred Schmid; Sandra Stotsky.

Dr. Benbow presented the progress of the task group since the last meeting, which includes the final recommendations. They reviewed the National Assessment of Educational Progress (NAEP) and state tests, as they're very important today in evaluating the outcomes of education for individuals, schools, states, and the nation. Because they're evaluating the outcomes of education, they can also drive the educational process. The Task Group specifically reviewed these tests to see if they measure what is important, how well they measure it, and if there is quality and accuracy in the instruments.

The first general recommendation of the Task Group is that NAEP and state tests must focus on the mathematics that students should learn, e.g., the conceptual knowledge and skills identified as important by the National Math Panel, and with the achievement on critical mathematics content reported and tracked over time.

The second general recommendation is that states and NAEP need to develop better quality control and oversight procedures to ensure that test items follow the best item design principles, are of the highest quality, and measure what is intended, with non-construct relevant sources of variance and performance minimized.

Reviewing what is measured by assessments, the Task Group primarily reviewed NAEP, which has implications for state tests. The content strands of the six states the Task Group reviewed were similar to the NAEP. The Task Group developed several principles for re-organizing the NAEP's five content strands to better reflect the critical knowledge and skills identified by the National Math Panel.

The Task Group’s suggested principles at the fourth and eighth grade level include whole number operations and fractions, with different emphasis at Grade 4 than at Grade 8. The Number Properties and Operation strands of the NAEP should be re-named to be called “Number” and it should be divided into two separate strands. At Grade 4, one strand should be

whole numbers and a second separate strand should be operations involving fractions and decimals to highlight the importance of these types of concepts and skills at this level. At Grade 8, the newly named Number strand should be divided into integers and fractions, decimals, percentages and related applications involving ratio, rate and proportion. One of the major concerns that has emerged is that fractions and whole numbers hasn't been assessed as deeply as they should be, and the Task Group is trying to correct this by re-organizing the content strands and being specific about what they include.

Geometry and Measurement should be combined into one content strand, and topics related to both Measurement and Geometry should serve as important context for problems within the Grade 4 and Grade 8 NAEP.

For Algebra, a better balance is needed within the sub-topics of patterns, relations and functions, and there should be much less emphasis on patterns.

For Data Analysis and Probability, at the fourth-grade level, it should be renamed "Data Display." At the eighth-grade level, the Data Analysis and Probability name is appropriate, but the content should be expanded to include both data interpretation and probability.

The next step was to review how well students should do at Grade 4 and 8 and what are the appropriate performance levels on these strands. The Task Group reviewed how decisions were made about where to place the cut score. Their recommendation is that the Modified Angoff method seems to perform well against several criteria for psychometric adequacy.

The panels that set the cut scores, which determine proficiency levels, should include mathematicians and teachers and should also draw on expertise of high-level curriculum specialists in education and academia. In addition, standard setting panelists should take the tests themselves, and standard setting should be informed by performance data. More research is needed in this area.

In the area of quality control and oversight procedures, the Task Group looked at issues around item design, which professionals should undertake and review, and calculator use during testing. The Task Group recommends that items should be designed to assess specified aspects of task performance. They reviewed the literature on multiple-choice test questions versus constructed response. The research did not support the notion that constructed response format measures different aspects of mathematical competency compared to multiple-choice. The important issue is not whether to select a multiple choice rather than a constructed response format for a test, but rather, to have the most efficiently designed items to measure content of the designated type and level of cognitive complexity.

The Task Group also recommends that more attention be paid to the mathematical knowledge that is being assessed by a particular item and to the extent to which that item addresses that knowledge, rather than non-construct relevant variance. They found seven types of flaws in the mathematics items that could introduce non-construct relevant variance. Because they found all of these flaws in the mathematics of the items that were being used in the NAEP, the Task Group strongly recommends that mathematicians, along with mathematics educators, should be included in greater number in the review and design of mathematical item content for state, NAEP and commercial tests, as well as for setting performance standards.

The Task Group also reviewed the literature on calculator use on tests, and they recommended that calculators should not be allowed on test items that seek to measure computational skills.

More research is needed on item design and test design features to come to stronger conclusions. Word problems tend to be particularly problematic. They are likely to introduce non-construct relevant variance.

TASK GROUP ON ASSESSMENT:
QUESTION AND ANSWER PERIOD

Dr. Fennell clarified that relative to the two suggested content areas, Grade 4 Number includes beginning work with whole numbers and operations, recognizing whole number fractions and decimals, and would not include operations with fractions to any great extent. At the eighth-grade level, Number would include work with all integers, including all of the operations with numbers, fractions and decimals, and related percent through operations.

Dr. Clements asked if the task group established, for the professionals that they are advising to take these tests, the cut off score under which they wouldn't be allowed to comment on the test. He also stated that they should be careful of the implications of the statement that says, "NAEP and state tests must focus on the mathematics that students should learn, e.g., the conceptual knowledge and skills identified as important by the National Math Panel." "Focus on," is different than a main focus on the things identified as leading to algebra, but that's not the entire elementary curriculum. Dr. Fennell agreed and said the intent is to ensure that those foundations are covered.

Dr. Siegler stated that one of the most important recommendations is that at the eighth-grade level, there is a separate strand for measuring knowledge of fractions.
Based on the Learning Processes Task Group review of the fractions literature, fourth-grade students do not know much about fractions. Dr. Benbow replied that it is very elementary at the fourth-grade level and the really important part of the fraction strand is at the eighth-grade level. Dr. Fennell stated that these are building blocks for rational numbers at the Grade 4 level. He stated that their efforts would be amiss if they didn't assess the beginnings of that. He and Dr. Fristedt have had a number of conversations as to what that math might look like. Dr. Benbow also stated that state tests can track year to year, and they wouldn't want to have the state test not measure anything until eighth grade.

Dr. Loveless stated that NAEP claims that it assesses algebra at fourth grade and the leap to assessing at least the rudimentary understanding of fractions is not really out of reach for most fourth-graders, as opposed to the idea of doing algebra at fourth grade. But the really important thing they wanted to convey was the fourth-grade test needed to focus on operations and understanding of whole numbers, and fractions would then shift to the eighth-grade level.

Dr. Wu asked in terms of item and test design, and specifically multiple choice and constructed response, if they are saying it doesn't matter which one people use, as long as they do it well. He would strongly suggest that they phrase the language differently, that they shouldn't have both, because they're different and each one is needed to assess a person's mathematical competency. There is no way a multiple choice item can test a student's sequential, logical thinking, which is the main issue in doing mathematics.

Dr. Embretson responded that it depends on the design of the multiple-choice item. It can be quite flexible and in a study that designed them that way, the multiple-choice items became more difficult than the constructed response.

One study showed that multiple choice items can be designed to offer all the wrong answers. But another study showed that students were able to apply strategies that they have

learned with multiple-choice items to constructed response. One comment about multiple choice is that the answer is there, and all they have to do is plug it in to the stem to figure out if that's the right answer or not. In another study on constructed response where questions had the same stems, students generated answers and plugged them in using the same type of strategies from multiple-choice. The context of the whole test might be very important in strategies as well. On tests with both constructed response and multiple-choice together, students develop strategies for solving items and there's a mixture of what students will do.

Dr. Wu replied that the focus is not on the answer. It is on whether one has the opportunity to observe what the intermediate steps are. They want to see the sequential thinking on paper and make a judgment.

Dr. Benbow stated that the goal is efficiently designed items to measure content of the designated type and level of cognitive complexity. If one has a reason for designing an item to get at a certain skill, then one should use constructed response. But one shouldn't just use constructed response because it's thought to be intrinsically better. Multiple-choice can be used to get to a higher level of thinking.

Dr. Wu replied that it still seems like they are saying, either type will do if it is implemented well. A multiple-choice test can in no way test whether a person can do a geometry problem, period. Dr. Benbow replied that they will look at the wording of that, because that's what they were trying to get at with the second sentence -- don't focus on the issue of multiple choice or constructed response, but rather, on what it is that needs to be measured.

Dr. Wu stated that he would prefer to say that several constructed response items are needed to test whether students are able to navigate the sequence of steps.

Dr. Schmid stated that they also have to think about how these tests are actually scored and if one checks, on the NAEP or a state test, whether an eighth-grader can do a geometric proof, it will not be scored competently. He stated that it must be pointed out that they are also talking about state tests, that therefore, at the state test level and in sixth grade, for example, there can begin to be some substantial questions on fractions. But it should also be said that fractions at the fourth-grade level can only be expected to be very rudimentary, and this limitation must be spelled out more clearly than it is in the accompanying text.

Dr. Gersten stated that an important issue about the scale of national assessments is that quite a few items are needed for them to be reliable and to show a range of performance. The task group’s recommendations don’t sound feasible for the NAEP to have a reliable, nationally reported sub-scale. Dr. Loveless responded that when they use the term fractions, they are really talking about rational numbers. So they are including decimals. Dr. Gersten responded that even with decimals at Grade 4, the knowledge is so low that it certainly doesn't pay to make it a separate strand.

Dr. Ball stated that they couldn’t make claims about what students can't do under conditions where instruction hasn't been appropriate. Dr. Siegler responded that he agrees, but for a national assessment, they are going to be measuring what they are learning, and hopefully 10 years from now, there will be enough variance in the knowledge of fourth-graders that it will make sense to have a fraction strand on the NAEP. But given the current status, the items would be better devoted to excellent measurement of understanding of whole numbers. Dr. Wu stated that a challenging item on fractions would spur learning. Dr. Benbow agreed that it does drive the educational process to have a few challenging items, but it remains unclear what the proportion of items on fractions and whole numbers are in the two strands at Grade 4 and 8.

Dr. Boykin stated that some of the recommendations in the content and performance level section of the Assessment report seem to have implications for curriculum design. He asked how well these recommendations are synchronized with what is proposed in the Conceptual Knowledge and Skills section. Dr. Benbow responded that they are very much in line.

Dr. Schmid stated that Dr. Wu may be implying that standardized or multiple choice tests can't fully measure conceptual understanding, but the American Mathematics Contest (AMC) problems are multiple choice, and there's no way that students can do most of them without having a full conceptual understanding of the subject matter.

Dr. Fristedt stated in relation to the separate strand at Grade 4, the Task Group never gave thought to putting the two together at Grade 4, but still splitting them at Grade 8. There seems to be this view that the strands are supposed to be preserved throughout, which does create a problem. There is a comment in the main report that tests should increase in difficulty. The real issue is whether the assessments assess the right things. Dr. Fennell responded that the Task Group did give that consideration. It could be argued that NAEP, as it currently exists in Grade 4, does combine wholes and work with fractions and decimals, in a very limited way. He also stated that in the research relative to multiple-choice versus constructive response items, the issue of diagnosis is never discussed. By "diagnosis," Dr. Fennell was referring to what we know about a student and his or her learning of mathematics as they look at those kinds of responses.

