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Brown Center on Education Policy

LESSONS LEARNED:

WHAT INTERNATIONAL ASSESSMENTS

TELL US ABOUT MATH ACHIEVEMENT

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P R O C E E D I N G S

MR. LOVELESS: My name is Tom Loveless. I want to welcome you to the Brookings Institution and the Brown Center on Education Policy this afternoon. The Brown Center on Education is a center here at Brookings that is dedicated to examining student achievement and the causes and things that correlate with student achievement, and related to that, in November 2006 we held a conference on international achievement in mathematics.

As you know, there is nothing really new about giving tests to children internationally and then comparing test scores from country to country. It has been going on since the early 1960s. But one thing that has not happened in that time is much use of the data other than simply comparing country scores, and we will get our lighting fixed while I am talking. What the purpose of the purpose of the conference was in November 2006 was simply to commission some scholars around the nation who are experts in this field to conduct studies using data from the IEA or TIMSS and PIRLS exams that are given, PIRLS in reading and TIMSS in mathematics. So today we have three authors of a book that is out called "Lessons Learned" that are a collection of papers from the conference, and there are order forms outside if you would like to get the book or perhaps you have them in your packet, and we have three authors today who are going to share some of their results after analyzing the

TIMSS data. I also want to thank two of the benefactors of the conference, the National Science Foundation and the National Center for Education Statistics, NCES and NSF.

Our first two speakers will be Ina Mullis and Michael Martin. Ina is co-director IEA's TIMSS and PIRLS International Study Center at Boston College, and Mike, who is known as Mick Martin, also is co-director of the TIMSS and PIRLS International Study Center at Boston College. They are going to provide an overview of what do we know now after four decades of international assessment in mathematics, what are some of the lessons that we have learned.

Our second speaker will be William H. Schmidt, Bill Schmidt. Bill is at Michigan State University. He is a University Distinguished Professor and is currently co-director of the Education Policy Center at Michigan State, and co-director also of the U.S. China Center for Research, and he holds faculty appointments in the Division of Measurement and Qualitative Methods and the Department of Statistics. Bill will be talking about curriculum and mathematics around the world.

Our third speaker will be Jeremy Kilpatrick. Jeremy is Regents Professor of Mathematics Education at the University of Georgia and he is going to be talking about U.S. performance in algebra compared to international performance generally.

The way we are going to do this today is first we will have our three speakers, and then we will have comments from Skip Fennell.

Skip is President of the National Council of Teachers of Mathematics. He is also Professor of Education at McDaniel College in Maryland. Skip will be commenting on the three presentations. Once Skip is done we are going to allow 10 to 12 minutes roughly for each of our four presentations. Then we will take questions and discussion from the audience, and at that time we will all come back up here for that. Enjoy, and I will see you in 50 minutes or so.

MR. MARTIN: Good afternoon, ladies and gentlemen. It is almost 50 years since the number of far-reaching researchers first came together with the idea that international comparisons of student achievement would be an ideal way for countries to learn from each other, hopefully for the common good. These first meetings resulted in two important outcomes from our perspective. The first international mathematics study, or FIMS as we now know it, which pioneered the whole field of international assessment of student achievement, and an organization, the IEA which has been conducting such studies to this day.

FIMS was conducted at a time of great expansion of educational systems and the need for valid and reliable measurement of student achievement was keenly felt. Although there was at the time plenty of expertise in applying psychometric techniques in national surveys of student achievement, there was still skepticism that student achievement could be meaningfully compared across countries. However, the idea that the would could be used as a great educational laboratory

was a compelling one, offering great promise for understanding and for improving educational systems. The study that was conducted in the early 1960s in 12 countries and examined mathematics achievement at two grade levels, the grid with the most 13-year-olds and the final grid of those students who were studying advanced mathematics. FIMS placed great emphasis on studying what we now call the educational context, that is, the mathematics achievement in relation to school organization, to curriculum and instructional practices, and to student attitudes and background. Apart from the results of the study itself which were significant of course, one of the most important lessons from FIMS was that international comparisons of student achievement were indeed feasible and were capable of producing reliable information for policymakers.

By the end of the 1970s, IEA researchers were thinking that it was time for a second international study of mathematics and this time with a major focus on curriculum and instruction. SIMS as it is called brought us IEA's three-level conceptual model of the curriculum, the intended curriculum, that is what educators would like students to learn, the implemented curriculum, what is actually taught in the classroom, and the attained curriculum, the achieved curriculum, what students have actually learned about mathematics. This model influences our thinking to this day, actually.

SIMS was conducted in the early 1980s in 20 countries, the

number had grown, and as well as international assessment of student achievement, pioneered a very extensive analysis of the curriculum both of the intended curriculum through analysis of expert reports, and of the implemented curriculum by asking teachers to report on students' opportunity to learn, a term pioneered at this time. Again which was learned from the SIMS data, that perhaps the enduring lesson from SIMS is that if the goal is improve mathematics education, then a very good place to start would be the mathematics curriculum.

TIMSS, the current and I suppose most famous of IEA's international studies in mathematics was conducted in 1994 and 1995 and was the first study to combine both mathematics and science. The launch of TIMSS coincided with an upsurge of interest in international student achievement fueled in part by the demise of the Soviet Union and the emergence of many newly independent Eastern European countries that were all very eager to improve their educational systems. Almost 50 countries participated in TIMSS in 1995. TIMSS was a very ambitious study. As well as wide-ranging assessments of achievement in mathematics and science at five grade levels, TIMSS included a comprehensive curriculum analysis, a video study of international practices, and in-depth case studies of international practices in three countries including the United States.

Following the success of TIMSS in 1995, TIMSS made a transition from project to program, becoming the centerpiece of IEA's core

cycle of studies as to mathematics, science, and reading, and conducted every 4 years. Focusing on the fourth and eighth grades, TIMSS which is now renamed the Trends in International Mathematics and Science Study, has successfully reported on student achievement in 1995, in 1999 at the eighth grade only, in 2003, and a similar report in 2007. You will be glad to know we are actively planning for 2011.

Over the years TIMSS has introduced many methodological innovations to the field of international student assessment, ambitious assessment frameworks implemented through extensive pools of items with complex sampling designs, and using advanced psychometric scaling for analysis of reporting, all were introduced by TIMSS to the international arena. Perhaps most importantly, TIMSS brought for the first time an explicit emphasis on high-quality in all aspects of educational studies, ensuring that the data which are collected at such great expense could be relied upon by national educators and policymakers as they work to improve mathematic and science education.

MS. MULLIS: Even though back at the TIMSS and PIRLS International Study Center we are busily working away on preparing the report on the results from TIMSS 2007, I am going to whet your appetite for that by providing an overview of the results from 2003.

You can see this is the fourth grade and there was a wide range of achievement within and across countries. About 13 countries were above the international average including the United States, 3 about

average, and 9 below. At the eighth grade, 13 were above average, 7 were about average including the United States, and 25 below average. Again, the data really shows a wide range of achievement both across and within countries that we see in the TIMSS results. We see that the range between the fifth and the ninety-fifth percentiles in almost every country is about 270 to 300 score points. You can also see then across countries that the average in Singapore is about the same as the ninety-fifth percentile in the lowest countries, so in mathematics achievement we have a wide variation.

At both the fourth grade and the eighth grade you will see that the Asian countries topped the charts. We have Singapore, Korea, Hong Kong, Chinese Taipei, and Japan. To demonstrate the gap between the results for the Asian countries at the eighth grade and the rest of the countries including the United States, TIMSS reports out results for the percentage of students reaching four international benchmarks. We have 400, 475, 550, and 625, 625 being the most advanced of our benchmarks. You can see here that of the eighth graders in Singapore, Chinese Taipei, Koran, Hong Kong, and Japan, up from 24 to 44 percent of the eighth grade students reaching the advanced benchmark. We have Singapore that is getting close to half of students, compared to 7 percent in the United States.

