LYNN FUCHS: Good morning everybody. Is the mic working back there? Okay. It's great to be in Pennsylvania. You guys do a great job here, very impressive. As far as I know way ahead of the other states in terms of your RTI practices. You guys know a tremendous amount of breaking developments in reading and math, it's very impressive of all of you professionals and the people in this state like PaTTAN that play a big role in delivering information to your guys. I'm glad to be here, always glad to come.

We are going to talk about math word problem solving this morning and we are going to kinda think about, I think about the presentation as addressing three topics that are related to each other, math problem solving, RTI and also instructional alignment, and what I mean by that is instructional alignment across the tiers of the RTI system.

First I'll give you a little bit of background information about our approach to math problem solving and in our work.

Yeah, am I in your way? See I'm right in the middle of the screen, I apologize. What did I do with my clicker? Can somebody remind me to take this to right around 11? Okay, I got it.

We think of math problem solving or word problems as a form of transfer, okay, which requires students to apply the problem solution rules that they've learned to novel problem. Whenever you are solving a math word problem it is a problem you haven't seen before and that's what I mean by a novel problem. Math problem solving can be difficult to promote, even for older individuals and even for pretty competent learners. That's why we have this Gary Larson picture, which is a picture of Hell’s Library and if you check out the titles in the library you seen that it's not only children who struggle in math who have difficulty with math word problems.

What we are trying to do in our work is provide exclusive instruction at second and third grades with the hope of decreasing long term difficulty in math problem solving. Our approach to teaching children about math word problems is based on what we call schema theory. It provides our conceptual framework, and students who are strong problem solves do not see each and every new novel problem as sort of a random new problem but rather they see, either deliberately or not, they understand a problem as fitting into a framework or a problem type, which they saw before. They have an approach to solving this new problem. A schema is a problem type for which a child or student has a solution strategy, and when children have relatively broad schemas then they more readily recognize that novel problems belong to a problem type for which they have a solution strategy, okay? When individuals recognize a problem as familiar, even though it's novel right, recognize it as familiar and think of it as a problem type that reduces the load on their working memory and it makes the problem easier to solve.

Novel problems differ from taught problems, so in school as teachers we teach word problems, but novel problems differ from the one that have been taught in school because of their transfer features, okay? Transfer features alter problems without changing the methods that are necessary for solving the problems, and I'll explain what I mean.

The most basic transfer feature is what people call the "cover story." If we think of a problem type when we talk to children we call it the buying bags problem type, it's a step up function. Let's say that we have taught in school the problem "Greg needs 16 balloons for his birthday, balloons come in bags of 10. How many bags does Greg need?" Okay, so you see why it's a step up function. You are going to have to go to the next step up even though you don't need all those balloons, right? What we typically do in school is we give children and we teach with problems and we provide them problems to solve independently that have new cover stories. We might say "okay, now you try this problem on your own. "Harriet serves ice pops to the 15 girls in her club. Ice pops are sold in bags of 3. How many bags does Harriet need?" Okay. It's a different cover story, new numbers, new story line, but it's the same problem type. It's easy for us to see that and it's easy for kids to see that.

However, limiting instruction to problems with novel cover stories, which is primarily what happens in school, does little to broaden children's schema's for that step up function problem type. What we can do instead is vary novel problems in our instruction with more challenging transfer features. We can vary the look of the problem, the key vocabulary that's used, the nature of the question that's asked. We can make a problem novel by introducing irrelevant information. We can also combine problem types, okay, which you see on standardized achievement tests, so it's not just a buying bags problem it's a buying bags problem that also requires the child somewhere in their problem to solve for half of a quantity, okay.

We can also combine transfer features. Let me show you what I mean. Same taught problem, "Greg needs balloons (16), they come in bags of 10, how many does he need?" Okay. Now here is a problem with a different look. The sign at the supermarket says "Come and get it, four frozen pizzas in a bag for one low price. Okay. You see the sign and decide to serve pizza for your next dinner party. You figure you'll need 10 pizzas, how many bags should you buy?" Okay. Then it's a multiple choice response. Now this may seem obvious to us that is a buying bags problem, but I assure from our research that when children see that problem many of them don't classify as a buying bags problem. It looks very unfamiliar to them. Okay?

