TRANSCRIPT

Instructional Shifts in Common Core State Standards—Mathematics

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PHIL DARO Okay. So one of the things that I think is valuable for school districts to think about is how these standards are different as a kind of standard, as a different species of standard than what they are used to. And they are different; we did a lot to make them different. It's much more obvious with the language arts standards than the mathematic standards, but they are also different. And they are different because we were charged with basing this on research, not on politics, and that means that we did not use as a principal tool for designing these standards the tools of politics. That is, we didn't use compromise very often; we didn't use consensus building very much. What we did was tried to understand the problem with the way the U.S. was teaching mathematics based on the evidence and tried to design a tool to help solve that problem. And the consensus building happened quite remarkably afterward, not as part of the process.So we didn't do what states had to do under the conditions they were working, which was basically put up poster paper around the room, have 30 or 40 people representing all the stakeholders, take turns making speeches, write it down on the poster paper. Poster paper is cheap so we can have everybody have their ideas in it. And if there is really an argument that can't get settled, someone clever with language will come up with language that different people can see what they want in it. And in the end, what you get is the foundation for what it turns out is the main problem with the U.S. mathematics in schools, which is that our curriculum is a mile wide and an inch deep.

And it starts with the standards, but it was a mile wide, inch deep even before we had standards-based accountability. It's a very old problem in the U.S., and it's probably caused by the way our curriculum has a garage door for adding stuff in and no real process for taking stuff out. When we talk to people in Singapore and Japan, particularly, about their standards process, they were systematic and meticulous about removing stuff from the standards when they added stuff to the standards and keeping the whole thing kind of manageable, something that they did because that wasn't for them a political process either.

So we have had decades of standards-based accountability, and it's accomplished a lot, but it's far from perfect. In fact, some people would say it's short of good, and we should certainly learn lessons from our experience. We shouldn't go on doing what we always do unless we want the results we always get. And so one of the things we did was look at the lessons learned. And from looking at teacher surveys, from looking at college faculty surveys, the message that came across: there is too much to cover. The books have too much in it, the standards have too much in them, which was the same finding that we heard from the comparison of our mathematics to that of other countries.

In fact, the title of the report analyzing why the U.S. was behind other countries was *The Underachieving Curriculum*, not the underachieving students, not the underachieving teachers, not the underachieving parents or schools or school districts, but the underachieving curriculum. So in mathematics, the problem is in what we are teaching, not necessarily in how we are teaching. And that doesn't mean how we are teaching is just fine and can't be improved. It just means the pedagogy in other countries we are competing with is also very much a mixed bag. That's not where they are beating the heck out of us. It's in the curriculum. And what is it that's wrong with our curriculum? Too much; mile wide, inch deep. We keep coming back to it.

But I want to translate mile wide, inch deep, because my main purpose here is that you understand how that works, what causes it and what cures it. And I want you to think about something I didn't really think about until we got to this point in looking at the evidence. Why is it a mile wide, inch deep? Who is doing that to us? And of course the answer is we are doing it to ourselves. So having standards with too much in them, that certainly contributes. Having textbooks that they have to sell in 50 different states with 50 different standards makes textbooks too thick. Having textbooks written to be sold to committees is a major cause of why there is so much in those textbooks.

But it's also the districts, the principals, and the teachers that are causing it, and they are causing it because of some very old habits and some new habits we formed within standards-based accountability. And it's those things I want you to understand because it's those things you can do something about immediately. How are we doing it to ourselves, we in this room?

So when we wrote these standards, we started by trying to articulate to ourselves what our revision of mathematics was because we knew we had to do, as Linda said, we had to get to a fewer. And to get to fewer, you had to know what you wanted, so you could get rid of things you didn't want. We studied state standards from all the states, and we found they weren't full of bad things. So we weren't going to have the easy job of simply throwing out bad things to get to fewer. So we realized fairly early we'd have to throw out good things to get to fewer. But we also saw that the curriculum was incoherent; the mathematics in the U.S. curriculum was incoherent. And if we could make it more coherent, that would help us get to fewer.

But there is a choice of coherence. The mathematics does not come down from the mountain; it's a manmade invention, and there are different coherences. The mathematics of today has a different coherence than the mathematics of the 19th century or the 20th century or the 16th century. The mathematics in our schools is a hybrid, and not a very pleasing hybrid, of mathematics from many different centuries and has many different fragments of coherence. So we put together a coherent view of mathematics and that involves the progression and everything else. And to us, it was as beautiful as this drawing of the Grecian Urn that can be found in John Keats' notebooks. And of course, as soon as it goes out to the states and districts, the first thing they do is break it down so it's manageable. There goes the coherence.