Dr. Benbow concluded with mention of fractions and the importance of mastering them to be well prepared for algebra. That came up in the Survey of Algebra Teachers as one of the areas where students were really lacking. Schools do not spend enough time on them and they are not assessed. That drove the Task Group to say they need to be a separate strand so that schools are held accountable for this and student performance is tracked over time.

NATIONAL MATHEMATICS ADVISORY PANEL:
FINAL REPORT DISCUSSION

Chair Faulkner began with a discussion of Item 1, which is the focused coherent progression. One of the related issues is on the words circular, spiral, or some alternative language for these. Dr. Clements offered an alternative version, which is "a focused coherent progression with an emphasis on mastery of key topics should become the norm in elementary school mathematics curricula." There is no change in sentence one, "The practice of continually re-visiting topics at the same level, year after year without closure, should be replaced with an emphasis on a small number of key mathematical ideas, related concepts, skills and procedures for each grade that build and connect, forming a cohesive Pre-K to Grade 8 curriculum."

Dr. Schmid stated that he feels the word "spiral" really should be in here in some form or another, because that is what it's usually called in education circles. It doesn't have to be the primary description of what they are talking about, but it has to be made clear what it is they are criticizing. In fact, very often it is labeled as a spiral approach. In some subjects, the spiral approach is appropriate, but spiral approach, as defined here in mathematics, is noxious. Dr. Fennell stated that they should define spiral. Dr. Schmid stated that it is an emphasis on a circular approach that revisits topics year after year, without closure. He asked that there be a parenthetical remark that that's what's often called spiraling. Dr. Fennell stated that the point of contention is that people define spiral differently. Their issue with the approach is the sort of situation where a topic is never given up. Dr. Schmid stated that is why it is very often called spiraling and no one calls it the circular approach.

Dr. Ma stated that the word spiral in education has a specific meaning. It has been in the field for 100 years. It means that, every time one comes back to the same concept, one has a higher level or deeper level of understanding. That's something that is not being carried out in practice. The problem is not with the word, but with the approach.

Dr. Schmid stated that if they refer to it as circular, then it really skirts the issue. If that were what was truly implemented, it would be okay. The trouble is in what happens in the classroom. Various curricula advocate a spiral approach, and the spiral approach is what they describe in these additional words.

Dr. Wu stated that they should poll administrators to see how they react to the word.

Dr. Loveless stated that they should drop the term spiral because it's loaded. They do not have research that it's bad or good. It can be done well, or it can be done poorly.
He asked that they just use the definition, which he doesn't think anyone would disagree with, and drop the term. They would say that they urge that topics not be continually re-visited year after year without closure.

Dr. Ball stated that that compromise would solve their problem, because what Dr. Schmid said in response to Dr. Ma is right. The approach itself, when well implemented, would make sense. It's that it's not implemented that way. That's what the Panel is worried about. Dr. Loveless' wording solves that problem, because it's that problem of re-visiting and never finishing anything that they are worried about. If they just avoid the term all together, they get themselves out of this. Dr. Wu seconded that. Dr. Stotsky stated that she would have to double check, but she thinks the word was used in Bill Schmidt's study. That is where the original term, as a critical issue, came, and she asked if Dr. Fennell remembered that better than she did at this point. She also stated that the Institute for Educational Sciences (IES) study was contrasting differences in curricular approaches, between what they call the A+ countries and other countries, and that was the term that came into play. Dr. Stotsky suggested as an alternative either a footnote or some material be added that explains that the spiral approach, as Dr. Ma mentioned, works well in science and history in different ways. In math, as it's been applied to the skill work, it has not worked appropriately. It would not apply even in foreign language teaching, where one is building with skills that must be mastered before one goes on.

Dr. Schmid stated that even in mathematics, as Dr. Ma said, if spiraling is like the mental image of a spiral, it would be okay. But he has not seen a math curriculum that calls itself spiraling that does that. When it comes to the actual phrasing, if they give up circular, and if it's true that Bill Schmidt uses spiraling, then they should have a footnote that says that this is referred to as spiraling in Bill Schmidt's curricular analysis.

Dr. Wu stated that the Panel report should be as simple as possible and that is one reason he prefers Chair Faulkner's present wording to Dr. Clements. If they have to add a footnote to explain something as opposed to simply omitting that word, he would prefer that they just omit the word.

Chair Faulkner asked if they are conveying their meaning here, as to what they are trying to do.

Dr. Fennell stated that he thinks the meaning is conveyed with the phrase "should be a de-emphasis on an approach that continually re-visits topics year after year, without closure." And every one of those words is important. Relative to a footnote, with regard to spiral, spiral is language that is abused a lot in the field. He agrees with Dr. Wu that there should not be a footnote.

Chair Faulkner stated that Dr. Fennell has made a nomination that the language must be changed to “a de-emphasis on an approach that continually re-visits topics year after year without closure.” He called a vote on how many people are comfortable with that language and how many are opposed to that language.

Dr. Ma asked if they could use the word “avoid” instead of “de-emphasize.” Chair Faulkner asked the group if anybody was against “avoiding.” There was agreement on that change.

Chair Faulkner moved to the next paragraph with the term “focused” and the Panel was satisfied.

He then moved to Item 2, “to clarify instructional needs and to sharpen future discussions,” and to the list of Major Topics of School Algebra.

Dr. Stotsky asked if they are trying to sharpen the discussion about the role of school algebra in the curriculum, which she had the sense everyone understands. She asked if it should be the “nature of school algebra,” not the “role.” Chair Faulkner asked if they would then drop, "in the overall mathematics curriculum." Dr. Stotsky agreed. Dr. Loveless asked if it could be “content,” instead of “nature.” Dr, Stotsky suggested they say, “the specific content of” and “the Panel developed a list of the major topics to provide educators with a clear understanding of…” Chair Faulkner settled the issue with the suggestion, “we developed a list of the major topics.”

Chair Faulkner then moved to the second paragraph on what school algebra is, which states, “to clarify instructional needs in Grades pre-K to 8, and to sharpen future discussion about the content of school algebra, the Panel developed a list of Major Topics of School Algebra."

Dr. Schmid stated that the paragraph should stay the way it is. If they want to have a discussion of what should be taught in lower grades, they first have to understand what algebra actually is. Dr. Fennell stated that when they talk about algebra in Grade 7 or 8, they are talking about the role, the nature, and the content. The focus really isn't on the role there. Dr. Schmid stated that the paragraph is okay.

Chair Faulkner called a vote of who was comfortable with the paragraph as it stands. The vote was to keep it.

Chair Faulkner stated that Dr. Fennell suggested bringing forward into the Executive Summary the actual table of benchmarks. If they are to do that and to put them in the document as a side bar in the executive summary, they might want to consider doing the same for the Major Topics of School Algebra. Those are the two blocks of items in the Conceptual Knowledge and Skills report. He then asked for the Panel’s thoughts about this.

Dr. Siegler stated that he would include both. Dr. Wu stated that it is either both or nothing. Dr. Siegler stated that from the point of view of effective presentation that, having two extensive tables in the main presentation of the Executive Summary will delay readers getting to other parts of the report. He would be in favor of having it at the end of the Executive Summary. Dr. Schmid agrees that there could be a page reference. Dr. Clements stated that he thinks the paragraph is too long. It just seems to bog down the presentation. Chair Faulkner stated that he would try to shorten it. The full version of this paragraph is in the body of the report. So it's not necessary that the whole thing be here.

Chair Faulkner moved to the Major Topics of School Algebra, and suggested inserting an action item that flows from the major topics. This recommendation is in the Conceptual Knowledge and Skills section, and would read, "textbooks for algebra (whether for an integrated curriculum or otherwise)…" The next point is that in an elementary and middle school curriculum, proficiency with whole numbers, fractions, and particular aspects of geometry and

measurement are the Critical Foundations. Dr. Schmid stated that there should be a page number reference to the Critical Foundations.

Chair Faulkner then moved to paragraph two, where the issue is whether fractions is the very most important point, or whether it's the very most important point not presently developed. Dr. Siegler stated that he likes the paragraph, in general. He suggested a small wording change that may address many concerns, which would be, rather than saying "is," which is probably overly strong, saying "appears to be," which indicates that, to some degree, this is a matter of judgment.

Dr. Berch stated that he has a concern about the first paragraph and the issue of assessment. They were talking about the difficulty of assessment, in terms of making sure that they don't over-emphasize or inadvertently emphasize the learning of fractions at the early elementary levels. By now combining elementary and middle school in the first paragraph, and information about learning whole numbers, fractions, particular aspects of geometry and measurement, they lose the point of what topics need to be learned at which level.

Dr. Schmid stated that the benchmarks quite clearly spell out what comes where. If there is a page reference to the benchmarks, then that should take care of the concern. Dr. Gersten stated that that is why the "appears to be" suggestion was made, and they need to be clear that there is no empirical basis. Although there is no empirical basis at the current point in time, they still believe, based on the analysis, that this is the case. Chair Faulkner asked the Panel if they were comfortable with "appears to be" and there was agreement.

Dr. Fristedt stated that the second paragraph could be improved. If something was said about operations with whole numbers, then the second paragraph is really middle school oriented. Dr. Siegler stated that maybe they could have the most foundational skill not presently developed, and have an insert prior to entry into algebra courses, because that's what the teacher's survey indicated. They were extremely concerned. Dr. Fennell stated that the teacher's survey and the NAEP results indicate that. They have a lot of descriptive data that would support that statement. But as the statement is currently worded, it swallows up the importance of whole numbers.

Dr. Berch asked that while the Benchmarks are laid out, why couldn't they have one paragraph for elementary and the other for middle school, and talk about the emphases needed at each level. They are trying to find ways to make sure that they emphasize both. Chair Faulkner asked that they work that language out off-line.

Chair Faulkner then moved to paragraph three, "These critical foundations are not meant to comprise or complete pre-school to algebra curriculum, but do deserve primary attention and ample time."

Dr. Schmid stated that they are not naming the foundations because the Executive Summary is not the place to lay out a curriculum.

Dr. Ma stated that they missed one thing with whole numbers, that students can learn the associative and distributive laws. Doing so will support algebra learning quite a lot, even before fractions. Chair Faulkner asked about Item 5, the development of students in Grades pre-K to 8 at an effective pace. "The Panel recommends a set of Benchmarks matched to the Critical Foundations (Figure 2)," and they will insert the page number of the Foundations. "They should be used to guide curricula, mathematics instruction, textbook development, state assessments."