Maybe even more challenging, here we have a problem that has a different word in it than is traditionally seen in a buying bags problem for the problems that the teacher uses in her instruction. Here we don't have the word bags in the problem, okay. "Frances is buying eggs for her dinner party, she needs 26 eggs for the dishes that she's making, eggs are sold in dozens, how many dozens of eggs does Frances need to buy?" A lot of children won't recognize that as belonging to the same problem type as the buying bags problems.

And even harder yet, here is a problem with a different question. It doesn't ask how many bags, how many dozens, how many cartons does the main character in the story need? Instead we have a different question, which is now requiring a two step or a combined problem type. "Jose has $25 to spend on ice hockey pucks, he needs 7 pucks, pucks are sold in bags of 3, and each bag costs $8. After buying the pucks, how much money will Jose have?" Very few children will read that problem and recognize this as a buying bags problem.

What we are trying to do in our instructional framework is to use schema theory to explicitly teach children to classify word problems into problem types and we're teaching children to think about transfer features beyond the cover story so when they see a novel problem then their work in their life outside of school on that high stakes achievement test they look at a problem and they think about the problem types that they know how to solve and try to find a problem type within that novel problem. Okay?

Any questions about that?

We have two very closely related lines of work using the schema theory approach to word problems and we refer to them when we are working in schools as Hot Math or Pirate Math. We have different versions programs, some are whole class programs, some are small group tutoring programs, some are one-to-one tutoring programs; but I will be in some way over the next couple of hours referring to both Hot Math and Pirate Math. At first I'm going to talk about Pirate Math.

I want to talk about tutoring. We do have Pirate Math, as I said in whole class format, but I'm going to talk about one-to-one tutoring with Pirate Math to help you understand how the instruction goes. In this Pirate Math one-to-one tutoring program there are 48 sessions to this program, 3 per week for 16 weeks. Each lesson lasts about 30 minutes. The lessons are scripted. We do not ever intend for any teacher or tutor to read a script because that is pretty deadly. I like to say it's like an actor getting on the screen and reading a script. Even different from acting we don't want teachers to be memorizing scripts we just want the script there to help teachers understand how the flow and language of instruction goes. It's a way of communicating how the lesson is designed to happen. Okay. It's not read, it's not memorized, it's just there as a resource.

There are four units in Pirate Math. The first teaches foundational skills for solving word problems and then the next three units each address one problem type and these problem types are very prominent in the primary grade. I'm going to refer to these problem types as total word problems, difference word problems and change word problems. Some people use different labels for these same three problem types.

In the introductory unit this is where we are teaching children in as efficient a manner as we can, some foundational skills that they're going to need to work in this program productively.

I'm sorry I'm in your way.

We are covering in this foundational unit, which by the way is three weeks, three sessions a week, so it's nine sessions. We're teaching them efficient counting strategies for driving answers to Math Facts. Okay, I'll tell you what those look like. We are reviewing, very quickly, two digit addition and subtraction with and without regrouping. We are teaching them in a very efficient quick manner how to solve X in addition and subtraction equations because we are going, in this program we use simple algebraic equations to represent the structure of the word problem; and we teach them how to check their work when they are doing math word problems. I'll tell you a little bit about each of these things.

For counting up in addition this is called the min strategy, probably many of you use it occasionally because even competent adults use a mix of direct retrieval from memory to answer Math Facts, as well as you know accounting strategies. Let's say we have the problem 2 + 5, alright. What we teach the children to do is to put the bigger number in your head, 5, 6, 7, okay so we have counted up two additional fingers and that gives us our answer of 7, okay. We teach children to do this and we also give them practice so that can count up very quickly. What we're trying to do here is, there is research, other peoples research that shows the more frequently you pair a problem stem like 2 + 5 with the correct answer the greater the likelihood that you will commit that Math Fact to long term memory. We are making them proficient in counting to the correct answer and for children, and there are some children like this, who will be very slow if ever committing these Math Facts to memory they have a very efficient fast strategy for deriving the answer.

By the way, what a lot of children who are bad at math will do is they will start with the first number even if it's the smaller, which takes a lot more time to count up 5 than to count up 2, or many children, young children, first, second grade who have math disability will count up the entire set of numbers, 1, 2, 3, 4, 5, 6, 7. Those are counting strategies but they are inefficient counting strategies.