The fragmentation, thinking about standards as a list of topics, is the beginning of making it a mile wide and an inch deep. I want to come back to that. Keats was famous for this equation—I look at this mathematically—where he equated beauty and truth, and there is something to that. Every mathematician can talk all day about how beautiful mathematics is. And Aristotle—we had this quoted to us repeatedly by our colleagues writing the English language standards in the next room—in ethics, he pointed out that each field has a grain size, a generality and specificity at which it is the simplest, most coherent, closest to the truth. And if you depart from that grain size in either way, by being too general or by being too specific, you depart from the truth; things get more complicated and messy.

So we were trying to find the grain size of mathematical knowledge that the kids were trying to learn. And one of the things we started with was the states implored us to make all the standards the same grain size. Because many state standards, there are little ones and big ones. And so we tried; it sounded sensible. But in the end, we realized that was a mistake; we should make the grain size of the standard the same as the grain size of the mathematics that the standard was about. And when we did that, went through that process, which was difficult for us, we learned and got very sensitive to the grain size of mathematical knowledge. And lo and behold, we discovered mathematics does not break down into lesson-size pieces.

If you focus on mathematical content at the lesson level, you are introducing noise, incoherence into the system. So one takeaway today is don't manage the content of mathematics at the lesson level. Fortunately, it does break conveniently into chapter-size pieces. So asking the question "What's the mathematics of this chapter?" has intelligent answers that most teachers can understand. Asking the question "What's the mathematics of this lesson?" usually doesn't have an intelligent answer, and it makes the teachers feel undereducated and unintelligent.

So translate that into district behavior: "What standard are you teaching today?" is nonsense. There is no standard you can teach in one lesson. The standards that we wrote, and the standards that were in the Californian Standards before the ones we wrote, are about chapter size. The smallest ones are about a week, three days to a week. They are not lesson sized. So teachers getting together to collaborate, part of that collaboration is what's the math we want our kids to walk away with. That collaboration should be at the chapter level. And each lesson in that chapter has as its goal making progress towards the chapter mathematics. I want to come back to that.

Okay, here is a problem I want you to work on. I would like you to work on it solo for a minute, and then I want you to talk to the person next to you to explain how you are approaching it. So just work on this problem by yourself for a few seconds…. This is what Japanese children in every classroom in elementary school in Japan, Singaporean children see when a problem is first presented in a lesson. And this is what they don't see. They don't see a question that has an answer. This is a very simple problem; they can get much more complicated. And the reason for that is the teacher wants to stop—the system, their system they have learned—they want to stop the answer-getting processed and have the kids focus on the mathematical relationship structure and the mathematics of the situation.

So this will go up on the board. Often they do it low tech. They have the problems on a piece of paper, and they simply fold the bottom of the paper where the question is and tape it. The kids know there is a question there; they just don't know what it is. And one of the things, we were studying how do you slow down the answer getting and get kids to focus on the mathematics in a project I worked on called SERP in San Francisco, Alan Schoenfeld and his group. And one of the techniques we adapted from the Japanese was this one where we show this to the kids, and then we asked the kids to make up a question that uses this information to make it into a word problem. So that's what I'd actually like you do to do right now.

So you make up a question that makes that a word problem, and then I want to collect a few of those…. Okay, let's hear a few of these problems. Gentlemen, what did you come up with? Tony? What did your partner come up with?

AUDIENCE My partner came up with, "Why?"

PHIL DARO Why? That's a question for English class. This is math class. All right, Jan? Why don't you think out loud and make up a question for us that makes that a word problem?

AUDIENCE Assuming Jason ran at the same speed, how many meters would he run in 9 seconds?

PHIL DARO Thank you very much, a very important assumption. Okay, so how long did he run—how far did he go on a given amount of time?

AUDIENCE What was Jason's velocity at 2.5 seconds?

PHIL DARO You were a science teacher at one time. Thank you very much. So how fast was he going?

AUDIENCE He has already said mine. If Jason can run 40 meters in 4.5 seconds, how many meters would he run in 9 seconds?

PHIL DARO You picked 9 seconds, too? Did anyone have a different kind of question? We have had one, how far could he go in a given time, how fast is he going. Who had a different kind of question?