Dr. Schmid stated that the paragraph really ought to be enough to address the concern. They are laying this out, but not in the Executive Summary directly. Dr. Berch stated that he agreed with Dr. Schmid. Dr. Loveless stated that Dr. Berch has a good point, and it goes back to

paragraph two. They talk about elementary and middle school, and then they jump right to fractions, which are a middle school topic, and whole numbers are not mentioned. He proposes a single sentence, such as, "At the elementary level, proficiency with whole numbers is essential." He recommends that they leave the first paragraph as it is, but change the second paragraph that currently begins, “the most important foundational skill,” to, “At the elementary level, proficiency with whole numbers is essential.” The second sentence then would begin, “For students beginning the study of algebra, the most important foundational skill not presently developed appears to be proficiency with fractions,” and they can cite the Algebra Teacher Survey, the Learning Processes report, and a number of sources.

Dr. Schmid stated that he would like to have a sentence that also talks about whole numbers. The Panel should not get into the dividing line between elementary and middle school. The phrasing should be functional; integers have to be mentioned, and then proceed to fractions. But at this point, he doesn’t recommend bringing in the question of division. While there may be problems with how whole numbers are taught, there are bigger problems with how fractions are taught. So if somehow the following thoughts come through, that whole numbers are a foundation for algebra, both directly and through their role as the foundation for rational numbers, then rational numbers are certainly a crucial entry point to algebra, but they are not presently well taught.

Dr. Siegler stated that the problems with fractions versus whole numbers are of a different order of magnitude. Dr. Berch stated that we are almost conflating two things. If we want to talk about what's necessary before entry to algebra, then we must focus on that, rather than on what one learns at what grade level, elementary, or middle school. As soon as we begin talking about elementary and middle school, it's leading to the suggestion that these are the things you need to know at those levels, but then we don't want to get too deeply into the emphases on those things. He suggests either not saying anything about elementary or middle school, but say what is necessary to be prepared at entry, with an emphasis on fractions. Dr. Schmid added that there is no particular reason to have an introductory sentence with elementary school and middle school.

Chair Faulkner then moved to Item 6; “Federal and state policies should give incentives to schools to offer an authentic Algebra I course.”

Dr. Fristedt stated that he disagrees with having that recommendation because if schools push algebra into eighth grade in this fashion, it will tend to get watered down.
A better statement is, "Federal and state policies should give incentives for schools to offer what is typically offered in ninth grade," to make that available in the same form at Grade 8 and possibly even Grade 7. For the students who accelerate, there will be something for them to take in Grade 12 and possibly 11.

Dr. Loveless stated that he has been against this every time it's been proposed. The only example where this was done was the District of Columbia. They required all students in Grade 8 to take algebra courses, and on NAEP, they scored at the bottom of the nation. So, just requiring a course is irrelevant. It has to do with what's actually taught. The Conceptual Knowledge and Skills group hesitated, in terms of recommending either an algebra course or an integrated course, to endorse either one. Yet here, they are endorsing an algebra course. The Learning Processes group hesitated to say that algebra should be taught at any given age and yet here, they are specifying the grade in which an algebra course should be offered. It doesn't logically flow from what the other task groups have done. There is the chance of unintended consequences from offering these incentives. There will be schools offering algebra courses

where they don't have a teacher who can teach it, or schools will load up on phony algebra courses. Districts and states do not have the ability to police the content of these courses.

Mr. Williams stated that he also has a problem with this. He would change it to say, "Federal and state policy should give incentives to school systems to offer the content of an authentic Algebra I course," but not in grade eight. The problem is that school systems are offering Algebra I courses that consist of fourth-grade math, with a little bit of data analysis thrown in. If they can get schools to offer authentic algebra courses, it should be whenever the students are ready. He has seen this happen in Washington, D.C., where superintendents state that they have 75 % of their eighth-graders taking algebra, and even though it may not actually be algebra.

Dr. Stotsky stated that she understands the concern about not having schools impose algebra on grade 8 and then have it watered down, which was why they tried to be extremely careful about this recommendation. It did flow from something that was in Schmidt et al's study, in which he noted that across this country many middle schools do not provide an Algebra I course in Grade 8. Students who are capable of taking one cannot until Grade 9, which then means by Grade 12, they cannot take an advanced mathematics course. But the point here is to make sure that it is an appropriate course, so the item is worded as "the content of an authentic Algebra I course," to make sure that it's not going to be watered down content. But unless there is an incentive for schools to think about this issue, what has been happening in the past decade--the removal of true algebra from grade eight and pushing it up to grade nine—will continue. While there are teachers who are under-qualified at all grade levels, this doesn't mean that they should stop offering math until they can get all these under-qualified teachers up to par.

Dr. Schmid stated that algebra in eighth grade is a movement that exists. If the Panel is silent, then we are being silent about something that now plays a major role in the school curriculum. If we are talking about incentives to prepare a larger number of students for algebra by eighth grade and then to offer a course, and in addition to calling it authentic, we should also say that it should cover the material that they referred to earlier.

Dr. Loveless stated that he thinks it is redundant for us to be urging that the content be authentic. We have already defined what authentic content is, by the time the reader reaches this point. The question is about policy, and it has to do with what happens when incentives are offered, and there are unintended consequences that will flow from this. There are all kinds of things that can happen when states dictate the course offerings of schools. This is a naive recommendation. He supports Mr. Williams' alternative wording. We want federal and state policies to give incentives to schools to offer the content of an authentic algebra course. Whether students take it in Grade 7 or 9 is fine, as long as they're prepared for it and that it's a good course.

Dr. Fennell stated that in this country right now, 40 % of the people who are in eighth grade are taking something called algebra or better. What we have to say in this statement is that there are places where students do not have access. In addition, schools are pushing a lot of students into such a course, be it integrated or titled Algebra I, without the kind of prerequisite background. This recommendation needs to deal with the prerequisites first, then access for those who do not had access currently. The word "incentive" is loaded because of some of the points that Dr. Loveless made.

Chair Faulkner asked that this be reworked off line to cover the points that various people have mentioned, including the point that incentives are dangerous and can drive behavior that the Panel is not looking for.

Dr. Benbow stated that the main point is that a lot of students are ready for algebra earlier than ninth grade and if they are held off until the ninth grade, they cannot take calculus in high school and it limits their career choices.

Dr. Faulkner moved on to the Curricular Content body. They can assume that the results of the discussion they have just had will get translated into the appropriate parts of the curricular content. He asked the Panel about the section on the nature of school algebra.

Dr. Fennell asked about the statement that said, "Most commonly, school algebra is organized in two courses, Algebra I and Algebra II." He asked if "commonly" is the right word. There is the issue of an integrated mathematics curriculum and there are states, five or six now, with standards dealing with integrated curricula. Dr. Schmid stated that it is a factual statement. Dr. Loveless added that they have factual data from NAEP, in terms of asking the teachers what courses they teach, asking the students what course they enrolled in, and the percentage in an integrated course at eighth grade. It is very small and steady at 2 %. Dr. Siegler stated that this is well justified.

Chair Faulkner then moved to the Critical Foundations.

Dr. Schmid asked about "standard" being crossed out. If we say standard algorithms, first of all, then it's clear what's meant. If we say algorithms, it's not clear what is meant. Various reasons have been given for leaving out the word "standard." The last one, as far as he knows, was that internationally, there are no standard algorithms. This is just nonsense. If they look at what is commonly called a standard algorithm, for example, for addition, subtraction, multiplication, and division, there is indeed, a standard algorithm that is taught in all the industrialized countries. The only difference is minor and notational. For example, with the division algorithm, the divisor and the dividend can be written horizontally or vertically. That makes absolutely no difference in the algorithm itself. There are standard algorithms and that's what we would like to have taught. There also exist so-called student-invented algorithms, a variety of non-standard algorithms, which very often mean that intermediate steps are actually included in the notation. What we are asking is that the standard algorithms be taught rather than the student invented algorithms, algorithms that are broken down with intermediate steps. Standard algorithms should be taught for commonality so that students in Arizona and Massachusetts learn the same algorithm. Striking the word "standard" might send a message that anything goes.

Dr. Ball stated that they do not need to get into a discussion now about transitional, alternative, or what is sometimes called student-invented algorithms, because that's not what this is about here. We know there is discussion that can be had about teaching stages, as opposed to final products. We are not talking about how to teach here. In addition, if we are putting "standard" in, they should take "the" out. There are multiple conventional algorithms and the point they are making is to get to conventional algorithms.

Dr. Wu stated that he would be happy to leave the article out, but he supports Dr. Schmid's point that "standard" must stay in. There's a misconception at the moment that if one writes something slightly differently, then one cannot call it a standard algorithm.

Dr. Fennell stated that he agrees with Drs. Wu and Ball in deleting "the" and adding "standard." They are talking about end points, whether it's a partial sums method or partial products that leads students to that final end point, it goes instructionally as well.

Dr. Williams agrees with Dr. Schmid that everybody knows what these standard algorithms are when they are mentioned, but he asked what they consider standard. Do they

consider student-invented algorithms standard? Dr. Ball stated that this is a longer conversation that they should not get into here.

Dr. Schmid stated that he would not be distraught if the definite article is left out, but he would much prefer it to be there.

Chair Faulkner stated that they would keep the word “standard” and delete the article. Dr. Ball supports that. Dr. Schmid asked if they could simply ask whether they would prefer “the standard” or “standard.”

Chair Faulkner stated that the question of the article is not agreed. He moved on to the section called Critical Foundations, and the paragraphs that indicate what they mean by fluency with whole numbers, fluency with fractions, and particular aspects of geometry and measurement. He then moved to the Benchmarks.

Dr. Geary asked about, "Students should be proficient with addition, subtraction of whole numbers." He asked if the Panel should state something about magnitude of those numbers. It might be interpreted as saying, "Being proficient with 7 + 9 meets this particular benchmark for Grade 3,” or do we want it really to go beyond single digits. Should it include multi-digit numbers?

Dr. Stotsky asked if the Panel wants to use the word “effective” in that second sentence or “optimal.” Effective sounds as if there is some measurement at the end, to judge effectiveness. Dr. Schmid stated that effective is the right word.

Chair Faulkner moved to the section headed “A Need for Coherence.”