The second counting strategy for subtraction and we again are teaching them the counting up strategy. To do that we have to introduce a few new vocabulary words. We talk about the minus number. We teach them that the minus number is the number that comes directly after the 2, okay. We don't like to talk about the smaller number in subtraction because when you get to two digit vertical subtraction you might have the number 52 - 17 and there you have two -7's and one column and the smaller is not what's being subtracted, okay.

We teach them to look for the minus number. That can be in a horizontal problem, it can be in a vertical problem as well. The number that's closest to the minus number is the number that you put in your head and say. Okay, so you are starting with a minus number and you're counting to the other number or the number that you started with. You go 2, 3, 4, 5 until you count to the number you start with, 2, 3, 4, 5 and your answer is 3. Again, this is called the missing addend counting strategy, it's just a rote efficient strategy and kids can get very fast at doing this and it helps them in their word problem solving.

Any questions about that?

AUDIENCE MEMBER: When you teach this to students I am seeing where they limit that strategy to only certain addends. Like with a plus 2 or a plus 3. And so if you were to get a number like 6 + 7 then you would not recommend kids using that strategy for those.

LYNN FUCHS: Well, because you could alternatively for a problem like 6 + 7 you could try to encourage them to do a decomposition strategy, which would be I know 6 + 6 so let's do 6 + 6 + 1. The problem is that kids who are not good in math first of all have a very hard time with decomposition strategies because it takes a certain amount of analytical thinking to say okay that's 6 + 7 is like 6 + 6 + 1; and it also takes an awareness of which kind of strategy to use for which problem.

We have decided in our work working with low performing kids that when we are teaching counting strategies we are telling them they will do two things. They either know it, meaning they pull that number out of their head, or they count up.

Now, we have a first grade program, it's not either of these problems. It really deals with basic "numerosity" and arithmetic. In that program we have 25 minutes of conceptual instruction and 5 minutes of drilling practice using the counting strategy. There we talk about things about decomposition, we don't call it that, but we talk about how a fact like, well a number problem like 6 + 7 can be thought of in many different ways, and so it is not as if I don't think those kinds of conceptual instructional strategies are important, I do; but I think when you're dealing with kids who have pretty substantial deficits in math right off the bat sometimes it makes sense to help them catch up and this is a very efficient and effective strategy for helping kids grab those math facts quickly. Kids get very fast at this.

Other questions or comments?

AUDIENCE MEMBER: Have you ever tried just using sign?

LYNN FUCHS: Sign?

AUDIENCE MEMBER: In other words, sign language for counting down, so you start with the number 10 and you have -7 you have 1, 2, 3, 4, 5, 6, 7 and you're counting 7.

LYNN FUCHS: We've tried that, and we actually in our first grade program, which is focused on number concepts, we use number lines law and so we go up and down; but we find that the at risk kids in our first grade studies that counting down puts a very hard press on working memory. It's like, it's much less rote than counting up; but for you and me it might be pretty rote to count down but for kids who are not you know fluent with numbers it's not as easy for them to remember what comes before 8 is 7 and we find in our work that that creates an obstacle and there's error when the count down, so they might skip a number counting down. The more times you pair an incorrect answer with the problem stem the worse the probability is that you're going to ever commit that accurately to long term memory. We try to encourage correct pairings.

Okay. I'm not going to talk about what we do for procedural calculation because it's not all that interesting. We just kind of reach it in a very procedural way.

We teach how to find X and we have been working with Hot Math and Pirate Math for probably close to 10 years now. We tried this different ways and we finally decided that we're not going to teach it conceptionally, how to find X; but we are going to give them a set of rules that the kids can learn quickly. If X is at the end of the problem just do what the problem tells you to do. If X is not at the end and it's an X minus problem then you add the two numbers you have and if it's not an X minus problem then you subtract the numbers. I would never teach this in algebra but we teach it in second and third grade as a quick easy way for kids to find X, okay?

We think we are teaching algebraic reasoning, by the way, in the way that we teach word problems; but by algebraic reasoning I don't mean simply solving for X in a problem, okay. I'll explain more what I mean by algebraic reasoning as we go along.

Then the final part of this foundational unit is teaching children how to check their work when they're doing math problems, and we cover these topics. First, you must make sure that your answer makes sense, okay, and we have instructional activities about that. Second, you must make sure that your numbers are lined up. You know one of the challenges in word problems, which does not exist in calculations, is that you have to grab numbers out of a problem and you have to line them up correctly, and some of our kids have difficulty doing that; and when you don't line your numbers up correctly you don't come up with the right answer. You have to then check to make sure that you added or subtracted correctly. You have to make sure that you have a label for your answer and you have to make sure that the signs in your problems are correct, the addition, subtraction, equal signs, things like that, money signs.