AUDIENCE Jason ran 40 meters in 4.5 seconds. Bill ran 30 meters in 4 seconds. Who ran faster?

PHIL DARO Okay, making it more complicated. Would he win an Olympic gold? Probably not. Well, usually you will get kids also asking how long would it take to run a give distance. So you get these three kinds of questions from a group of kids: how far in a given time, how long does it take to go a given distance, and how fast is he going. These three questions are the heart and soul of what is in the Common Core Standards in grades 6 and 7 as far as understanding rate and proportional relationships, understanding that every proportional relationship has three questions like this. There are three quantities. In this case, there is a distance; there is a time, and then there is this magic thing, which is the most important thing to learning grades 6 and 7, which is when you divide one of those quantities by the other, you get a brand new quantity: velocity or speed or rate.

This is the seed out of which calculus will eventually grow. In one short lesson, you can get to these three questions as tightly bound by a deep mathematical idea, and that's in fact what the Japanese and Singaporeans do by postponing answer getting and instead going after the mathematics. So I want to get a little further into that. I want to come back to those.

So my overall message is if we just swap out these new standards for the old standards into the same system, the same way we manage instruction, nothing is really going to change. We tried to build a platform for a different kind of instructional system. So mile wide, inch deep, and it's to solve this problem. I want to translate mile wide, inch deep. We have all heard that so many times. We forget what it means. What it means is we spend too little time for concept. And the cure? More time for concept, more time for topic and to take it literally from—I keep referring to Japan and Singapore; I could talk about Finland and now Canada. Finland and Canada are interesting because they have risen from levels that were close to ours to levels that are close to those high-performing Asian countries.

I spent two weeks in Japan this summer. I spent about same amount of time in Singapore last summer. Saw a lot of classrooms. One of the things that strikes American visitors visiting those classrooms, the first thing you hear people saying is “They are going so slowly. How they can go so slow?” At one point, they were asking us what we saw, and I used the word the teachers are so *patient*. This is in Japan, and the guy shook his head and scolded me and said, “You call it patience. It's not patience. We teach at the speed of learning. Learning doesn’t happen faster than that. That’s how fast learning is. We teach at the speed of learning. That’s not patience.” To us, it seemed very slow.

They spend a long time on each problem. Many lessons, they work on one problem the whole lesson, more typically three problems. Our lesson is 20 problems. The answer comes out fairly early. They spend the rest of the time getting the mathematics out of the problem. And partly what they do is postpone the answer getting using techniques like this. I will show you a few more. More time per problem, more time per topic. That means we need less topics, and I will show you some ways we get them. One, you can delete topics. You can’t get too far that way. We did delete topics; we deleted good things.

When the states gave us feedback—this is an example of how the governors essentially protected us from the political process—every state wanted us to add in things that we deleted, even though everyone agreed we should have fewer. In fact, when the states said, “You left out such and such,” we said, “Well, I know. We had to get fewer.” And they said, “Yeah, but it's good.” “We know. We have to leave out good things.” And then what people would say, very common: “Then you are watering down the standards.” This is the American idea of standards: more stuff faster is higher standards to an American way of thinking.

Does that sound familiar, more stuff faster? Sounds a lot like a mile wide, inch deep, doesn’t it? That idea of higher standards is part of the problem; it's not the solution. If I am on a class trip, and I look behind me, and the kids are too spread out, if I am an American leader, what do I do? I speed up. That’s my idea of how to deal with the problem my kids are too spread out. Well, in fact, our kids are more spread out than other countries in their achievement. And when you look more closely at that data, one of the things you see is the one place where the difference is, the variation is much greater than any other country, is the between-school variation. Our schools are more different from one another than the schools in other countries.

And another place where we have more variation than other countries is between-teacher variation. Our classrooms are more different from one another than in other countries. The place where the variation is not so different from other countries is within-classroom variation. Our within-classrooms is not so different than in other countries. It's between schools and between teachers. It's sort of the invisible tracking that our society has that's really showing up. Kids are spread out; a more intelligent thing to do would be to slow down. And in fact, they systematically look at that in countries where they actually use standards to manage instructions. If the kids start spreading out, they slow down. I will give you some examples of that.