Dr. Boykin stated the issue was raised previously about the possibility that the curricula of some low-performing countries might also share some of the same characteristics as those of high-performing countries. Dr. Reyna asked if anyone checked on this. Dr. Schmid stated that he is sure that's true. Some low-performing countries do exactly what's being advocated. On the other hand, the phrasing here in no way suggests that low- performing countries could not share these characteristics. Dr. Boykin stated that his concern is that if they simply state, let's do what the high-performing countries do, not realizing that maybe low-performing countries also do it, then they miss the possibility that it's how you do it, not that you do it, that is important.

Dr. Siegler stated that they do not have to go to other countries to see the problem here that Dr. Boykin is introducing. Within the United States, it happens by coincidence that of the six states cited as having the highest rankings, they include the states with the highest score on the current NAEP, which is Massachusetts, and the state that has the lowest score, which is New Mexico. This illustrates a problem in saying that it's important for states to adopt these standards without qualifiers about the absolutely critical nature of the implementation of the standards. Dr. Reyna asked that they add a phrase that the implementation of the standards is critical and that comparisons across states must also take into account those that do not score high, as well as those that do score high. Chair Faulkner stated that they say that in the body of the Conceptual Knowledge and Skills report. Dr. Schmid agreed that is where this belongs. Dr. Stotsky stated there's a sentence about the quality of high- and low-performing states’ assessments and the implementation in the classroom curriculum as intervening variables, before one can get to performance.

Dr. Berch asked to go back to Benchmarks, under Geometry and Measurement, to a point about similar triangles that needs more specificity. All of the other ones speak to the idea of becoming proficient and then spell out, even in Geometry and Measurement, what students should be able to do. It could go into the understanding of slopes and graphing, and the ability to understand those relationships.

Dr. Fristedt stated, about the section that starts, “A need for coherence,” in the recommendation that starts, “international studies," he would take out the “mile-wide, inch-deep” phrase. It has too much emotion connected with it, due to recent developments in the last decade. He also asked whether the distinction on a number of key topics is as strong as stated here. Dr. Schmid stated that the mile-wide, inch-deep phrase has become almost a trademark and Bill Schmidt has done a lot to convince many educators that this is a serious problem. He would prefer this phrase to remain, especially since it's in quotations marks. It really serves a purpose to clarify what they are talking about there.

Dr. Fristedt agrees except when he was doing the 2002 standards in Minnesota, he heard the phrase used in exactly the opposite way for people on the opposite side of the issue.

Dr. Fennell asked about the use of the word “mastery,” and he is concerned about that because of the way that's interpreted in a variety of contexts. In this sense, they are not talking about a Benjamin Bloom’s 8 out of 10 correct mastery. He would prefer the phrase “proficiency with key topics.”

Dr. Geary stated that it depends on how it's going to be interpreted by the people who are reading this document. He has a sense of what mastery means, in terms of learning. The way it is stated sounds like it has a different meaning than what they would mean if they were going to say mastery in a learning processes sense, which means automaticity or the automatic use of standard algorithms. Dr. Reyna added that there is a distinction here between proficiency and mastery, and mastery has the added benefit that it does signal this issue of closure, whereas, proficiency doesn't quite get to that level. Dr. Gersten stated that what mastery would be interpreted by school districts is either 80 or in some cases 90% on weekly quizzes and senseless review. He sees the problem with proficiency, but he’d rather go that way, unless they can find a third word.

Dr. Wu asked if there were some way to refer to the word “proficiency” in a sense of Adding it Up, because it is accepted in mathematics education and is clearly defined.
Dr. Schmid stated that “proficiency” on that ground is understood to mean what they want to say here.

Chair Faulkner asked for a vote on deleting “mile-wide, inch-deep.” The Panel agreed to keep it. He also asked for a vote on substituting “proficiency” for “mastery” with a footnote that says, “in the sense of Adding It Up.” The vote was for proficiency.

Dr. Loveless added that No Child Left Behind (NCLB) is on the minds of all the states and they use the word proficiency and each state gets to define it as they wish.
Dr. Wu stated that they may not want a footnote here, but they might want to add it to the Conceptual Knowledge and Skills report itself.

Chair Faulkner moved to the point on “Integrated versus Single Subject Approach.” Panel members had no objections to it. He then moved to Learning Processes.

Dr. Ball proposed that they accept some version, whether exactly like it or something close to it, of what Dr. Stotsky proposed as an alternative, where she combines points 7 and 8 into a positive statement about interventions. Dr. Gersten seconded that.

Dr. Siegler stated that one issue they have to think about is that there is truly minimal reference in their report as a whole to the special difficulties that low-income and ethnic-minority and linguistic-minority students face in learning math, and often, schools are blamed for this problem. It's important to acknowledge that while some of it is the school's fault, it's not all their fault. Teachers resent being blamed for problems that exist because of the general structure of society, rather than because of anything the teachers have done. By explicitly acknowledging

that students from low-income and ethnic- and linguistic-minority communities often start school behind, it recognizes the reality. Dr. Stotsky took out this point when she combined them.

Dr. Schmid stated that these are both valid points, and the two points should be combined, reversing the order to give it a more hopeful spin. And then, explicitly make the point that this is a big factor in numeracy, as well as reading.

Dr. Ball stated that the question is not about whether schools, teachers, or students are blamed. This is one of the reasons why she would like to see the Panel make a much stronger statement on teacher education. What she likes about Dr. Stotsky's recommendation is they don't deal with whose fault it is. They say something positive about what the Panel members know can help. They need, later in the report, to deal also with how they are going to equip professionals to have the capability to be responsible for student learning in this country, something the Panel has not done. She would like to avoid this question. Students and their families have been blamed as much as schools have been.

Dr. Siegler stated that it would be fine to list 8 before 7. Some of the content was lost, though. For example, it isn't that a variety of approaches was supported, it's that particular approaches were supported that had effects for students from low-income backgrounds. Dr. Loveless added that it's important to have 7, because it is an empirical observation that kids come to school with these vast differences. This isn't assigning blame to students or to families, but it is a fact that schools have to deal with differences that are over a standard deviation between income groups.

Dr. Stotsky stated that the opening sentence is purposely worded stating, "should use a variety," because she didn't want to limit it to use one of the carefully developed and evaluated programs because that would preclude others that might come along. Dr. Clements added that the phrasing, "use a variety" almost recommends that they bring in five or six and just throw them in there, and so, it's just a wording problem. He also added that although he sees the logic of trying to come up with a positive spin first, the original ordering is just more chronological to him. Students come to school with a wide variety of math backgrounds. However, some kids have more than others. Therefore, interventions, especially for those kids, are very important to their future success.

Dr. Berch stated that Dr. Stotsky's phrasing starts out telling them that these intervention programs would help children who are at risk, without knowing why. Dr. Geary agreed, and does not see a problem with starting out bleak, because that's the situation. Dr. Clements stated that they should start out by saying, "most children come to school with a wide array of foundational skills or abilities. However, there's a big difference..." That starts it out positive and gives the impression that students aren't a blank slate coming to pre-K or K.

Dr. Embretson stated that one of the problems with number 7 is trying to pinpoint the source of being at risk and that is kind of objectionable. Start it out that there is the wide array, but then there are students at risk and why they are. There is more material in the body of the report.

Dr. Boykin stated that one of his concerns with number 7 is that the sentence, "These differences influence the math learning for many years thereafter," has a fatalistic tone to it. If one comes in handicapped, one is going to be handicapped forever. It does not say that something can happen to intervene, to reverse whatever might have been a problematic beginning. He likes the language that says, "Mathematics knowledge that kids bring to school can influence their math learning." That takes away the pejorative connotation, the fatalistic nature of the statement that's right there.

In addition, the use of the term “at-risk child” is pejorative; it presumes the problem is in children themselves.

Chair Faulkner asked the Panel if they wanted to combine 7 and 8, and edit it later.

Dr. Schmid stated that 7 has to be rephrased, maybe 8.

Dr. Stotsky stated that there should be a positive recommendation to the schools. Dr. Schmid stated that there's a pretty broad consensus.

Dr. Ball asked if the Panel could accept the revision that Dr. Stotsky proposed, with a discussion of the last sentence. Dr. Siegler supported Dr. Schmid’s opinion that they need to change the language, but without proving or at least, asserting that there is a problem here. The recommendation to do things differently comes out of nowhere. As Dr. Loveless said earlier, most people probably don't understand that students know much of anything about math when they come in, and if that were the case, there wouldn't be any particularly compelling reason to have pre-school education programs. But the fact is that students in general know a fair amount about math. Low-income kids and other at-risk groups, for want of a better word, are far behind the majority and they statistically have long-term consequences for these deficits. Without that basis and logic, the recommendation for these pre-school programs comes out of nowhere.

Dr. Berch suggested that they state something about the findings and then the issue becomes softened in a way. He proposes to say, “Without appropriate intervention, these differences may persist.”

Dr. Ball stated that the finding is as follows: students enter school with a wide variety of background, skills, and knowledge, and there are students who come with less than others. Schools can actually make a difference in that, and the Panel is reporting that interventions and good teaching actually make an enormous difference.

Chair Faulkner called a vote on substituting Dr. Stotsky’s language as the starting point 7 and 8 with later editing. The Panel voted yes to this and would edit later off-line.

Chair Faulkner called a recess at approximately 11:40 a.m.

NATIONAL MATHEMATICS ADVISORY PANEL
U.S. SECRETARY OF EDUCATION MARGARET SPELLINGS

Secretary Spellings thanked the Panel for the tremendous service that they have done for students in this country and will do doubly so when they finish the report and deliver it to her and the President by February 2008. She acknowledged that it's been a very challenging assignment and a little bit overdue that the country would have some more understanding or more definitive words for teachers and educators. She stated that the folks in the field anxiously await the Panel’s work. She recognized the staff and contractors who supported the Panel’s work, including Tyrrell Flawn. She also recognized her friend, colleague, and fellow Texan, Larry Faulkner. His steady hand, his keen intellect, and his public policy experience have been hugely valuable to the Panel’s efforts.

The Secretary stated that the Panel represents various areas of expertise, different points of view, scholarship niches and so forth, and together constitute the most elevated work on this issue that has the approval of the of federal leadership under the Department of Education. The Department looks to provide guidance, the best scholarship, and the best research. The Panel’s experience has really added to the weight of this work.

The Secretary visits schools all the time, all around the country, and she sees a starvation for what is the best thinking about math instruction. Teachers and school administrators are

people of good will who want to do right, who want to close the achievement gap, and follow the "tell us what to do and we'll do it" phenomenon. She believes that the Department owes them that guidance.

Medical professionals are not expected to go into operating rooms without the best scholarship and the best research, and a lower standard should not be expected for those who work with children every day.