That's a foundational unit, and after we're done with the foundational unit we are now first really moving into word problems. When we're talking about checking your work we have very simple word problems that are used for those instruction lessons. We're not really teaching word problem solving or based on schema therapy until we move into unit two. Units two, three and four are schema broadening word problem instructional lessons. Each lesson has four components once we're done with that foundational unit, okay?

The first part of the lesson is a flash card warm up with math facts. We have taught those two counting strategies and the children have some understanding in how to use them. The first activity we quickly review with the child. They tell us how you count up for addition and subtraction and we do a very brief drilling practice, and I'll show you how that works. Then we go onto the second part of the lesson, which is conceptual strategic lessons about schema broadening instruction. That's the heart and the biggest part of every lesson. We spend approximately 20 minutes on number two. Then the third activity is a relatively brief sorting activity where kids look at word problems, listen to them (they are read to them) and they have to sort them into the problem types. Then the last component is a pretty brief paper/pencil review where children are actually working for the first time in the lesson independently to answer math problems.

The math flash card warm up there is deck of 200 flash cards. The sums go from 0 to 18 or the subtrahend the top number in the subtraction goes from 0 to 18. This is sort of a full deck of basic facts. The tutor shows the flash card to the student and the student knows, has been taught that he either pulls the answer out of his head (knows it) or he counts up. Now, if the student answers correctly it goes in the correct pile, but if the student answers it incorrectly immediately the tutor says count up. There is sort of a penalty for getting it wrong in terms of the total number you're going to end up getting in this 2 minute flash card practice. The tutor says count it up. You can't go on to the next problem until you get the right answer. When you finally get the right answer that goes in the correct pile.

The student graphs his score on a graph and has another 2 minutes to beat his score. It is sort of like repeated reading it's like repeated math facts. Okay, let's try this once, shuffle the deck, let's try it again and see if you can beat your score.

Any questions or comments about that?

AUDIENCE MEMBER: 29:23_______ the score your providing the graff? They they're coloring it in. I am looking at your example and I don't see how they know so that Blue 1, 2, 3, 4, 5 ______?

LYNN FUCHS: Right, right.

That's right there is a label for the access with the numbers on it, it just didn't make into the slide. I'm sorry about that.

AUDIENCE MEMBER: Oh I see the ________.

LYNN FUCHS: Sometimes, you know they're mysterious to me why things show up. When you are drawing and have a graph with a slope that slope line never makes it in the right place.

AUDIENCE MEMBER: It's there. _________.

Did you have a question back there?

AUDIENCE MEMBER: When you repeat it the second time will you graph that as well_____?

LYNN FUCHS: We just show where you made it to this time. Right, right.

Now we are in the heart. We've had that little warm up, you know, on the math flash cards and now we are into the heart of the lesson. Students are taught to use what we call the Run strategy, you run through the word problem. If you have a word problem, the first thing you do is take a run through it, okay; which means that you read the problem, you underline the question, and you name the problem type.

As the student reads the problem he also circles relevant information that he wants to hold on to and he crosses out irrelevant information. Okay, right there on the problem. Like I said, at second grade depending on if we're doing this remedially at third grade we are addressing three problem types. The first is what we call change problems where we have a starting quantity that either increases or decreases to make a new ending amount. We have a starting amount, something happens, the quantity goes up or down, it gets changed, that's why it is a change problem and now there's a new ending one.

We have total problems where we have two parts that are combined to make a total, and we teach difference problems, which are the hardest by the way of the three where you have two amounts that are compared to find the difference between the two quantities.

Children are taught the words change, total and difference problems, but not all at once. The first problem type we teach is total, which is relatively easy. We teach difference problems next, which is definitely the hardest of these three problem types and then we teach change problems, which are the easiest of the problem types last. As we move from to total to difference, we're repeatedly contrasting the gist of the story line in total vs. difference problems and we are mixing them in the Pirate Math program so that children as they are getting introduced to difference problems have many opportunities as they are learning difference problems to contrast difference problems to what total problems do and same for change.