Across time, we seem to have many countries staying about the same. At grade four, 6 countries improved, between 1995 and 2003

where we have two cycles of change, 7 stayed the same including the United States, and 2 countries declined. At the eighth grade, we have three cycle trends for 17 of the countries, and 34 had two cycle trends. Between 1995 and 2003, 5 improved including the United States, the other 4 consisted of two Asian countries, Hong Kong and Korea so they are not standing still, and 2 Baltic countries, Latvia and Lithuania.

In summary, through the years of conducting TIMSS there have been many lessons since the pioneering days that Mick was talking about. Different countries use different approaches, but an effective educational system always requires enormous effort. So first to have the opportunity to learn, high percentages of students need to be in school, and not only that, they need to be enrolled in advanced courses. All of the courses need a rigorous and progressive curriculum, also well-prepared teachers to deliver the curriculum, the economic resources to provide facilities and materials to support he delivery of the curriculum, and finally, I cannot underestimate the importance of the home and cultural environment in encouraging student achievement and their preparedness to learn. Thank you.

MR. SCHMIDT: It is nice to follow Mick and Ina with whom I worked very hard during the 1995 TIMSS, the original meaning of TIMSS, and in that context we did the extensive curriculum analysis that Mick reported on, and I wanted to speak from some of those results.

I want to start out with a simple premise, and that is in

today's highly technologically oriented economy which is highly competitive, we have been told it is the flat earth, that in such an environment nations no longer can simply develop their own policies and standards with respect to hardly anything. Take the manufacturing and service sectors. No longer can the United States just decide how it is going to build a car. They can, and they will not sell and we have been there for quite some time. But the standards are now set internationally for any of the products or services and those judgments of quality then are made against those international standards and not the national standards.

I would argue that the same thing is true in terms of education. In this kind of world it would be folly for us to simply ignore what other countries do and the standards for what is a good solid education that prepares people to work in that kind of an environment is now being pretty much set internationally. So these kinds of studies that they have summarized, and especially the IEA ones, really are tied very closely to educational policy and give us a window into what other countries do with respect to those kinds of policies.

I think what we have learned as summarized by Ina is that curriculum does make a difference in terms of what the expectations are, what the intended curriculum is, what is delivered, these are the things that really do matter in a very serious way. What we have learned from that work is there are three characteristics of the curriculum that seems to

really make a difference. Those three characteristics are the coherence, the rigor, and the focus. Focus is easy. It is the degree to which you have a small enough number of topics that they can concentrate on those, that you are not trying to do so much that very little effort can be put into any one of those topics, the mile-wide, inch-deep slogan that we invented that sort of goes on and on. Rigor has to do with the degree to which the curriculum moves at the middle grades especially into more mathematics, that it begins to develop the deeper ideas and begins to bridge from simple arithmetic into an abstraction of that arithmetic and to points beyond through algebra and geometry. Finally, coherence is the one that I think is the most important. It comes to the deeper notion that where you cover a topic, it is not just that you cover it, it is where you cover it, it is in what sequence you cover it, and it is in its relationship to the other topics within the curriculum. The definition to us for coherence is simple. If the development of the topics in school mathematics reflects the internal logical structure of the discipline, that is, mathematics as a formal discipline, then there is coherence. The degree to which it is not treated that way, that is, the organization of the topics becomes much more a matter of political issues, of compromise of what traditionally is covered in which grade, compromises such as I want to teach it here, I want to teach it there, so we teach it in both places. That is the opposite which leads to what I suggest is a more chaotic interpretation of curriculum.

Those are the principles that we have found. Let me

illustrate especially the coherence and the focus which is the point of this talk. We did this empirically from 1995. This is the intended curriculum. We looked across the six top achieving countries. We called them the A plus countries. What we did was to look at what they did and we developed what is like a statistical average. It is an amalgam of that. This is not what any one of those countries necessary did, but it is a reflection of what the majority of those countries did as to when they covered a particular topic at which particular grade. The columns are the grades, the rows are the topics, and when you show this kind of structure to mathematicians, research mathematicians will say, yes, that has a logic to it, it is consistent with the structure of mathematics and math educators will tell us that is the pattern that you have to do when you unfold that logical structure to children. So you end up with this kind of upper triangular structure. In fact, in this case, two-thirds or more of the top achieving countries actually taught that particular topic at that particular grade where you see the dot.

Look at first grade. If you are focusing on three topics and usually the top achieving countries might have one or only or one or two more, by contract, in the United States we sometimes try to teach 20 topics to first graders, so that is the focus issue. The coherence is the structure, the pattern. You do not teach the topics toward the bottom of the list until the topics at the top of the list which are logically prerequisites to the later ones. This is not Piagetti and developmental, this is

mathematics, and so you cannot really learn something about some of these things until you know some other basic ideas, so that is this structure that you see here.

Why do I make point about this? Because on the next slide I will show you what most of our U.S. states look like, where you can see that the logical structure of the principle of curricular development is to teach everything everywhere because then somehow somebody will learn something somewhere, and I suggest to you that is not a particularly strong basis for curricular development.

In this paper that Tom asked us to do to explore this issue further, we looked at this, at the later grades, in 33 countries, at the earlier grades about 20 countries, on which we had such extensive curriculum data and we characterized and defined coherence and lack of focus and then we related this to the achievement scores that these people had developed as a part of the 1995 TIMSS and looked at the relationship between these measures of coherence and focus against the achievement pattern across these different countries to see what difference these things might make. Before I show you the actual results, let me define something first. Coherence was defined in terms of that pattern right there. We just defined it very simply, you look at a country and developed one of these maps for each country and then counted the number of dots that coincided with the coherence model which is this model. There are 99 possible topic cell combinations. What is important to keep in mind is

the topic cell combination because that is a potential place of opportunity. You can teach that topic at that grade level as opposed to teaching the topic. Teaching the topic, yes/no is not the issue, it is where it is taught.

The focus is how many topics are in the curriculum. Or the other measure we developed for that is what we call the early coverage of topics, anything to the left of the relevant dots would be too early a coverage, premature coverage of a topic before the logical structure is in place for that. You can also count the places after, but there are not many afters because the thing tends to be somewhat cumulative.

Here is what you can find. If you look at the distribution you can see at the earliest of grades, three, and remember at grade three you only look at that small part that goes up to grade three, there are only 13 topics in that coherence model there, so you see there is hardly any variation. The median is 11 and everybody is right there plus or minus 1, so everybody at third grade is doing what the model would call for, but you will see in a minute as the problem develops. As you go to fourth grade where there are 28 topics, there is still not much variation. But now as you get into the seventh and eighth grade where there are 99 possible topic-grade combinations, you can see that there is quite a bit more variation there. It goes from about 55 to 95 topics in there that would align for different countries, so this distribution is over the different countries, and you can see that not all countries are the same with respect to this issue.

This one which you can see immediately has much more

variability has to do with the introduction of the topics prior to the coherence model. So this is what I like to call premature coverage. You can see the wide range here. Look at third grade. Remember that everybody was pretty much covering the 13 topics in the coherence part of the model? Look at the wide range of extra topics prematurely covered outside of that. You can see that there is quite a bit of variation on this issue of focus. This is what we are calling the focus because the more you put into here the less focus you are going to have especially with respect to the coherence part of the model. Keep in mind as you see these graphics that a topic as it says here is a combination of the topic together with the grade. One more thing just to give you a more concrete sense of this, here is a select set of countries listing what you would have as to terms of the total number of topic-grade combinations in the curriculum, the number that are premature, and then the number that align with the scenario. You might look at where the U.S. tends to come out first in this work, probably about the only spot, is we have 186 topic-grade combinations which is more than anybody else. And I think we are the highest in terms of the number of premature topic-grade combinations. Of course, we are very high in terms of the coverage of the scenario because we cover everything everywhere so eventually you are going to hit the marks where everybody else is going it in the top achieving countries.