The Secretary is struck by, as she reads the Panel's work to date, how much they actually do know around high standards of research and evaluation, which really is not very well understood in the field. To have it captured in one place what they do know and maybe don't know about good practice will be very useful.

Observations about additional research and understanding are also overdue. She pledged her support for those efforts as well, because the Panel's work is a start. There certainly are more unanswered questions that they all need to continue to work out.

The Secretary stated that this is a critical time for education. There is an incredible need for the United States to continue to be the world's innovator, leader, and competitor, but we as a nation know that that will be done only if we prepare our students with skills particularly in mathematics. This is an essential time to be having this discussion.

The country is on the right track with the focus on accountability and a high-quality education for every child. Because of NCLB, we are starting to see some real and meaningful progress, especially in mathematics and it's not an accident.

The Secretary acknowledged the ex officio Panel members from National Institutes of Child Health and Human Development (NICHD) and National Science Foundation (NSF) and the other participating agencies. She stated that they should have government agencies cross-pollinate and work better, as it relates to programmatic funding.

The Secretary chaired the U.S. Congress-mandated Academic Competitiveness Council. The participants discovered that although agencies spend about $3 billion a year on math and science education and soon will spend more with the passage of the American Competitiveness Initiative, they did not have a coordinated understanding about what they wanted or expected and whether they had any evidence to support exactly what they were doing. The Panel's work will be doubly useful in that regard, so that agencies can invest wisely on behalf of students.

The Secretary acknowledged the incredible care the Panel has taken, with respect to the high quality of research and the standards of evidence. The research-based approach has become sort of the buzzword of choice amongst teachers. But that really does mean something and it adds great value to their work.

The Secretary stated that when the Panel completes its assignment for her by February of next year, they would all be on a mission to tell the story and to raise the level of awareness with the people who are with students every day. She will be the Panel's great champion, as they bring clarity to some of these vexing issues. Although the Panel's terms officially end in April, they will continue to be warriors and spokespeople for improved math achievement in the country. She again thanked the Panel for their great work and wished them all the best.

NATIONAL MATHEMATICS ADVISORY PANEL:
FINAL REPORT DISCUSSION

Chair Faulkner continued the discussion of Learning Processes and Item number 9, which is "computational facility with whole number operations, depending on sufficient practice…"

Dr. Fennell asked about the word “standard” being deleted, and whether it should be inserted back and the phrase would then read “the standard algorithms.” Dr. Schmid stated that the question has been settled. They need to be consistent. Dr. Clements stated that he was against the “the” and if they are going to keep it, they should at least be talking about what they mean by “the standard algorithm.” There's a big difference if one takes it that the standard algorithm is an exact procedural mechanism or whether one takes it as a broader abstract kind of thing. That should be clarified and it would take a lot of the tension out of this discussion.

Dr. Schmid stated that it would be appropriate to refer to that in the main body and the discussion then has to stand on its own.

Chair Faulkner then moved to Item 10.

Dr. Schmid stated that in fractional concepts, what the Panel are really talking about is conceptual understanding of fractions and it should be said that way. Dr. Ball asked if what he was saying was, as opposed to learning fractional concepts, it's conceptual understanding of fractions. Chair Faulkner said yes. Dr. Siegler stated that they want to keep in the idea of learning here, and grammatically they can do it well by incorporating Dr. Schmid’s comment in the following ways, with whole numbers, acquiring conceptual understanding of fractions, and operational procedures for fractions and decimals re-enforcing one another.

Dr. Stotsky asked if they could re-word Item 9 as a recommendation, which would depend upon how the Learning Processes group sees this, as capturing all the important things. Dr. Geary added that Conceptual Knowledge and Skills makes that recommendation. It could be re-worded, but he wondered if they are getting into redundancy. Chair Faulkner asked if the Panel wanted to leave it as is, and there was agreement. He then moved to Item 11.

Dr. Fristedt stated that this is the first place the term rational number appears, rather than fractions. He added that the term “mixed numbers” should appear in all the work with fractions. Dr. Reyna added that they mention mixed numbers in the body of the report. The question is whether it should be in the executive summary. She suggested that they take the topic sentence, the difficulty with fractions as pervasive, and put that in for 10. That's a key point that comes up again and again and is well supported by evidence, namely that conceptual knowledge, procedural knowledge, and computation re-enforce one another. They should also mention that teachers feel that there's very poor preparation in this area, and time on task is extremely important.

Dr. Schmid stated that the sentiments expressed here need to be expressed and there is real redundancy. Rational numbers here appear as a quote. Elsewhere, they make the distinction of talking about fractions when they are talking about pre-algebra. When they enter algebra, they talk about rational numbers. That division seems to make sense and it's in no way violated by the word rational numbers in this spot, since it's a quote. He doesn’t feel that mixed numbers needs to be in the executive summary.

Dr. Loveless stated that the last sentence in 11 is in 10 and it should be stricken from 11.

Dr. Reyna added that her suggestion was that the difficulty with fractions is pervasive. It would be a lead in to both 10 and 11. Dr. Siegler suggested that they start out with the first section in 11, and this becomes the lead in to 10, and then go to the first sentence that's currently in 10. They then could either have the curriculum to allow for sufficient time first, or instruction focusing on conceptual knowledge. He would vote for curriculum going for sufficient time first, and then just finishing up what's left in 10.

Chair Faulkner clarified that what they have is, "Difficulty with fractions is pervasive and is a major obstacle to further progress in mathematics, including algebra. A nationally

representative sample of teachers of Algebra I who were surveyed for the Panel rated students as having very poor preparation in rational numbers and operations involving fractions and decimals. As with whole numbers, acquiring conceptual understanding of fractions, including decimals and percents and operational procedures for fractions and decimals, re-enforce one another. The curriculum should allow for sufficient time on task, to ensure acquisition of conceptual and procedural knowledge of fractions and of proportional reasoning. Instruction focusing on conceptual knowledge of fractions is likely to have the broadest and largest impact on problem solving performance, provided that it is aimed at an accurate solution of specific problems. A key mechanism linking conceptual and procedural knowledge is the ability to represent fractions on a physical and ultimately mental number line." Chair Faulkner added that they could edit this to take out any repetition.

Chair Faulkner then moved to Item 12.

Dr. Fristedt asked to remove the word "simultaneously" because it's too strong. Dr. Loveless stated that he doesn't think it means at the exact same moment, the way it's used, because the noun is the curriculum that extends over a year. "Simultaneously," in this case, just means that all of them need to be occurring roughly at the same time.

Dr. Schmid agreed with Dr. Loveless that if they left out the "simultaneously," there's not that much left. But, "simultaneously," as interpreted in a context like this, does not suggest doing it at the same moment. It just means that they are developed together.

Chair Faulkner then moved to, "Teachers and other educational leaders should consistently help students and parents to understand…"

Dr. Fristedt asked about the second paragraph, and how they know that. Chair Faulkner stated that he addressed this point by saying it was self-evident. Dr. Geary stated that evidence for this second paragraph of point 13 could be found in some of Harold Stevenson's work, comparing U.S. to East Asian countries. Dr. Reyna added that there is other work with experimental studies by Carol Dweck and others showing that not only can these beliefs be changed about talent vis-a-vis effort, but that the change affects academic performance in mathematics.

Dr. Boykin stated that these two paragraphs together truncate the research literature that was reviewed to address these considerations. This is one of the very few places that the Panel takes on the issue of the achievement gap. It should play a more prominent role in this report. There's other work that speaks to the enhancement of student's outcomes in math that this particular point 13 is silent on. It's good to see the point made that effort matters, but the data clearly show that relationships matter in the process of learning. The data show that teacher effects are real and they impact upon achievement. When there are high expectations, it makes a difference and the data backs that up. Chair Faulkner asked Dr. Boykin to help with a word change to reflect that. Dr. Siegler asked if it would make sense to have this additional literature as a separate item.

Chair Faulkner then moved on to Grade 1 teachers and instructional materials. This is the Piaget point.

Dr. Gersten stated that the allusion to Piaget detracts from the message here. More people in the current teaching workforce know about developmentally appropriate practice. Vygotsky's theories are much more influential.

Dr. Fennell stated that this might not rise to the level of import for the section. It was based solely on an over-reference to Piaget, where the point is more importantly developmental appropriateness.

Chair Faulkner then moved to teachers and point 15, “teachers are critical to student's opportunities to learn and to their actual learning of mathematics…”

Dr. Ma asked about Piaget, and whether he is mentioned in another place in this report. Chair Faulkner answered yes. Dr. Ma stated that according to her experience with teachers, they don't know much about Vygotsky, but many teachers are familiar with Piaget. She feels that it is good that they make a clear statement about Piaget's theory.

Dr. Fennell stated that he thought they agreed to revise what's there, to deal more directly with developmental appropriateness. Yet, in the body of the Learning Processes report is the full discussion, including the Piaget discussion. He would like to see the reference in the body of the final report. Dr. Clements asked whether in the body of the report, they don't claim that Piaget said these things. They just claim these are interpretations of Piaget. His theory implies stage-related learning, and that's been questioned, but he never claimed that there's an age for it. It was always an interaction between the student and the environment and the like, and the same thing for developmentally appropriate practice.

Dr. Boykin added that Piaget himself said that he didn't think his theory of development really applied to education practice. Dr. Reyna stated that Piaget probably came down on all sides of this question.

Chair Faulkner then moved to Item 16, “schools must develop…”

Dr. Ball stated that the Panel should delete this as it does not come out of the Task Group report. There should be no reference to those three alternative hiring programs since the Panel has literally no evidence on those. Dr. Stotsky added that she would urge that the Panel consider having something positive about the recruitment of knowledgeable teachers, even though it isn't addressed directly in the Teachers report. It does relate to the evidence that teacher's knowledge of mathematics is related to student's achievement, which is why she believes these three programs should be mentioned as examples. All of the programs look to recruit knowledgeable people into teaching. The programs are all are aimed at making sure that those who are going to go into teaching have the knowledge to begin with. They are only examples. Whether the examples stay or not, is not a major issue. It was only to point out that there are innovative programs being developed. This makes the Panel look up to date.

Dr. Ball stated that she would like to make sure that they do say something strong about teacher's mathematical knowledge and it should draw on the research reviewed. The Panel can strengthen that considerably and not reinforce misconceptions people have about the nature of that knowledge. The typical ways people think of knowledge have not been predictive of teacher's skills. It is not the kind that has to do with having degrees or having a certain amount of course work.

Dr. Stotsky stated that she is still concerned because this is mainly about secondary school teachers of math, and a good part of what is in the document is really about the problem of elementary school teachers. The Panel needs to make those identifications much clearer.