AUDIENCE MEMBER: 33:03.

LYNN FUCHS: They do. That's a good question. Generally, we in this program and in a lot of our work we begin with first of all problems that have no missing information. It is not technically a problem it's a story, it's a change story, no missing information, and we are just role playing with what's happening in that story. We're talking about, we're providing visual representations to help the children translate the narrative to a picture that captures the essence of what's going on in a change problem. After we sort of teach conceptually the underlying structure of what goes on in a change problem then we introduce problems that first have missing information. When we do that the teacher begins by using what we call a worked problem. Here is a problem that I've already solved and the explanation is "here is how I solved it" step by step and gradually the child takes responsibility for doing part of the problem until the child has all the parts of the solution strategy, so that's how the instruction goes.

Any other questions?

Here is the solution strategy. It may seem confusing to you but hopefully in a few minutes it won't. What children do is they've run through the problem, they've read it, they've underlined the question and they've named the problem, the problem type. For that problem type they have what we call a Meta Equation. They are writing down the Meta Equation for that problem type. Let's think about change problems for a minute. Starting amount, it increases or decreases, to change, to make a new amount. There is an example of a problem. Regardless of what the specific problem is this is the Meta Equation, starting amount ST, plus or minus the change amount equals the ending amount, that's what I mean by the Meta Equation. Any change problem can be represented by that Meta Equation.

After the child identifies this is a change problem, writes down the Meta Equation, then he has to take that problem and actually derive the information that creates the algebraic problem that matches that specific change problem. The child has to try to figure out what's missing in this problem. Now sometimes, and this is what makes word problems hard, if it's always the ending amount that's missing that's pretty easy. What makes a word problem hard is that sometimes in a change problem it's the ending amount that's missing but sometimes it's the starting amount and sometimes it's the changing amount. The child has to figure out what is missing in the Meta Equation in that problem and he has to write X in that slot of the equation. Then the child has to figure out well what numbers are given. Sometimes there's irrelevant information in the problem. The child has to figure out what numbers are given, which is the starting amount, which is the change amount or the ending amount; and then write the math signs, which would be either a plus or a minus sign for a change problem and an equal sign and then has to solve for X. See that's why we want them to like just be able to solve X like that and that's why we give those simple of rules for doing that because we're trying to teach them about conceptually what these word problems are, how to use algebraic thinking to represent word problems. We don't care so much about them you know balancing the size of an equation because that introduces a level of challenge that is beyond what we have found, even kids who are strong in math are ready for it second or third grade. We just give them a simple strategy for finding X and then they have to make sure that the answer has a number and a label and then they check their work.

We also, in this conceptual lesson, after the child becomes strong in solving the basic change problem we then teach transfer features like irrelevant information, finding relevant information in graphics, which is a very big part, by the way, of most standardized achievement tests. Usually when you have graphics you have both relevant and irrelevant information in that graphic. We teach children to handle that and then we also teach even in second grade combining problem types. Sometimes you have a difference in a total problem, and I'll get to show you one in a few minutes, all in the same problem. When you read the problem you have to be aware that sometimes those extra numbers in that problem are irrelevant information but sometimes those extra numbers in the problem are important information because there are more than three relevant numbers because this actually had two problem types that are combined in the same narrative.

We teach them explicitly to be aware of transfer. Okay, we know change problems but sometimes change problems look different than we expect them to look, and we have to be on the outlook for that. We teach them the transfer features in connection with that units problem type and we're encouraging students to think broadly about the problem type so they won't be thrown off when they see a novel problem it's harder or has unexpected features in it.

Everybody, why don't you take a minute and try to solve that problem on your paper. You did already, oh thank you. Sorry. Okay, first we had to identify that as a change problem then we wrote down our Meta Equation. We had to identify what information was missing in this problem. Well, it's the ending amount. We put our X at the end in that slot of the equation. Then we had to give the numbers that were given to us that are relevant and know where to put them, which is the starting amount, which is the changing amount then we could solve for X and label our answers.

Any questions about that?

AUDIENCE MEMBER: 41:34

LYNN FUCHS: We do, then they do. We require them to do that; but what's nice to see, and we hardly ever see this generally. How often do you like teach a child to do a set of explicit careful steps in solving a problem and you seem them do it at times outside the instructional session or if you are tutoring them you see them go back to their classroom and when they are solving word problems they actually do that or during Pirate Math and we're doing whole class lessons kids know they have to use the Pirate Math strategies but then how often do they use that Pirate Math strategy when they have a problem in the context of the science lesson.