So where does all this come down? To look at this analysis and to explore this more carefully we did some regression analyses with

the country as the unit, as I said with the scaled scores from there, and we did this in several ways. This one is to show you one of the ways graphically. We took the ratio of the number of aligned topics that is consistent with coherence model, the proportion that is of the total number of topic-grade combinations. In other words, if you are right on target, this ratio would be 1. So you can see here there is a quite strong relationship between that and the achievement pattern, that the higher that ratio, the close it gets to 1, the greater the country level achievement.

But pulling it apart we looked at it in terms of a regression analysis. This one looks at and uses the focus measure as the total number of topics in the curriculum. What you can see here is that right across the board, the lack of focus is strong and has a significant effect at all four grades. It is negative the coefficient because the more topics, it is a drag on the achievement of the country. The coherence is significant at the upper grades and marginal at fourth grade and not at third grade, but keep in mind at third grade there was hardly any variability, there were only 13 topics and virtually everybody was doing it so there is not much room for variability there to support a relationship to the variability in the achievement measure.

We also looked at this with using this premature coverage as the measure of focus and you can see it is pretty consistent. In all cases it comes out to be somewhere around 20 to 25 percent of the variance without putting any other variables into the equation at the country level

and you can see what it effectively says is that coherence makes a difference. It is a positive, statistically significant result especially at the upper grades. By the way, if you turn these into effect sizes, you get somewhere from between about a fourth to a half a standard deviation for an increase of being more consistent by 10 or 20 topics with the coherence model and those numbers of 10 and 20 are not that large when you look at the 99 possibilities and the range across countries. That is not a huge movement of any strange sort, yet you can come up with an effect size that is quite respectable.

I think the other thing to notice in this is that the lack of focus is significant at all the grades but it is also larger at the lower grades. It seems that the lack of focus, that is, prematurely covering topics, is going to have a larger negative impact at the earlier grades which makes logical sense because in effect when you are trying to get them to understand the basics for moving on, if you dilute the time that you have by lots of other topics that are really outside their real realm of understanding, you are probably going to reduce the amount of time for the real study and therefore it has a drag on the achievement of the country level. The thing that is important to note here which I thought was really quite interesting, if I put the focus measures into the regressions just by themselves, nothing happens. They are not significant. So they are significant conditional on the coherence, that is, the drag on the coherence, the coherence is the main effect here and what happens with the focus is the larger it is against

the coherence the more it dilutes that and has its negative effect that is statistically significant. When you consider that the U.S. had 60 premature topic-grade combinations and then you look at these effect sizes, you could see that it could make quite a difference for a country like the United States.

I would suggest relative to my opening comment that we do have to pay attention other countries and this is one area. The curriculum is powerful, they keep finding that in 2000, 2003, and probably in 2007, and it is an important dimension. It is an area of public policy and clearly it makes a difference and I would suggest these characteristics of coherence, focus, and rigor which we have established elsewhere in another source that that is really clearly related, and that this is where we have to pay attention to the competition. Otherwise our children will simply not be competitive. If you listen to the economists, if we do not fix this problem and really soon, they are suggesting the drag on our economy is going to be severe. No matter how many ways economists cut this study, they come up with 70 percent of the economic growth is related to the training and education of the workforce. Put that together with this and you can see why I think we need to do something and now, not later. Thank you.

MR. KILPATRICK: I am going to continue this discussion of curriculum by focusing our attention on algebra in an international context because for those in mathematics education, it is not the case that a math

test is a math test is a math test or that an algebra test is an algebra test is an algebra test. We are interested in looking below that surface and saying what is it that the test designers for example decided was algebra. So we decided to take a look, my colleagues and I, Vilma Mesa and Barry Sloan, decided to take a closer look at how U.S. students do in algebra relative to students in other countries.

Before we looked at the data we wanted to make some observations about some particular characteristics of school algebra in the United States that are somewhat different in other countries. In the United States as you all know, we tend to have separate algebra courses, year-long courses devoted only to algebra. That is changing a little bit in some places, but it is not the same as what other countries have. Another characteristic traditionally of what we have is that our algebra courses are designed for the college-bound students or they have been in the past. The notion of algebra for everybody is a relatively recent curricular notion in this country, but it is not so recent in other countries. Other countries tend to teach algebra to everybody who is still in school at that time.

Our particular characteristic with this layered approach of a year of algebra, a year of geometry, another year of algebra and so on is a product of our history. It comes about because the college entrance requirements were first of all a year of algebra to get into college, then algebra plus geometry, and so as these college entrance requirements were laid down in the last century, the courses become layered in the

same way sort of like geological strata. As these courses moved from the colleges to the high school, they took on this particular form which as I say is not the form that is used in most other countries of the world.

In recent years we have seen the first year of algebra moving to the eighth grade and even earlier. That is a relatively recent development. In our country, algebra, as in some other countries, began as a generalization of arithmetic, and again, unlike other countries, it has kept much of that character in recent years, whereas in other countries there is, first of all, a more practical approach to algebra and a basing of algebra on the idea of functions. That has a long history in other countries; it has a relatively short history in ours.

Looking at performance in TIMSS 2003, our fourth graders actually did somewhat better in algebra than they did in all mathematics items taken together, and it was better than the average for fourth graders in other countries. In contrast, the eighth graders' algebra performance was above the average on all items and also above that of eighth graders in other countries. It is not really a contrast. They are both pretty good. Let's take a closer look at the fourth grade situation. Here you see that relatively speaking, relative to the other 26 countries in this group, our fourth graders did actually very well in data. That was the top thing for them; they were above the 26 country average in patterns, equations, and relationships, which is the term that TIMSS uses for algebra. The places where we did not do so well you can see are geometry and measurement,

and that is a pattern that has appeared in previous assessments. When we look at the situation for eighth graders, it is pretty much the same. Our best performance relatively is in data, but then our algebra performance is above the average there; our geometry and measurement performance are not as good. This is eighth graders in 2003.

We did a number of different analyses across 1995, 1999, and 2003 TIMSS, we tried to look at various characteristics of the algebra items. So we looked at them from three dimensions, content, representation, and cognitive demand. The question of content, we used an elaboration of the framework that was used in classifying some TIMSS items except we added the category of algebraic manipulation in order to cover the various kinds of items that we were seeing in the TIMSS test. TIMSS categories are not as many as this. We were trying to sort TIMSS items into smaller content categories.

We were also interested in what was the representation, whether it was numerical, verbal, graphical, symbolic, or pictorial, that was given in the item stem and then what was asked for, so we had all these various combinations. It might be a numerical question asking for a verbal response or something like that, so we were interested in those categories as well.

Then finally and maybe most interesting, we were interested in the question of cognitive demand, what was the item asking the student to do, and we looked at this following some work done by other people in

science. We looked at this work on two dimensions, a content dimension which goes from rich elaborated content, to rather lean and Spartan content. We looked at it at the same time from an open-ended kind of process that was much more up to the student, and a constrained kind of process at the other end where the student did not have much choice of what to do. That gave rise to four different quadrants which were numbered using Roman numerals in the way that mathematicians number the quadrants of Cartesian space and you can see then the tasks that fall into those different quadrants tend to make different kinds of demands on students. So we were interested in what were those demands and we wanted to know on what kinds of items, whether it is content, process, cognitive demand, or representation, do U.S. students do well and on what kinds of items do they do poorly.