Dr. Gersten asked whether there is something that isn't in the report from this group that is injected into the Executive Summary. Dr. Loveless added that the reader of the report couldn’t go to the task group report and find the body of evidence that justifies the naming of those three programs. He is familiar with the evaluations of Teach for America, but he is not familiar with mathematics necessarily being broken out on the Teach for America evaluations. They're very sparse in number to begin with and to name those three programs, he would expect to go to the task group report and then find some really good solid evaluation data that would show that

they're effective. He suggests that the Panel remove this point. Dr. Clements seconds that proposal.

Chair Faulkner called for a vote on the deletion of the examples. The vote was held off as the Panel wanted to discuss the matter further.

Dr. Wu added that the first sentence stands by itself as a recommendation, without the reference. Dr. Gersten added that it sounds like he is recommending these evaluated methods, but the quality evaluations aren't visible to the naked eye. It says, "Schools must draw on a variety of carefully evaluated methods." Dr. Wu added they need something that says, "Schools must develop methods to attract and prepare mathematically knowledgeable teachers." Dr. Schmid stated that item 16 be replaced by the sidebar labeled LFR-31, the Dr. Stotsky suggestion, re-phrased slightly. Dr. Stotsky is saying that they have to address the need for getting knowledgeable teachers and that this might require alternate pathways. The Panel does not have to mention the word alternate pathway, but there has to be some understanding that at the moment, the nation is not producing enough teachers, that there is a need, and one has to think about ways of satisfying that need.

Dr. Fennell added that if the need is to somehow account for alternatively certified teachers, it could be inserted within the statement, Item 20, that begins, "The nation has a high need for better informed and better prepared teachers of mathematics," which goes into the issues of teacher background, as well as preparation. Dr. Schmid agreed.

Dr. Stotsky also pointed out that Item 20 is really a focus on getting research. It's talking about preparing teachers, but that more rigorous research on learning is needed. Dr. Ball proposed that they keep moving through teachers and teacher education and then stand back to see if there's something crucial they are missing.

Chair Faulkner moved to Item 17, "There's little generalizable research…"

Dr. Siegler added that this is a negative statement, and he suggested that it be eliminated. There's no policy recommendation in it. There's a research recommendation behind it, but that's made in other places. Dr. Loveless would like it to remain because it serves a myth-busting role. There are people who think that the characteristics of an excellent teacher are known, but actually, they're not. Good teachers can be identified, but usually after the fact. A lot of teachers are evaluated and observed with a checklist, and different behaviors are looked for. If the qualities are not there, the teacher is judged to be inadequate. He thinks what this does is raise questions about that kind of procedure. Dr. Ball stated that if it stays, it would be best rephrased and added to Item 15, because in effect, that's where the Task Group originally had it. They said it's interesting that one can identify teachers who consistently produce achievement gains in students, but unfortunately, the methods are not sufficient to identify the qualities, characteristics and skills of those teachers. She suggests putting this together with Item 15 and not calling it a superior teacher.

Dr. Stotsky added that the Panel should identify teachers only from value-added measures, as there has been no other way of identifying quality teachers.

Dr. Wu stated that the Panel should make the point about the inadequacy of the research in capturing the essence of teaching. Dr. Ball stated that this is a different point, because they can only work backwards. A separate point is going to be what the Task Group learned about teacher knowledge and what they learned about measurement of teacher knowledge. Those both belong, but they're not the same point.

Dr. Siegler stated that if the Pane is going to keep something like the wording in Item 17, they need to substitute "rigorous" for "generalizable," because generalizable calls to mind

research about the qualities of excellent teachers in Brooklyn, but not in Kansas, and that isn't the case. They also need to substitute “identifying” for “defining,” because identifying is an empirical kind of term. Defining is a logical deductive one.

Dr. Berch asked that the Panel change the second sentence to, "The impact of teachers on students' achievement is compounded." It gets very confusing about the effects on effective and ineffective.

Mr. Williams added that the term “value-added” is important because many teachers are evaluated on measures other than successful outcomes of their students learning.

Chair Faulkner moved to Item 18, “the Panel takes this as self-evident…” Dr. Fristedt asked that in the last phrase, where it says “knowledgeable,” the Panel put in “the actual knowledge,” rather than “courses completed.”

Dr. Boykin asked if there was overlap in the point made in Item 18 and the point made in Item 20. One refers to mathematics knowledge. The other refers to teacher knowledge. If those are to be different, they need to be separated better in the semantics of it. Dr. Ball stated that Item 18, when it's finished, is going to the strongest point about mathematical knowledge and its relationship to student achievement and teacher capacity. Item 20 is going to be about teacher education.

Dr. Clements asked if the Panel could replace “define” with “identify” again in Item 18. Dr. Ball agreed.

Dr. Schmid stated that Item 18 could be strengthened. Dr. Ball stated that the Panel is saying a little too much about how little they know. But actually, on the question about elementary teachers, the Task Group was not able to show relationships between courses or certification, but were able to show some results for closely measured teacher knowledge of the kind Dr. Fristedt just said and student achievement.

Chair Faulkner asked Dr. Ball to help with the wording. Dr. Stotsky asked that this be worded for K-8 teachers if this is what the Task Group is talking about all the way through, because currently it sounds like wording for teachers in general.

Dr. Gersten stated that the Panel could say at the beginning that they focus on K-8 teachers because their charge is getting students ready for algebra. Mark Lipsey has guided the Instructional Practices group to not use words such as small, moderate, and so on. If it's significant, it's significant.

Dr. Fennell stated that the Panel talked about defining best hiring or development practices, and he asked if that is about professional development. Dr. Ball responded that it didn't come from the Teachers report. It is a little bit out of place here, because to have a strong statement about what they know about teacher development, it would be better stated separately from the teacher knowledge finding. Dr. Siegler agreed that statements about development and hiring wander away from the main thrust of the point, which is that measures of number of courses taken in math and certification status correlate minimally, if at all, with success in helping children learn math. Item 20 more specifically addresses that and it is important for policy to know that measures like certification and number of courses taken do not have positive relations to teacher quality.

Dr. Ball stated that the Panel should be a little careful with this, because it bears on the point about elementary teachers. Math certification isn't very relevant to the elementary teacher question.

Dr. Loveless asked about the use of the word correlation. Is that to imply that studies of the proxies of certification status and courses taken were designed in such a way that they just

looked at correlations, maybe with controlling for some covariates? Dr. Ball stated that the Task Group was looking for causal inferences, so that's probably technically not a correct sentence that they need to clean up.

Dr. Stotsky asked whether the final sentence is actually a logical conclusion. The Panel agrees that math teachers should know the subject they teach. Do these studies show people how to hire and provide the best development possible for the teachers? If this is the case for elementary teachers that the courses taken are not a good proxy, one could come to the logical conclusion that one needs to look more intently at the courses they had taken. Dr. Ball stated that in the Teachers report, the Task Group used three different methods for trying to identify teacher knowledge. The two that didn't predict student achievement were the proxy measures, but the place where the Task Group found the closest relationship was where measures were closer to the actual usable knowledge in practice.

Chair Faulkner then moved to, "Adequate preparation of students for algebra requires their teachers establish strong math background," which is Item 19.

Dr. Loveless stated that he was unclear as to what this proposal was targeting. He asked if it is suggesting that they assess whether pre-schools through Grade 3 teachers know the pre-school through Grade 3 Critical Foundations or how to teach them.

Dr. Stotsky stated that this comes directly out of the Conceptual Knowledge and Skills report. It's related to the knowledge base that is the focus of the report. One of the recommendations is that this knowledge base should not only be in textbooks or elsewhere. It should also be in teacher preparation programs if they expect prospective teachers to be able to address the Critical Foundations and then to be able to address the Major Topics of School Algebra. Dr. Loveless responded the Panel has already made that point earlier, when it said that teachers must know the content they're going to teach. Dr. Stotsky stated that this deals with separate things. It is broken down into different levels because there's a different amount of content to license different programs.

Dr. Wu stated that the original intention of Conceptual Knowledge and Skills was that the Task Group wanted at least this much knowledge for every teacher, because they ask every student to know this. He is slightly worried that this would be misinterpreted. The Panel should at least set a bar as high as saying something like, while it is a judgmental decision, teachers should know at least 2 years beyond what they teach. That's a suggestion that someone made, that teachers not only know that part of the knowledge prescribed for the Critical Foundations, but beyond that. There is no research on this, but that's sound. Dr. Fennell stated that this is a recommendation to take the mathematics that has been defined as leading to algebra and what algebra is, and use that as consideration for how they build in the background content knowledge to inform teacher education practice. This is how Conceptual Knowledge and Skills informed the Teachers Task Group.

Dr. Wu added that it is true to say they want teachers to know more, to for example, enable them to teach fractions because they also have knowledge of algebra. Dr. Ball stated that she sees the logic, but there's something a little peculiar about it. The Teachers Task Group was charged to investigate what's known about what teachers actually have to know, so that we can link to their instructional efficacy and student achievement, and this is coming out of a different part of their thinking. She would like to figure out a way to do this that doesn't seem to short-change the fact that the Task Group found a lot of research on the relationship with teacher knowledge and student achievement.

Dr. Fennell stated that because it is one of the Conceptual Knowledge and Skills (CKS) recommendations, it doesn't have to be repeated here. Chair Faulkner agreed to put it only in CKS.

Mr. Williams stated that it is very embarrassing, to say that a teacher who has had a K-12 education and 4 years of college and happens to be teaching fourth grade should at least know sixth-grade math.

Dr. Loveless added he had never heard of a pre-school through Grade 3 certification or training program. Dr. Stotsky stated that each state has a program for pre-K through 3, early childhood. Dr. Loveless added that most states grant licenses that are not pre-school through Grade 3 or Grades 1 through 5. Dr. Fennell stated that elementary certification is typically 1 through 6, depending upon jurisdiction. There are 40 states that have something in the name of middle school, and those are very different across platforms, and secondary ranges from 7 to 12 to 9 through 12. That's pretty much the landscape.

Dr. Benbow stated that by limiting themselves to a specific set of studies that follows certain evidence and standards, there were things that the Panel couldn't say because the studies weren't there to support those views. It may be that the views are correct, but they couldn't find the studies to support them. The Panel can't use different standards of evidence to put in new recommendations.

Dr. Siegler proposed that the Panel delete that item for all the reasons that many people have already said.

Chair Faulkner then moved to Item 20, "the well designed program of research..." Dr. Ball stated that the first item there has to do with systemic improvement of teacher education. It's not about research. The second point should be removed as it is from Learning Processes. On the research, they should keep only the first point, because that's what comes from the Task Group report.