We actually see children using these strategies at other times. Now, we explicitly tell them they should. Okay, we're teaching you this, when you this on a test back in your classroom, when you see this during math instruction in your classroom use it, that's what we want you to do. Come show us your paper, bring it back to us and let us see where you used it, things like that.

AUDIENCE MEMBER: 42:51

LYNN FUCHS: We have used this program with children with math learning disabilities. The research that we've done has been limited to children who are high performing, average performing, low performing, at risk so they're sort of between maybe the 15th and the 25th percentile in math and then children who are very low in math. Many of these kids who are in our MD studies have IEPs.

It sounds hard, but you have to realize that the instruction builds and it's very explicit and it's very supportive to the kid to understand how to do this.

AUDIENCE MEMBER: 43:46 Is there a video on the website?

LYNN FUCHS: We don't have a video, but that's a good idea.

AUDIENCE MEMBER: 43:50 ___ parent and child that has ___. If they're not doing this in school, which I don't believe they are doing it explicitly the way that you do it. Could the parent find these______.

LYNN FUCHS: It kind of depends on your relationship with your child. Sometimes that can go very nicely sometimes and it's not the parent's fault, the child's fault, sometimes it just doesn't work out that well. You might want to have another tutor outside of school using with the child. I'll tell you, we have not used the program or evaluated it with a parent, you know in a parent study; but in our studies most of the people doing the tutoring are not certified teachers. The instruction is laid out in a way that makes it doable for non-certified teachers.

Thank you, I took my pill. Somebody else reminded me or I never would have.

Okay, now. Okay, here's a harder problem, so give that a try. We had you decide it was a change problem. We have our Meta Equation. The tricky thing about this problem is that X is not the ending amount, right; but the nice thing about this approach to word problems is that the child can, even though many children and some adults, would get confused when they see that problem, it's a little confusing. Our kids don't get confused because they see that as a change problem and they come to be aware that in a change problem X can be in the first, second or third position. So they are on guard, so to speak.

They've identified X as the missing information then they have to figure out which is the change amount, which is the ending amount, whether the initial amount is changing, increasing or decreasing, and then they can solve for X and label their answer.

AUDIENCE MEMBER: I’m struggling with how to phrase these questions. One of the practicies I’ve seen during the problem in schools is teaching them signal words.

LYNN FUCHS: Okay. We do not teach signal words. We try to vary our vocabulary. When I was looking at my slides I didn't like the way in these particular problems I had "now" so often, but when you think about difference problems, I'm going to shift for a moment because that is a very important point. Key words generally don't work consistently well. We actually address that head on and we say "when you see the word more that does not mean to add. When you seen the word less it does not mean to subtract." In difference problems you know "John has 7 cats (I'm going to screw this up), Jose has 4 dogs, how many more animals does Jose have than John?" The word more is in there; but you don't add to find that answer. We talk about that. We don't talk about relational phrases but we call it the difference part of the problem, and we actually have kids practice reversing quantities with more or less in between them; and what I mean by that is, you know, John has 5 more cats than Jose is the same as Jose has 5 fewer cats than John. We try to get them to be flexible with those words to really deeply understand relational words like more, less, bigger, smaller, older, younger, things like that because in difference problems, which are as I said are these three problem types difference problems are much more difficult than the other two and part of the reason for that is because of these vocabulary words that kids who struggle with math problems, struggle with language, generally that is one of the cognitive underpinnings of difficulty with word problems, and they need explicit instruction in the vocabulary of word problem solving. We do that explicitly and we explicitly teach them not to use key words. We vary our language so that they are not successful by just relying on key words.

Any other questions at this point?

Okay, try that one. What's different about this problem? It's a change problem but what's different? What are the transfer features that have been added to this problem?

AUDIENCE MEMBER: Irrelevant information.

LYNN FUCHS: Irrelevant information and you have to find relevant information in a graphic. Okay. That's a big thing in a standardized unit tests. So take a minute and try to solve that problem. Our kids, after they'd read the problem, they would cross out the irrelevant information. They also, by the way, are taught to go to that graph and the first thing that they do is they label Milo with a number so that they can just decrease the amount of work they have to do. They immediately go to that. They label Milo, Trish, David and Alisha each with a number and then they go back to the problem and run through the problem.