We particularly looked at seven systems. We chose them because they were all members of the Organization of Economic Cooperation and Development. In other words, they are our peer countries, and we chose them because they participated in TIMSS 1995, 1999, and 2003. We had to make some substitutions. Canada participated in 1995 and 1999 as a country. Two of its provinces participated in 2003. So Canada and the Czech Republic in the first two were replaced by Ontario and Quebec in the second two. But all of these except the U.S. and New Zealand were what Bill calls the A countries in TIMSS 1995. So these are countries that follow the pattern that Bill talked

about and that are considered our peers internationally.

First of all, we looked at absolute high performance and absolute low performance, but I do not have time to go into that. So I just going to give one example here of an eighth grade item in 1999 on which the U.S. students did relatively well. The question is, which of these expressions is equivalent to N times N times N for all values of N, and then you get some choices there. In the United States we got 85 percent correct, and the nearest of the other seven countries was the Czech Republic getting 81 percent correct. So we did relatively well on that item and on items of that kind. If you summarize them there were three of them in 1995, one of them in 1999 I just showed you, and seven of them in 2003. There were six of them in grade four and five of them at grade eight. If you characterize these items they tend to involve a transition from arithmetic thinking to algebraic thinking. This is this notion that algebra in the United States is generalized arithmetic. It did not involve pictorial or graphical representation. Those items tended not to do that. And most of them were located in the third quadrant which is lean in content and the process is very constrained. So that is a particular kind of algebra on which our students do relatively well.

Here is one example of relative low performance. You have a series of figures in a geometric pattern and a number of circles in there. The students are only asked here to extend that table to add what figure 4 would have where all you have to do is count, and figure 5 where you

have to figure out what the next figure in the sequence is, and we had the lowest of the countries that we looked at. It was 73 percent. Hungary was the next lowest, and it was 77 percent. You can quarrel with Mick and Ina.

If we look at the relatively low performance items, there were 8 of them in 1995, 5 in 1999, and 4 in 2003. They were all at the eighth grade and most of them involved as that one did pattern generalization. They involved either numerical or pictorial patterns and most were in either quadrant two or quadrant three as before. The items on which we did relatively lower were generally difficult for students in all countries.

Just quickly, some observations about U.S. performance. Fourth graders do relatively well in such things as interpreting a rule, engaging in transitive reasoning, and extending numerical patterns. For an example of twelfth graders, they can interpret function graphs, but otherwise their performance is relatively weak. Eighth graders understand exponential notation, they an interpret simple expressions, reason about sequences, and do relatively mechanical things with algebra, but they are relatively weak at interpreting symbols, completing tables, finding sums of series, generalizing patterns, or solving word problems.

There was a study by Alan Ginsburg at AIR and his colleagues. U.S. performance was below the average for 12 countries at high and low levels of rigor for TIMSS and high and low levels of difficulty for TIMSS and PISA, and we found pretty much the same thing, but our results showed that although U.S. performance is low in general, it is not

uniformly low and the biggest differences in algebra performance between the United States and the other TIMSS countries come at eighth grade. U.S. eighth graders however I think do better than expected given that most of them have relatively limited exposure to it. The AIR study also found that U.S. eighth grade teachers are far more likely to say that they relate mathematics to students' daily lives in most lessons and that makes it surprising that our students do not do better with that kind of problem. The TIMSS video studies show that U.S. eighth grade teachers use few high-complexity problems and spend 30 percent of their lesson on review. Just to sum up, algebra is of limited use if it is understood as generalized arithmetic only, if students are to use algebra, they need to be proficient in functional thinking, and the data that we have looked at indicates that so far they are not doing that. So we have a ways to go in our algebra curriculum.

MR. FENNELL: I had an opportunity to attend this conference last year and because of a family emergency was not able to do that, so I am happy to be here. I am also happy to report, Tom, that I read the book. You are welcome to inspect that. Tom and I have worked together for the last year or so on the National Math Panel, so among other people in this room, he should know that it is pronounced Fennell and not Fennell, but I enjoyed that.

Rather than reporting on literally every chapter in this book, I am going to report primarily on the three that you have heard about then

lean into another couple two quickly. I have far too many slides, but I am going to talk fast.

With regard to what I guess I had heard earlier, the overview chapter by Mick and Ina, I would like to make just a couple of observations. One of them is in the arena of teacher experience and preparation that they cite in their chapter, a bullet that talks about relatively little evidence of direct relationship between teacher training and student achievement, and throughout this talk I will give some I suspect highlights, proposed highlights, from the soon to be released National Math Panel report where in the teacher group that worked on this they too find that the issue of teacher certification as a proxy to student achievement is not particularly well founded at all.

Another issue that they cite in the chapter which I just find interesting is, you look at the 47 countries that were involved and the number of those countries that in fact require a degree for teaching mathematics, require a level of practicum of some sort, some sort of examination, some probationary period in the teaching practice, and then some sort of an organized induction plan, and you can see great differences among that scatter of 47 and you can see some of those elements of what we might say fairly common teacher education practice are less likely in some countries than others. No surprise perhaps, but I think quite interesting.

With regard to instruction, the three predominant activities at

both fourth and eighth grade levels accounting for over half of classroom time, teacher lecture, and teacher guided student practice. Clearly, if you put instruction across polar opposites of direct instruction and student engaged instruction or student centered, however you cite that, you see two of those moving in that direction, and the last one, students working on problems on their own, moving in the other direction so that the paradigm or instruction around the world gives I think some indication of how those differences play out in this country. Again I found that interesting as something to talk about.

They also cite, and they are not the only chapter to cite, the value of home support, and just noting here higher levels of parents' education are associated with higher eighth grade student achievement in mathematics in almost all countries and I see that issue in a couple of the other chapters as well. Nevertheless, some research has indicated that the students following a demanding curriculum may have higher achievement but little enthusiasm for the subject matter and that is a slice of that work that has given rise to the happiness factor and that issue particularly among higher scoring countries is something too that we should at the very least investigate.

With regard to Bill's chapter and the chapter clearly getting at the issue of more than focus as he indicated in his presentation, the first part of the chapter presents pretty well-known stuff from 1997 and follow-up of TIMSS and United States curriculum, many topics, two of state

standards, textbooks, the TIMSS standards and the like, gives rise to states today in this country having over 100 or more objectives at a particular grade level, gives rise to textbooks of 750 or so pages at the third grade level, gives rise to and I suspect to some extent we are at fault, by we the organization I represent, NCTM and the original version of the standards curriculum and evaluation standards sort of promoting the fact of this notion of breadth and people taking that at a level of seriousness that was probably never intended, but I will come to that in a bit. The issue has resulted in as he demonstrated - and this is not in the book - that slide, Bill, of the twenty-some states with all the dots and so forth and so on, clearly little focus resulting in a surface or skim level of coverage.

The issue here to me as it was to Bill and his colleague as they wrote this chapter is somewhat multifaceted. The issue of coherence, and I took some liberty with your chapter on coherence because I see too that it is articulated over time in sequence of topics and the depth, but I also extend that myself to the need to reach closure, the need to sort of understand for instance that we have spent enough time emphasis-wise say on addition and subtraction of whole numbers, and that is not to say we would never revisit that, but it is not an emphasis topic at a particular grade level, so that notion of closure. And then the large number of topics and how that is symptomatic of the larger issue, that problem of coherence.