Chair Faulkner clarified that it should read, "A sharp focus should be placed on systematically improving teacher preparation programs." Dr. Ball added that it should say, "as well as professional development strategies." It should be rewritten to say the Panel was not able to identify those processes that would do that, but there should be more research. Then some version of what begins with "a well designed program" could be kept, but then delete the middle part by incorporating "more rigorous research on student learning." Dr. Reyna added that that was intended to come from the statement they added to the synthesis document. There was an attempt to integrate some of the things from one task group with some of the things in the other.

Dr. Stotsky stated that this point comes from out of nowhere. There's nothing in the Task Group report itself that is the basis for this. Dr. Ball stated that the report is filled with observations about the lack of students' knowledge of fractions and other aspects of mathematics, and they make a strong effort to learn what they know about how to instruct students better, both from the research on learning and research on instruction.

Dr. Siegler added that he does not like that sentence because there are measurement problems. Dr. Ball stated the Panel has the point about measures under the mathematical knowledge item that they discussed a few minutes ago. So, they don't need it here. It can be deleted here.

Dr. Schmid stated in the teacher section in the Executive Summary, professional development occurs only very peripherally. It's a huge enterprise and certainly many are deeply troubled by what goes on in professional development these days. He hopes that something can be said about professional development, if only that there is a tremendous outlay and very little

evidence that this outlay is achieving what it's supposed to. Dr. Ball stated that they could strengthen the language to say something about that. But they need to deal with it in a way that doesn't lead logically to the conclusion that the nation shouldn't be educating teachers. Dr. Schmid added that there could be a separate item specifically devoted to professional development, that professional development should be focused on providing teachers with a knowledge of the mathematics they teach.

Dr. Stotsky added that the Panel is talking about two kinds of professional development and most of what is at issue is what she has labeled remedial professional development. The major issue is the amount of money that is being spent on remedial professional development for elementary and middle school teachers, teachers who are academically underqualified in mathematics. The kind of professional development that nurses, doctors and others take, which is enrichment, updating in the field, this is not what is at issue. Dr. Benbow asked Dr. Ball to work on that point.

Dr. Benbow, in the chair, moved to Item 21, "schools should be encouraged to pilot the use of full-time elementary mathematics teachers for direct instruction."

Dr. Siegler stated that on the one hand, the text says there's no research to support this, and then it says schools should be encouraged to do it. It makes sense to recommend research on this topic, but as a policy for schools to adopt, he asked where the evidence was. Dr. Schmid stated that he does not think there is evidence that leads to the recommendation. What leads to the recommendation is a practical consideration. What the Panel does have evidence for is that subject knowledge of many elementary teachers is inadequate and the pool of mathematically qualified elementary teachers is just too small.

There is a practical reason for having math specialists, because then, schools may be able to make do with a smaller number of well-educated elementary math teachers. Dr. Siegler added that it seems very plausible and even likely, that the same people who are good math teachers are also good reading teachers and good science teachers. They're smart, motivated, creative, and charismatic, whatever combinations lead them to being good teachers, and if they are made full-time math teachers, it means leaving the others to do all the other teaching.

Dr. Gersten asked if the Panel could say there is no research on this, but just state that it's the opinion or the view of the Panel. Dr. Fennell added that there is a tremendous need for specialists in the field of mathematics at the elementary school level on into the middle school level and some would argue for similar kinds of specialists in a different manner, even in high school mathematics. The point rests on the issue of the background of existing staff. The Teacher Task Group examined all of the current models, the coaching model, the specialist model and so forth, and came up with the teacher specialist model as the one that is most attainable at this time. They also indicated that there's a tremendous need for research in this area, at a time when virtually every state in this country certifies somebody called a reading specialist and such people are in schools all over this country. It's about time they make a similar research investment in elementary math specialists.

Dr. Berch suggested that the Panel say that they have no evidence to validate or invalidate the effectiveness of full-time elementary mathematics teachers. Likewise, they have no evidence about mathematical coaches. However, if they want to ignore the evidence, they can say that one is more realistic and less costly and they should put their efforts into piloting something. It just doesn't follow. Dr. Schmid stated that they could make an argument on practical grounds. While there isn't a lot of evidence, the Panel know that there is a need for mathematically trained elementary school teachers and the question is around how they get

enough of them. One way is to have mathematics specialists. Dr. Berch stated that that is departing from their standards of evidence. Dr. Schmid stated that they were asked to make recommendations and those recommendations, at times, have to be informed by what is practical and what's possible.

Dr. Stotsky stated that the wording is wrong here. There is no research on the full-time elementary math teacher. It should read that that there is no research to either validate or invalidate. In other words, it's a new idea. It has no research. However, there is research on the mathematics coach, but the evidence from it is not positive.

Dr. Ball disagreed and stated that the Task Group was not able to find studies of math coaches that met their standards. So, they don't have negative evidence of math coaches. Dr. Schmid is right, that the basis for the Task Group's interest in this was the logic of the scale problem, and since in other parts of the report, they do rely on other kinds of logic, the question about logic is a good one. They go from the finding that mathematical knowledge is a predictor of student achievement, that they see a strong signal for that and they have this problem of having an inept educational system to prepare teachers, especially those already in practice with sufficient knowledge. So, it's a good bet to think about narrowing the pool of people who would need to be provided with that kind of knowledge to do that work.

Dr. Siegler stated that the Panel could still get at this by starting with Dr. Berch's point, that there's no evidence. However, they need to gather evidence. Further experimentation with a pilot, which they are encouraging, could fill this void. Dr. Stotsky stated that it is encouraging research, and 114 studies that did meet the Panel's criteria in this area are in the Teachers' report. Those studies did not produce positive evidence for math coaches. But there was no research at all on the elementary math teacher. That has to be distinguished.

Dr. Siegler stated that he agrees that this is a very good problem to do research on, but he is concerned with more than just the wording. When the Panel says schools should be encouraged to pilot, that's a very different level of implementation than some researchers ought to study this. This means schools all over the country should try this out and see how well it works, and there just isn't the evidentiary base for the Panel to recommend anything like that.

Dr. Fennell stated that this is going on all over the place. At the very least, the Panel needs to say that this needs investigation, and resting back on the content knowledge of math teachers at this level, this is something that is probably a safe bet. Dr. Siegler added that the teacher isn't teaching his or her original classroom now. They're teaching math in all the other classrooms, as well as their original one. It would seem that this would require the hiring of additional teachers. Dr. Ball responded that this is a departmentalization model. Dr. Siegler asked if this meant that there would be a re-organization of the entire basis of elementary instruction, not just math, because if they are going to do it without hiring more people, they need to do it in every subject.

Dr. Schmidt stated that if reading specialists are common and if there is evidence that they work, then one can make an argument on practical considerations that what works in reading is likely to work in mathematics for very similar reasons.

Dr. Benbow called a vote on whether language about math specialists should be in the report. There was a majority in favor of keeping the language in the report. She appointed a group to work on that language.

Chair Faulkner, presiding again, moved to Item 22, "teacher's past effectiveness in the classroom is by far the strongest predictor of future effectiveness."

Dr. Fristedt stated that the Assessment Task Group reports that if the NAEP is used as criteria, that is a problem. Dr. Reyna added that the phrase "on-the-job measures" is so vague. The Panel should say something about learning, correcting for the obvious things that value-added measures would correct.

Chair Faulkner moved to the item on, "mixed evidence on influence of salary schemes." He introduced Dr. Stotsky's alternative, "School districts should be encouraged to pilot and carefully evaluate a variety of salary schemes for supporting teacher's effectiveness…"

Dr. Berch added that it may be confusing to sometimes see recommendations embedded at the end of a finding and sometimes, there is no recommendation, but a finding.

Dr. Benbow stated that she would have a problem with the addition. To conduct really rigorous research, the Panel should not ask school districts to experiment with various proposals. They have a Center for Pay-for-Performance at Vanderbilt University, and it's rigorously designed and involves mathematics. She is not convinced that the nation will learn much from school districts experimenting with these ideas. Chair Faulkner observed, on the basis of his experience, the phenomenal degree to which this country will alter its educational system on the basis of no evidence at all, while it would never do that with the banking system or national defense. Dr. Clements asked if there was other alternate wording, where they can say that these have to be school-based or classroom-based studies, when applicable. He would like to encourage schools to participate in the research, under the direction of a researcher and that's not always easy to do. Dr. Benbow agreed because it is very hard get into the schools to participate in research.

Dr. Boykin commented on the last statement about pay-for-performance, and that the National Education Association (NEA) has come out strongly against merit pay for teachers. This is going to put a bull's eye on the back of the Panel, for better or for worse. He asked whether there should be a statement in the executive summary that doesn't really have strong evidence to support it, or should it just be put into the body of the report. Mr. Williams responded that he hopes they don't base the report on what the NEA might want or not want.

Dr. Reyna stated that it really does require a careful look at the quality of the evidence. The Panel should not avoid saying things simply because they're controversial. But she agrees that the potential for controversy should be considered.

Chair Faulkner moved to Instructional Practices, Item 24, which states "all-encompassing recommendations that instruction should be more child-centered or teacher-centered are not supported by research."

Dr. Loveless stated that the two middle sentences might be too stern: "If such recommendations exist, they should be rescinded. If they are being considered, they should be avoided." But within the Instructional Practices group, the first sentence, the basic idea that these sweeping recommendations are unsupported by research still is agreed upon. Dr. Ferrini-Mundy stated that the language should be child-centered or teacher directed. And she would agree to strike the second two sentences. Dr. Schmid felt the stern tone is more than appropriate as the evidence is substantial and therefore, it is appropriate to make a loud recommendation. Dr. Siegler agreed. Dr. Clements asked if the evidence is that substantial on that particular issue. Dr. Ferrini-Mundy stated that the definitions of child-centered and teacher-directed that are being used make this difficult. This is short-hand for a much longer and more complicated set of discussions, and so, the problem with keeping both of those sentences in their current form is that it assumes there is some well-defined meaning for child-centered or teacher directed that the Task Group does not see in the literature.

Dr. Loveless added that that is taken care of in the first sentence, and that is the "all-encompassing recommendation." When they did the literature search, they came up with more than 100 studies, but once they boiled them down, there just aren't that many that examine strictly the contrast between student-centered and teacher-directed. Dr. Clements stated that if the evidence is limited and the definition unsure, then the stern recommendation is based on very shaky ground, first of all. Secondly, he does not like the wording of the all-encompassing sentence. What should it be more child-centered than? Chair Faulkner asked if they should take out the word "more."