But the real way to get to fewer topics, if you teach mathematics superficially as about a hundred different ways to get answers a year—we are going to show you a hundred different problems this year and show you a method for getting the answer to each one—that's a hundred different procedures and methods you have got to learn. If you go just a little deeper, not way deep like mathematicians, not even as deep as scientists, just a little deeper, where you learn some small number of basic principles and then learn how to apply them to different situations, there is actually a lot less to learn, and the things you are learning fit together a lot better. And that's what we tried to do when we wrote the standards.

So coherence is a source of reducing the number of topics. So understanding the coherence is part of what teachers have to do over time. So let's get to understanding a little bit how we are part of the problem. So here, in the spirit of California, we have a multiple-choice question. So we are good at taking multiple-choice tests, so it's obvious that's going to be the answer we are supposed to pick. But if you open the door of almost any classroom in the U.S.A.—good teacher, doesn't matter—it's as though "A" was the answer.

What we think mathematics is, what we think the teacher's job is is to teach the kids how to get the right answer. And what you see in the classrooms is answer getting, and what you hear is the ch-ch-ch [sound effect] sound, which comes from "What did you get? How did you get it?" And you see in the classroom the teacher going over the problems, as soon as they know how to get the right answer, done, move on the next problem. That's why we can get through so many problems; we are not stopping for the math.

We want to give kids problems to solve. Don't say that I am saying that answers don't matter. Right answers matter; the correctness matters; they are essential. I am not saying that; I am saying that the answer is part of the process; it's not the product. Product, the math the kids walk away with. Wrong answers are part of the process. You see this all the time. "Bill discovered an approach that didn't work. Bill, explain your discovery to the rest of the class. Class, let's figure out why Bill's way of thinking didn't work. Bill, any ideas?"

You see that routinely in the Japanese classrooms. Why? Ask the Japanese educator. He says, "You Americans think there is something wrong with Bill, and the first thing you want to do is separate him from the other kids, get the other kids who are getting it wrong, put them all together, and reteach them. That's a mistake," he said. "That's not the first thing you should do; that's the last thing you should do. Bill's way of thinking"—this is the way the Japanese think about it—"Bill's way of thinking might be any one of my students' way of thinking tomorrow or next week or next year. I want all my students to understand why that way of thinking doesn't work. My students who got it right, many of them got it right because they made lucky assumptions, not because they understood the mathematics. We will learn more about the mathematics learning why Bill's way doesn't work."

Then he summed it up by saying, "The problem with the way you approach differences among students in the U.S."—because they study us all the time. Make no mistake that all our good ideas show up over there, and they implement them. We quit on our own best ideas. But he said, "You start with the differences; we start with the common humanity. You make the differences worse; we make the differences better." And they do it using basic common sense. It's just the starting point of what the goal is is different.

So these three things are all important: Answer getting, that we spend way too much. Number two is making sense of the problem situation; we have done a better job of that. It's number three that we neglect, making sense of the math you can learn from working on the problem. I just want to get to some examples, and then I will stop. But by the way, this answer getting is a habit. The kids are going to say, "Just show me how to do it." They are going to say what my daughter says: "Daddy, I don't have time to understand it. I just want to get it right on the test." About a month later, she and her friends told me, "We know how to get a B on a math test without learning anything." American teacher: how can I teach my kids to get the right answer? Japanese: how can I use this problem to teach mathematics?

If I think number one is my job, and I look at my class, they are all over the place, I am going to think, "Well, I teach them some math they don't know. Then I'll show them how to use that math to solve a problem they haven't seen before." Some of the kids will learn the math; some will think they learn it but they won't learn it. And even some who learn it won't—this sounds like a classroom management nightmare. I have got a better idea. I will teach them how to get the right answer without learning any math. They can use the math they already know and a trick or two I'll show them, and it'll only take one period.

Example: butterfly method, adding fractions with unlike denominators. You draw the wings. I am going to multiply on the wings. Then you draw the body, plus sign to remind me, multiplication sign, 4 x 1 is 4; 3 x 3 is 9; 9 + 4 = 13, write it in the head. 4 x 3 = 12, write it in the tail. Answer, 13/12, correct. Works every time. What does this have to do with mathematics? This is not mathematics; this is the foundation for future misconceptions. This is going to get garbled with set up proportions and cross-multiply, invert and multiply. They all seem sort of the same; they get all mixed up, and the kids…

When you add this to the curriculum, you are making it shallower and wider. And our teachers are doing this all the time because they think their job is to teach how to get the right answer because that's what we tell them their job is. And when we emphasize the pace—pacing plans, we all have them—what does that sound like? To me, that sounds like mile wide, inch deep again.