One of the things that is cited in that chapter is the following,

a decrease of 50 in the number of intended topic and grade combinations would predict an increase in achievement of almost three-fourths of a standard deviation especially relevant in the United States. A decrease would put it more in line with Japan and Korea. I took the license of taking what Bill reported as the United States curriculum and took the curriculum focal points which were also referenced in that chapter although not in the dais and you will see the difference there in terms of originally 186 topics, now down to 111, before from 63 to 34, aligned with 72 puts it right up there with some of the countries that Bill would probably characterize as A plus, and very limited in terms of after the ideal just as a very rough count on my part.

They continue on with that chapter, for a country to have a high mean level of performance it must have a high degree of focus and coherence. The issue of separating out is I think pretty important, that the sort of knitted notion of focus combined with coherence is the issue that ought to be really dealt with very seriously. In the chapter they also mention, I actually love the use of the word clutter here, clutter created by covering too many topics too early or before their time from a mathematical point of view must be kept small.

They conclude the chapter with the following: the results of these analyses do not bode well for the United States. They depict poor levels of performance especially in the middle grades. In fact, poor performance in the middle grades has been seen repeatedly as recently

as 2003. Again I took the original version of the NCTM standards and overlaid what I call middle-grade mathematics, grades six, seven, and eight, and found that there were only five of the focal points before ideal, there were only four of the focal points after ideal, and so again it is a pretty nice fit and would say that maybe as states and school districts pay serious attention to this issue of focus and coherence, we have a chance to make a difference. We now have 50 states that have state standards. I think they are beginning to realize that you cannot expect a fourth grade teacher however good that person is to attend to levels of import for 100 topics or more. Clearly, anybody with experience, anybody who knows the mathematics, realizes that there are far fewer topics than that that demand emphasis, demand depth, and then we move on and that sort of articulation across the grades is critical for this country.

Jeremy's chapter was next and I found it very interesting from a variety of perspectives. One is, frankly, the history lesson and in there he alluded to it very briefly about the history of algebra in this country -- after the Civil War was geometry required for entrance and this was into college -- the order in which these mathematical subjects continues to shape college prep courses offered in secondary school to this day. 2000, 26 percent of eighth graders reported taking algebra. That has grown as many of you in the room know to somewhere around 40 percent. The data that I have and it is fairly recent indicates about 40 percent of the eighth grade kids in this country right this minute are either

in a course entitled algebra 1 or better and by better I mean that they started the sequence earlier. We see that, as you can see there, somewhere around 5 percent of the seventh graders in this country are beginning that sequence even at that particular level and both of those are growing. So the issue becomes, there are lots of issues here, first of all, is that really algebra that is in that course, and I suspect that is going to come up later as well, but clearly early access to higher-level mathematics is not only occurring, it is growing, and that is something that is important.

A couple of issues that I felt were really interesting, United States students do not do well on items that involve the extension of a pattern if the item requires that they explicitly produce, describe, or represent a relationship rather than simply find the next terms in a sequence. What's important to me there, frankly, is teacher background. Just as the comment came a few minutes ago when Jeremy was presenting this, you can take a pattern and essentially take it lots of different directions. It says to me that that classroom teacher who is presenting that is prepared to deal with a particular interpretation of pattern and what that can do in terms of its potential for richness or, frankly and unfortunately, its potential for seeing it in a very limited way. That to me is kind of interesting as it is played out in the chapter.

U.S. students do relatively poorly in setting up an equation to model a real situation. I suspect that one of the major import areas of algebra however it is couched is that and so one questions what we need

to do to get that. U.S. eighth grade teachers spend considerable time reviewing topics already taught. Almost 30 percent of their lessons are devoted entirely to review. Having spent pretty much the last 2 years talking with teachers of this subject, they all say that. They frankly are far more specific than that. They tell me that they are teaching fractions so that they can get ready to do the algebra that is allegedly the intent of the course. So the issue of review and what is algebra and having time to do it the way that this chapter portrays I think is a huge issue for us nationally.

U.S. students appear to need many more opportunities to engage in functional thinking with complex problems, and in particular, in functional thinking as it is related to realistic situations, reported a few moments ago by Jeremy. But the issue of centering around or thinking about the role of function in algebra comes very clearly through this report and is certainly an element of I think serious consideration. As is algebra is of limited use if it is only understood as generalized arithmetic, the sort of historical definition that he presented and perhaps all too often being played out in classrooms.

The U.S. is not the only country in which eighth grade teachers could be giving greater attention functions but is one in which too many people have assumed for too long that most students cannot learn user value algebra. At a time when almost half the kids in this country at grade eight are doing this, it seems well advised that we take a hard look at that particular statement and to me this has tremendous implications for

some of the work that will soon be released from the math panel, actually the math panel which was to identify algebra and to suggest what it takes to have students become successful with algebra. To me it has implications for NAEP and how NAEP is defined at the fourth, eighth, and twelfth grade levels as well in terms of the elements of algebra.

A couple of issues from this particular chapter, I know it was not reported, Tom, but in the chapter which is defined as "How Can TIMSS Surveys Tell Us About Mathematics Reform in the United States or in the 1990s?" and there are some statements here that are interesting, there are signs of a partial ceasefire in the math wars, growing acceptance of more traditional approaches on the part of NCTM and NCTM includes individuals who have been associated with both sides of the debate, early indications and greater degree of consensus than has been obtained, NMP meaning the National Math Panel. The point is I suspect a lot of the discussions that are centered around the phrase "math wars" is more about the mathematics than it is anything that is called approaches to mathematics. It is more about are you making sure kids know the basic multiplication facts? Are you making sure kids have access to standard algorithms? Are you making sure that that is really important for students as they understood whole number operations and move on into rational numbers? I would like to believe that there has been great consensus about those elements, those, if you will, critical foundations for mathematics leading to algebra, and they have not occurred in the last

year or 2 years or whatever, but I think there has been a movement to engage both important people who happen to be mathematicians and important people who happen to be mathematics educators in doing what is best for children in this debate. And it talks about some of the limitations of this particular survey in that chapter. I am going to skip over that and speak briefly about the technology chapter having not even attempting to pronounce the authors of this particular chapter.

There are a couple of issues here. The advent of calculator technology has influenced the teaching of mathematics. Graphing calculator values and the importance of that is out there. This results about children from stronger educational backgrounds are advantaged in schools while children from less educated backgrounds are disadvantaged supports the earlier contention in the initial chapter. The need to not only harness technology but to use it appropriately for students relative to use of the computer or the calculator. I am going to skip over some of this.

I am going to close with a couple of comments here. In this chapter there is plenty of evidence to indicate a positive relationship between technology and student achievement, and my retort to that frankly is where is it particularly related to the use of the graphing calculator in high school classrooms and higher level mathematics because I do not know that we have seen that.

A couple of thread issues through these chapters and beyond, certainly the issue not just from what I will refer to as the Schmidt

chapter for the moment, but throughout, this need for focus and coherence within the curriculum both across and within, but the within part frankly gets at Jeremy's chapter looking at how we define algebra, looking at how that is if you will spaced out across curricula.

Similarly, the lack of penetration of reform. This issue of reform is bantered around in lots of different ways using lots of interesting language, but the penetration of that as noted through this book is limited at best. And finally, the need for research on much of what we are talking about here, the need for research about curriculum and the things we do in curriculum as they impact children in learning the student, need for research with regard to technology, need for research with regard to instruction, teacher background and the like. Thank you.

MR. LOVELESS: We will open it up now to questions and discussion. Jerry I know wants to make a point about the pattern problem. Please identify yourself and the mike will be coming to you so that people can hear you.