Dr. Boykin stated that for Item 24, when he reads the first sentence, he infers that there are just no findings from the research. When he reads the fourth sentence, he gets the impression that there is just badly conducted research. He wonders if these are connected or if they are two different points. Dr. Loveless stated that it is both. There just are not that many good studies, and the good studies that do exist are neutral. Dr. Reyna added that this is a similar point she made earlier about variability.

Dr. Loveless stated that the topic here is that directives are coming down to teach a certain way because it is supported by research, and what they are saying is, they really did an exhaustive search and they can find nothing that would support either direction on that.

Dr. Fristedt stated that on Item 24, the fact that student-centered and teacher-directed are ill-defined is actually another reason to make a stern recommendation that there not be messages out there that are advocating something that will be read by some people quite differently than by others. Dr. Gersten added that they were well defined in the 1970's, in the reviews of that era by Flanders and Goode, and Brophy and Rosenshine. The field has shifted.

Dr. Ma asked if the Panel must put these two phrases as either/or, in conflict. She asked if there could be a balance between student-centered and teacher-directed. Chair Faulkner stated that everyone would agree that it's possible to achieve a balance, but there are pretty strong directives of the kind that have been discussed here that don't address that.

Dr. Loveless stated that it's important to know what the Task Group did *not* look for, which was the best form of direct-instruction or teacher-directed instruction, and the best form of student-centered instruction. They did look at studies that contrasted student-centered with teacher-directed and to do that, they really have to be posed as a contrast. Dr. Berch stated that they are making a strong recommendation here about two kinds of instruction that they haven't defined very clearly based on research that wasn't done well. He feels that they are obligated to briefly define them in the ways that they represent the extreme examples. Dr. Loveless responded that they determined that it was important to look at two instructional regimes where in one instructional regime, the student did the bulk of the teaching, and in the other, the teacher was doing the bulk of the teaching.

Dr. Ferrini-Mundy stated that the Task Group is still grappling with these issues, and the Panel should let the Instructional Practices group take another pass at it, having heard the sense of the group. Dr. Schmid stated that what Dr. Loveless said is right, that researchers don't particularly define the terms, but out in the field, there are programs that say to use a student-centered approach and they don't define it very well either. So, therefore, the recommendation as phrased seems entirely appropriate. He made a motion to keep the phrasing with an adjustment on the matter brought up by Dr. Boykin. Mr. Williams added that teachers are evaluated at times on how child-centered they are. Dr. Fennell added that in any classroom, any teacher uses elements of both of these. Dr. Ferrini-Mundy added that it would be helpful to reference in the

report the language used of these types of policies to clarify what the Task Group means by these terms.

Dr. Reyna asked if in the literature, if there were at least some studies for which these concepts could be defined and that for that small body of studies, there wasn't a clear winner. The Panel is not just talking about teachers, but also about theorists and educational researchers, as potential audiences for this kind of recommendation. They should say that there really is some evidence, the evidence is acceptable and it doesn't clearly indicate that one is superior to the other. If there really is a presumption out there, that one is superior to the other, they should address it.

Dr. Stotsky stated that she could supply them with material that was just presented to the State Board of Education in Massachusetts by superintendents and other administrators who are defending or explaining their school system's response to the designation of being under-performing or low performing. They are very clearly talking about moving their curricula and their schools into the direction of more student-centered or child-centered, and buying materials that are more student-centered or child-centered. Dr. Clements added that in Buffalo public schools all teachers, including pre-K teachers, do direct instruction. So, it's not true that it only goes in one direction.

Dr. Loveless added that if any of the Panel members are aware of these examples, like Buffalo and Massachusetts, please send them because they'd like to put those in the body of the main report.

Dr. Berch stated that he would vote against the motion, despite the fact that he would like to have some statement in there like that, because what he hears being stated is that people use the terms in the field, but they don't agree on what they mean. Dr. Loveless stated that in the body of the Task Group report, the members talk about not only the definitions used, but also they are putting in historical material of how these definitions have changed over time. Chair Faulkner called a vote and there was clear intent to proceed with this recommendation.

Chair Faulkner then moved to Item 25, "teachers should be encouraged to use and be taught how to use a full range of instructional and assessment strategies from direct instruction to small group work, both formative and summative assessments…"

Dr. Stotsky stated that this language intended to encompass the fact that there was very little that was totally positive that was found for any of these strategies. Most of them had so many qualifications and limitations that it would leave teachers with a negative feeling about doing anything. For example, the student assisted learning strategy was one out of five. Real-world problem solving had all kinds of conditions attached to it. Dr. Gersten stated that half of their reports have not been completed, and they are seeing that the peer-assisted learning does have significant outcomes. There are at least two types that do. Also, there are all kinds of approaches for low-achieving students, which is about a third of their target population, that are effective.

Dr. Loveless stated that this item did not come out of their task group and he is concerned about the phrase "a full range of," because that's exactly what the research doesn't show and the qualifications are important. Team Assisted Individualization (TAI) was not effective with teaching math concepts. It was not effective with teaching problem solving. It was effective with teaching computation skills, and that's important to know. Dr. Fennell stated that the group of students and the teacher's teaching style is important. Dr. Ferrini-Mundy stated that it really wasn't a kind of recommendation that their group has discussed at all. Dr. Fennell asked that the Panel delete Item 25, in the hopes that the full analysis of Item 24 and the formative assessment

analysis addresses much of this, based on the research. Chair Faulkner called a vote on that motion, and there was agreement.

Chair Faulkner then moved to Item 26 on formative assessment.

Dr. Embretson stated that this statement originally had a clause about when it's linked to states' summative assessments. Dr. Gersten responded that it was there, and all but one case was aligned to the state of Tennessee standards. But this is a truncated version. The other point we could put in is that when it is linked to annual objectives or annual state standards, because they definitely were. They basically sampled from important annual standards. Dr. Gersten stated that he would add the language that Dr. Embretson wanted.

Chair Faulkner moved to team assisted learning strategy. Dr. Loveless stated that it should be Team Assisted Individualization. TAI should be capitalized and it's a cooperative learning strategy.

Dr. Stotsky asked if they were making the qualification that there were three or four other types of small groups that had no evidence. Dr. Gersten added that when Ellen Bobronikov analyzed the data, peer-assisted learning has a significant positive impact on student's computation. So, that also should be in there. Dr. Loveless added that for peer-assisted learning, that the recommendation is based on six studies and they all agree on the inclusion of the six studies.

Dr. Stotsky asked whether the Panel should mention that for several other small group work approaches, none of them led to any positive effects. She asked how many studies are needed to make a conclusion. Dr. Loveless responded that three is the number and the Task Group has six with TAI. There are other forms of cooperative learning that have been studied and they have non-statistically significant effects.

Dr. Ball stated that there's an infinite number of things that don't have statistically significant effects and that really means that they don't have effects.

Chair Faulkner thanked the Panel for working intensely. He will have Dr. Ball take a look at the Teachers section. He asked if Instructional Practices could get him more updated recommendations and the body, and asked Dr. Benbow for revisions to the body of the Assessment report based on the material she provided today. He will then put together a more complete document for the Panel and then will map out where they go from there. But they are going to still try to get this document put together by December 14th. Mr. Williams added that he has a problem with voting on some things today in the report with the possibility that they will change without the rest of the Panel being involved. Chair Faulkner stated that they just have to see if that's the way it turns out and they may have to have a conference call.

The session adjourned at 3:35 p.m.

I certify the accuracy of these minutes.

Chair Signature_____Date_____

Vice Chair Signature_____Date_____

A**DDENDUM: PUBLIC PARTICIPANTS**

Last Name	**First Name**	**Organization**
Beers	Jack	Cambium Learning
Birch	Emily	Heinemann Publishers
Brickner	Leslie M.	Howard County Public School System
Brown	Judy Ann	Words & Numbers
Burt	Janeula	SRI International
Carter	John	A.E. Stevenson High School
Casey	Ruth	NCTM, Board of Directors
Cavanaugh	Sean	*Education Week*
Chintala	Jennifer	Pearson
Churnis	Kathy	MPR Associates, Inc
Conroy	Connie	Howard County Public Schools
Coro, Ph. D.	Christopher M.	U.S. Department of Education Office of Vocational and Adult Education
Dancis	Jerome	University of Maryland Mathematics Department
Frank	Karyn	Community Day School
Geschel	Mary	Borenson & Associates
Gill	Alice	American Federation of Teachers
Ginsburg	Lynda	Rutgers University
Greenberg	Anita	CompassLearning
Gunsallus	Heather	Words & Numbers
Hearn	Meghan	HCPSS
Inskeep	Rhonda	Howard County Public School System
Ittigson	Dr. Robin	Department of Curriculum and Instruction Pittsburgh Board of Education

Jaffe	Cheryl	Northrop Grumman Electronic Systems
Johnson	Asha	Bollman Bridge Elementary
Kepner, Jr.	Henry S.	National Council of Teachers of Mathematics
Knight	Dr. Genevieve M.	Coppin State University
Kreamer	Kent	Carroll County Public School
Krehbiel	Ken	National Council of Teachers of Mathematics
Krownapple	Kelly	Howard County Public Schools
Kundert	Bette	Office of Mathematics Division of Instruction Maryland State Department of Education
Leinwand	Steve	American Institutes for Research
Marsh	Laurel	Howard County Public School System
Mason	Charlotte	Glencoe/McGraw-Hill
Mervis	Jeffry	*Science Magazine*
Morrongelle	Karen	National Science Foundation
Mulroe	Sorsha	Howard County Public Schools
Paysinger	Cheryl	Walden University
Rosier	Ronald C.	Conference Board of the Mathematical Sciences
Rosowski	Arlene	Buffalo Public Schools
Ross	Pat	U.S. Department of Education
Ruehl	Scott	Howard County Public School System
Sammons	Kay B.	Howard County Public Schools
SanGiovanni	John	Howard County Public Schools
Schwebash	James	National Science Foundation

Setajn	Paula	National Science Foundation
Smith	Margaret	University of Pittsburgh
Smith	Jacqueline G.	Burrville Elementary School
Snowhite	Larry	Houghton Mifflin Co.
Sparks	Sarah Dockery	*Education Daily*
Trigg	Timothy	Unionville-Chadds Ford School District (PA)
Uy	Erin	*Education Daily*
Vaden	Karen	Howard County Public School System
Whiting	David	McGraw-Hill Cos.
Wilson	W. Stephen	Department of Mathematics Johns Hopkins University
Wray	Jonathan A	Howard County Public Schools
Zimmer	Janie	National Council of Supervisors of Mathematics