MR. DANCIS: I am Jerome Dancis. I am a retired math professor from the University of Maryland. Actually, the point I wanted to make is that we have half the students in the United States taking algebra but we do not actually require the eighth grade math teachers to know algebra or even actually to know arithmetic. No Child Left Behind says that teachers are supposed to be highly qualified and leaves that up to the states most of whom have used the practice to exam and the first rule for

the practice to math content exam is that the middle school math teachers get to use calculators so they do not have to know how to add fractions. My question is to Bill since you have just done an international study on how much teachers know in various countries and its connection with how much the students know, if you would comment on your recent study.

MR. SCHMIDT: Just briefly since that has nothing to do with what we were talking about, it is related but not directly, we just did a six country study looking at what future middle schools teachers in six countries know. These were people in their last year of teacher preparation, Taiwan and Korea whose middle school students in these studies do quite well, Germany and Bulgaria whose students do around the middle typically, and the U.S. and Mexico whose students do not do very well. We found some very disturbing results. Put simply, when you test those future middle school teachers in the United States on algebra, of the six countries, we were dead last, and in analysis functions we were second to last. But it is not surprising. The bottom line is you look then at their preparation and you see their preparation is exceedingly different. It is not just different in terms of the amount of mathematics they study, but it is also different in terms of the amount of practical pedagogy they encounter as a part of their preparation. So they have a nice mix of those things which is missing in the other four countries.

May I quickly speak to this algebra thing? I would be very cautious about that 40 percent. In 1995-1997 when we did the analysis on

this, it was being reported that the number was up to around 30 some percent. We had the best data ever to analyze this. It was actually the sampling framed data from what WESTSTAT did. If you did that analysis, it was like 18 percent that were really taking algebra, not the 30 that people were touting. I know it is going up, but if I wonder if 40 now means it is more like 25 or something like that. One other quick piece of data from the TIMSS study where we actually had the textbooks analyzed as well, we found that of the courses called algebra at eighth grade, one-third of them were using textbooks that were arithmetic books or pre-algebra books so you really question whether those would really be algebra courses.

MR. LOVELESS: Yes, there certainly are courses called algebra that are not algebra, but I will say that we are doing a study using NAEP data, restricted use data, and the question that is asked of kids "What course are you currently enrolled in in mathematics?" about 30 percent say it is called algebra, 5 percent roughly say geometry, and 5 percent even say algebra II. So that number gets right around 40. So I am actually a believer in the 40 number. Skip, do you want to comment or anybody else on the panel?

SPEAKER: You are right. I think you and I are talking about the same data.

MR. LOVELESS: Another question? Here in the front.

SPEAKER: (inaudible) I have some background in

California education and I know that we increased people taking algebra I from about 17 percent in 1998 to over 50 percent in 2007. The scores since we have scaled scores did not drop. If you take algebra in California you are supposed to take the test of algebra. So there are very few teachers, there are some, that push kids to algebra that is not algebra because then they are forced to take tests that they are not up to the test. So I believe in this number.

MR. LOVELESS: And California does report one of the highest numbers of eighth grade enrollment in algebra and also has some of the lowest test scores at the eighth grade. A separate issue.

SPEAKER: But the scores did not drop since 2002 when we had scaled scores. I think at that point we were like 25 to 26 percent taking algebra and now we have doubled that already and the scaled scores did not drop. So at least something is half working.

MR. LOVELESS: Yes. Another question or comment? Gail?

MS. SUNDERMAN: Gail Sunderman from the Civil Rights Project. I am interested in trends over time in the curriculum in terms of focus and coherence and particularly if that could be put in context of the standards, accountability, and testing movement that we have been pursuing in the United States since the 1990s. Are we moving toward greater coherence and focus or away? Is there data on that?

SPEAKER: I would answer that somewhat informally. The

data you saw were on the basis of a very formal analysis. Over the last set of years I have been asked by many states to look at their standards to see how they are improving in these issues. I can tell you from that sort of less formal analysis that there is a movement toward greater focus. I think the one thing that I see more often than not which is scary which is not going to surprise some of you is they picked up on the easier of the two things to deal with, that is, focus, so they just cut topics down and sometimes they cut holes right into the middle of where the issue of coherence is really important. You especially see this in a set of topics like the properties of rational numbers and the relationship between whole numbers and those deeper topics that are the glue for the coherence in some sense and moving to a deeper understanding of math are often left out which of course then begins to destroy the coherence.

SPEAKER: Again somewhat informal indicators of that process, since NCTM released the curriculum focal points in September 2006, we have had close to a million downloads of the document which frankly surprised us. We physically have been in over 20 of the 50 states. We have commissioned, actually it did not come from us but it came from the Curriculum Center Project at the University of Missouri where they did a survey of state math supervisors around the country relative to when are you going to take a look at your curriculum standards and how might you use the focal points or other initiatives and there is a tremendous amount of interest by the majority of the people who responded to that survey. So

again this may be a step up of the informal nature that Bill talks about.

But the issue of coherence while not understood and I think Bill's point is right, yes, we have looked at that and we have far fewer topics, part of the issue but not the whole issue, so there is buzz about the need to do this. One of the things that is not mentioned here as we think about this because we are looking at international comparisons, but if we think about it inside this country just for a moment is the issue of mobility. People in this country move and so as they move from New Jersey to Maryland or to Kentucky or whatever it happens to be, not to say because talk about a volatile issue as a national curriculum would be, but the issue of some coherence across such standards is one that people resonate with.

MR. LOVELESS: A question over here?

MR. SANCHEZ: Claudio Sanchez, National Public Radio. If I may pose a question that the typical parent out there may be interested in and have anyone up there respond, if there is a model out there, if there is an ideal benchmark with which to know what a child should be able to do and know in mathematics by eighth grade, why is it so difficult for this country to take that benchmark and create a sense of urgency so that eighth graders throughout this country can meet that goal, can meet that benchmark, so that parents in Maine and parents in California can say my child is learning what he or she needs to learn in order for this nation and its schools and its kids to be competitive to be up there with that ideal

benchmark? Why is that so difficult?

SPEAKER: I will take one try at it. I will tell you my opinion. This is based on some data, but it is not a data-driven statement. That is that I believe it is because the process of setting standards in this country is very often driven by political and ideological and practical concerns of what teachers tend to have done in the past. So pushing for a standard that elevates it, raises the bar and is driven by the concerns of the discipline is just not that readily resonated with and so people push back and resist it because it is not what has been done. I will tell you the story in Michigan. They were asked to put their math standards together. What they did is they contacted the 600 local districts and asked them what they did and then they just did an amalgam of it so they ended up with every one of the topics almost in almost every one of the grades because somebody somewhere in the state was doing that. That is not the way you make standards and so I think there is this deference to local control and so people do not push very hard to try to make the serious changes. Unlike him, I make my point really clear, what we need in this nation without any doubt in my opinion from 10 years of research on this is to step up like virtually every other country and have national specification of standards, not federal necessarily, but some national specification of standards. Without it we are going to continue to flounder as we have.

SPEAKER: Why do you say unlike me? How do you know that I'm opposed to that?

SPEAKER: In your earlier comment you seemed to be backing away.

SPEAKER: You have no idea.

MR. LOVELESS: At least he can pronounce your last name.

SPEAKER: That's right.

SPEAKER: But I think the issue of states latching onto their province is huge. The state that he mentioned, Bill, Vern Hillers is probably the biggest proponent in this country for a national voluntary curriculum.

SPEAKER: I can see that happen in history and other topics, but mathematics?

MR. LOVELESS: Mick and Ina's point about cultural supports is very, very important.

MS. MULLIS: Yes, and I was going to observe interestingly enough we work on reading, mathematics, and science at the TIMSS and PIRLS International Study Center and when we release our results for reading no one, press included, ever says why is it important for students to be able to read. But when we release our mathematics report, that is often the first question and often with an introduction something like, "I never could do math and look at me, an important member of the press." So I think there is a huge difference in the United States that starts right there. When you say why can't we get anybody interested, that is kind of starting from zero in the United States.

MR. LOVELESS: We conducted a survey a couple of years ago of foreign exchange students and we asked 500 foreign exchange students who had come to the United States from other countries to compare how important it was for them to be successful at two things, math and athletics and what was more important. Overwhelmingly the kids from other countries said it is really important in our country to be good at math. We then did the same survey with 500 American kids who were going abroad and asked them that question. Opposite results. Mirror image, it is really important in our peer group to be a good athlete; to be good at math, not so important. So these kinds of cultural supports as opposed to some of the engineering of standards or national standards or state standards, they play an important part too and we cannot overlook that. Other questions? Yes, back here.

MR. HOWELL: Jim Howell from the Center for Public Education. With the debate of national standards heating up and wherever that takes up, how have other countries been able to design more coherent curricula and have been able to isolate themselves from the political process unlike what we have not been able to do here?

SPEAKER: Let me just quickly say that in some countries of course it is a political process but they are not faced with designing let's say a textbook that would be acceptable in 50 different locations and that is an issue for us is that we have 50 states and textbook publishers would like to be able to sell their textbooks everywhere and so they have to look

at what these states are asking for and if the states are asking for different things, then we get the kind of curriculum we have. So that is a strong powerful force for diffusing the curriculum and in other countries I think somebody in the Ministry of Education is able to say we will have these topics at eighth grade and that is it.

SPEAKER: I would just add that probably a sense of tradition and that in most of these other nations they never started out with this notion of local control. They pretty much have always had a national ministry. And as Jeremy said, they convene a set of mathematicians and math educators and math teachers and they simply put the standards together and there is no real challenge to it. That is not to say they do not have trouble coming to agreements and so forth, but once they reach the agreements, they are there. And to the point that Ina and them were making, in many of those countries unlike the United States, when two or three parents are gathered together they do not pay any attention to them. In this country we think that we have to pay attention to parents which is what causes a lot of this movement at the local level because they say this is not good enough, you have to raise this, my kids are brighter than anybody, you have go have these other course, you have to raise this and that just generates this confusion in standards that we have.

MR. LOVELESS: Susan?

MS. SCLAFANI: I am Susan Sclafani formerly with the U.S. Department of Education, now with Chartwell Education Group. Jerry

mentioned earlier the Praxis test and the low standards that our states have set on that for highly qualified. You have been studying what other countries are doing and you said there are real differences between the way in which teachers are prepared. What recommendations would you make to states about changing their preparation requirements so that our particularly elementary school teachers would come prepared to teach elementary mathematics? Because right now, elementary and middle school people are unprepared to teach the foundations of mathematics that are so necessary for young people to grow up liking, understanding, and able to use mathematics for their careers both in school and later on.

SPEAKER: Just quickly, I would say that the situation is probably worse at middle school than it is at elementary school. We can argue about what is enough preparation for elementary school teachers but if there are good materials out there for the teachers to use, I think we are in better shape at the elementary school than we are at middle school because as Bill's study showed, we have middle school teachers being prepared with elementary school preparation and we have middle school teachers being prepared with secondary preparation and we have not made up our collective minds as to what is the appropriate preparation in mathematics for somebody who is going to teach grade five, six, seven, or eight. So I think we have a more confused situation there because the levels of preparation are all over the map whereas in elementary school you cannot count on it, but if people go through a reasonably good

elementary preservice program at most universities, they do come out with reasonable preparation in mathematics. It could be better, but I am not as worried at elementary school as I am at middle school.

MR. LOVELESS: Skip?

SPEAKER: I would just add if I could one quick point to that study he was alluding to. I think that one thing that was very clear in the data and in relational analysis we are now doing which we have not reported yet, and that is that in addition to just the straight mathematical knowledge, there is also this thing that my mathematician friends call the advanced treatment of elementary math and that showed up pretty strongly in this. They took their formal math up through abstract algebra, functional analysis, all this kind of stuff, real functions, but then they also took course work surrounding what it was they were going to teach but at a deeper level than you teach it so that it is the undergirding to fractions like the rational numbers system. So that was a big factor in all of this that seemingly is emerging.

I think the issue from this study so far of what we learned is that there is a balancing issue of real math, not real math, I should not say it that way, advanced math, pure math and academic subject matter math, and then the practical pedagogy both general and math and different countries have different balances and what seems to make the difference is that balance.

MR. LOVELESS: Skip?

SPEAKER: I would say that we need to be concerned at every level, and people who are left out of this mix include the following, people who are teaching special education. Such teachers teach mathematics. People who are teaching early childhood education. Such teachers essentially build the bedrock for the subject. So the notion of teacher preparation programs really getting at the mathematics for teaching those particular levels deeply and very, very well is important and I think Bill alluded to that.

With regard to middle school, I really agree with Jeremy and the National Science Foundation science, and engineering indicators that I believe came out last week has some data in there that says somewhere around 54 percent of those teaching middle school mathematics today have strong math in their backgrounds. That is still only about half and we are pushing on that half teaching algebra, so who is teaching that algebra, do they have the background, is that mathematics appropriate. And there are reports that come from the RAND Foundation in 2003, the Conference Board for the Mathematical Sciences and others can help advise us, but it is a serious question for every level of certification.

MR. LOVELESS: Yes?

MR. ALTMAN: Fred Altman. I am retired. My question is there seems to be a problem with the weight of books in all subjects including math, and with the emphasis on focus on coherence can we get down to more reasonable book sizes?

SPEAKER: No, because as Jeremy said, they have to fit every 50 state's standards so everything is in them.

MS. MULLIS: You should weigh in here.

SPEAKER: Yes, I will. The fact that there are all these states is a problem and that certainly does cause inflation of book size. However, there are some states like California, for instance, the publishers make their own California edition. That particular edition has also grown something like 75 percent in size over the last 30 years. So there are other reasons. Some of those other reasons have to do with making math into a topic that is not just math but also has interesting stories, interesting photographs, artwork, and tries to engage kids in math beyond mathematics and that also has led to an increase in size.

SPEAKER: Does that work?

SPEAKER: There is no evidence that it does anything.

MR. LOVELESS: A comment back here also on the aisle?

MS. ORCHOWSKY: Peggy Orchowsky. I am with the Hispanic Outlook on Higher Education. I think it was Skip who said something about that you need a sequence of topics over time and expectations to reach closure. Could you talk a little bit more what you mean by that? Is closure evaluated by tests or what is it?

MR. FENNELL: I mean I think it is way past time for curriculum in this country to take a look not only at the importance of a topic but the level of import it has within the curriculum. That is, when I

pick up those bloated textbooks at the fifth grade level that still have a number of lessons on addition and subtraction of whole numbers, at some point we need to say this is time well spent earlier and we need to move on because there are more important topics at say the fifth grade level than the one I just mentioned. That does not mean it cannot be reviewed, cannot be put in the context to solve problems and those other kinds of things, but this is part of what happens when you saw all the dots in I will say the original Schmidt chart because we as a culture, maybe it will do just a little bit, when we send that message to ill-prepared teachers, that means I can stay here longer than I should.

MR. LOVELESS: Back there on the aisle.

MS. LEWIS: I am Latasha Lewis from the Consortium of Social Science Associations. I was wondering what the role of universities pay in this. You mentioned earlier the reason why we are teaching algebra or geometry or algebra II is because the entrance requirements for universities require that. But now that a lot of students are going into universities ill prepared for university level math, what role can universities do to push states and local school districts to really ramp up their math preparation and are any universities actually starting to do that?

MR. LOVELESS: Does anyone want to comment on that?

SPEAKER: I do, actually. I think we have a tremendous paradox in that country and by that I mean the following. We have more students at the high school level taking something called calculus than we

do at the collegiate level taking calculus I. This comes out from the Conference Board on Math and Science's 2005 report. So you have that. At the same time you have American the American College Testing Program saying that when kids come to college they essentially do not know algebra. So we are very good at saying we have our kids taking all this higher level mathematics and, excuse me, not knowing it. It is easy to say. I can clearly understand how this happens. It is easy for a district to report we have so many of our eighth grade kids taking algebra, we have so many of our kids taking pre-calculus or calculus or whatever, in other words, allowing access to higher-level mathematics. Not a bad thing if students are prepared, and that is the issue.

Then we have such students moving on into higher education and the collegiate professors of mathematics in particular are saying, wait a minute, the transcript said you did X in high school, meanwhile you are having a hard time in my particular course and so there is a tremendous disconnect there and we need to do something about that.

SPEAKER: It seems like all the way down the line teachers do not think their students are adequately prepared.

SPEAKER: Exactly. Faculty room father. It happens every day.

SPEAKER: We surveyed algebra teachers as part of the National Math Panel and the two main obstacles they said to their

students' success in an algebra I course, number one, was working with word problems, they were inadequately prepared to do that, and number two was working with fractions, that kids just do not know fractions and they are asked to do algebra and they fail.

MR. LOVELESS: Right here on the end of the row.

SPEAKER: (inaudible) National Science Foundation but once from something called Schools Around the World. My question is for Dr. Mullis. I am interested in the inadequacy about the functional ability of students in algebra, the ability to work with functions, and I wonder if that same kind of lack carries over into what you see in the science tests in terms of abstract thinking and also in the reading, whether we are failing our kids consistently at the more abstract deeper kind of work which is what I would guess but I just wonder if you saw that.

MS. MULLIS: It is very interesting, and Mick, feel free to elaborate, but it is my sense that our data show a similarity between the mathematics and science in that regard. But interestingly enough, in the reading the strength seems to be more in the process areas than in the actual ability to decode and find specific information. So I do not know. That is kind of an interesting irony there.

MR. LOVELESS: So we are higher level readers but low level mathematics?

MS. MULLIS: When it comes to abstract thinking, or you could look at it the other way around, too, we have strengths in the basics

like Jeremy was pointing out in some regards in algebra that we do not have in the reading. So I do not know. More research.

MR. LOVELESS: Two more questions. We are actually running over here.

MR. GROSS: I am Bob Gross. I am with the Office of Overseas Schools with the Department of State and one is a statement and one is a question. I just recently finished 8 years in Singapore as the head of the school of the Singapore American School in Singapore. I am actually somewhat surprised sometimes when I see the disparity between the scores of the U.S. and Singapore and that it is not larger than it is because it is incredible how this immersed in the culture there and how the people value mathematics and the way it is emphasized and how many of these students are in tutoring sessions on Saturdays and after school. I talked to quite a number of people who tutor kids and say we have nicer homes and we have nicer cars as a result of the Singapore Math Program because we are tutoring so many students and getting good money for it.

Just year because I just finished here in June I had an Asian family who came in with a 2 year old and they wanted to enroll their child in our 3 year old program and they asked what our mathematics curriculum was like for the 3 year olds. This was not just one example. There were many examples like this. So again clearly when I see how it was not encouraged in our culture that we have a major challenge ahead

of us if we ever want to try and catch, and that is important.

Secondly, when I was at the American School in Singapore and the head of schools here in the States, this discussion and question about a traditional approach compared to an inquiry based approach in mathematics is something that communities continue to struggle with and people are getting fired over. It seemed to me that I heard here that it does not seem to make too much difference which approach, if you use a more traditional approach or more inquiry and investigative approach. I am not sure I heard that. I was wondering if you could comment on that because I think a lot of our communities really need direction on this because there is a great debate going about this in our society so I would be interested in any comment on that.

SPEAKER: I will respond to a piece of it because I mentioned the traditional issue. In my experience, and I guess I am going to capitalize the two words, My Experience, my experience has been when you get down to the discussion it tends not to be a discussion about instructional approaches, it tends more to be a discussion about are you spending less time on particular aspects of mathematics. That tends to be by the way, I am going to generalize, more of a discussion that is related to elementary school mathematics than middle and high, and more of a discussion that is centered around, if I can use the elements of the curriculum, number and operations more than say geometry and measurement and other aspects of the curriculum.

That is not to say that there is not debate relative to instructional approach, but my experience has been when you finally have the discussion and get right down to it, it is more about the mathematics than it is about instructional approaches. There are people on this dais who have had several perhaps more experiences and they ought to chime in like yourself.

SPEAKER: That is totally consistent with what I have seen.

MR. LOVELESS: I totally agree. There is a chapter in the book, Laura Hamilton's chapter, on looking at reform oriented mathematics and she generally draws the conclusion that there is no strong evidence here one way or the other. On the National Math Panel we also had an instructional practices group. Joan Ferrini Monday is here and she chaired it. Again we found that looking at this evidence that there is not simply enough evidence to demand that you have one instructional regime or approach over another. So the content appears to be the key variable, not how it is delivered. We found some evidence supporting particular "inquiry based" approaches like one particular cooperative learning technique where we found some fairly persuasive evidence that it is effective but only again a very narrow kind of mathematics too. It turns out with computation skills, with elementary school kids that there is sufficient evidence that it is an effective means of teaching. But mostly the problem we have in math education is that when it comes to instruction we still have these huge holes. We do not have a lot of scientific evidence

like the reading community does in terms of nicely designed studies looking at instructional techniques. Yes? This will be the last question.

MR. NELSON: Howard Nelson, American Federation of Teachers. It seems like we have a silver bullet here that keeps coming back, it is actually an old silver bullet, focus and coherence in the curriculum, it would not cost that much to do, make sure NAEP is right, hold states accountable to NAEP's benchmarks, they have to fill in the blanks between the grades. However, the NCLB really does not deal with this. The discussions of reauthorization ignore all of this. Do you think NCLB has hurt or advanced this silver bullet?

SPEAKER: I will say one thing. I think when NCLB began with the vision that it had, I think it presupposed such a sort of standard that be there. Then it went through our political process, translation, it hit Congress, and came out the other end with every state allowing its own set of standards and so forth. So I do not know that it hurt or harmed it. I think it is the correct vision. But I think it is the political process that keeps getting in the way probably of it really happening. That would be my take on it.

SPEAKER: Your point is really interesting if you frankly take it to the classroom because when states, and I believe states are beginning to invest time in this issue of thinking about what should we focus on, let's look at coherence, and I know that is somewhat irregular as states do this but I see some evidence of them doing that, many of them

are not ready for the second question and he second question is I know you have worked hard on working on what you claim to be a focused and coherent curriculum, the next question is, how have your assessments changed? Because until you do that, until there is this mesh of linking that assessment to a coherent focused curriculum, then we are sending teachers the wrong message and the teachers live this issue every day.

SPEAKER: I think the biggest impediment to getting where we want on coherence and focus is that you cannot do it in 16,000 different places in this country and somehow out of that come any common equitable system for all kids in this country. We keep coming back to that. It is the elephant that is here that nobody looks at or pays any attention to. It is the Achilles' heel of No Child Left Behind and we just ignore it all the time. How could we expect anything else when the system is built to generate inequalities among children in this country?

MR. LOVELESS: On that note let's give our panel a hand. Thank you. Thank you all for coming.

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