Questions? Kids actually think of irrelevant information as irrelevant information. They're taught that phrase. They're taught to watch out for it.

The first unit that we teach is actually total problems, two parts that are combined to make a total. Here you have a total problem and there's the Meta Equation that goes with a total problem. Then we do difference problems, okay, comparing two amounts to find the difference between them. There you have an example. The Meta Equation is bigger number minus the smaller number equals the difference.

The third part of every lesson, and as I said by the time they get to this probably a good 20 minutes of the lesson is now done. They are now doing sorting. It is a very brief activity. They have 2 minutes. The tutor reads the cards to the student and the student takes the card and has a sorting mat and places that card on the sorting mat that shows what type of word problem it is and at the end of the 2 minutes they count up the number correct. The tutor uses a correction procedure for up to 3 errors. There is the sorting mat. There's an example of some sorting cards. They're shuffled in the deck, but what I wanted to show you here is that we have problems in sets of three. The story is about Maria, Jackie and flowers. That's kind of like the theme of the cover story. You can have Maria, Jackie and flowers but a problem might be the underlying structure of that problem might be a change, total or difference problem. Take a minute and read those three problems. It's not easy. Think about whether the problem is a change, total or difference problem. So just first spend a minute on that one. That's a total problem, but one of the parts is missing.

AUDIENCE MEMBER: 55:20 Why are you calling it a solution problem when _________.

LYNN FUCHS: This is a sorting activity. When the tutor reads that problem to the child and the child has to decide whether to place it on the sorting mat as a total, difference or change problems, or I don't know.

AUDIENCE MEMBER: 55:38

LYNN FUCHS: Right they're sorting the word problems into problem types without having to solve them.

AUDIENCE MEMBER: 55:43

LYNN FUCHS: Oh, I'm so sorry. I'm sorry.

AUDIENCE MEMBER: 55:50 it makes it confusing.

LYNN FUCHS: Okay. I apologize for that. I'll change that next time. Thank you for pointing that out.

Why do we have these sort of highly confusing sets of problems in the deck? Well, because first of all we don't want to have a new deck of cards every time the tutor does the activity. Because if the theme of the story is associated with the problem type then the kids would just learn. When I see Maria, Jackie and flowers I know that it's a difference problem. When they get to Marie, Jackie and the flowers they have to really think hard about what's going on in that story to decide which problem type it is. They can't rely on a very superficial cover story to associate it with a particular problem type.

AUDIENCE MEMBER: 56:54

LYNN FUCHS: It is a total problem. You can, but the story is not about the difference between two quantities. You could think of it as a difference problem but really only in the sense that you're subtracting to find the answer.

AUDIENCE MEMBER: 57:16

LYNN FUCHS: You could decide to do a program differently and you know sort of teach children that subtraction is about the difference between any two numbers. If you did that I don't think that it would be that useful to children. There what you're teaching children is just look at a problem and decide whether to subtract or add. That's very different from what we're doing in this program. That said, there are sometimes, change and total problems sometimes can be difficult to distinguish, and if a child wants to call a change problem a total and we won't argue with them, that's fine with us. Actually, difference problems are pretty distinctive because they explicitly contrast two quantities.

Here, this is a difference problem. Marie picked 8 more flowers than Jack. That's the relational part of a difference problem, than sentence. That's the hard part for a child to handle. What we teach them to do is actually say "okay, who has the . . ." First of all, think about without the 8. Maria picked more flowers than Jack. That's the first thing we teach them. Forget about the number for a minute. Maria picked more flowers than Jack. She M is greater than Jackie, and that's how they then know which is the bigger number and which is the smaller number.

AUDIENCE MEMBER: 59:08 I guess looking at the first one again though, like I can see that even __________________.

LYNN FUCHS: Yes. Total and change problems often are interchangeable, not always. That's what I said but that is not a difference problem.

AUDIENCE MEMBER: 59:24 Assuming ___________

LYNN FUCHS: Yes. That's exactly right. We always have the sorting mat looking like that and we have all the problems in the deck. Children are read a problem and they, when they are on the total problem which is the first kind of problem taught, they either say it's a total problem or I don't know. As they go through the program difference is taught next. Now they can either do total, difference or question mark and when they get to all three problem types then they are using for the first time the full mat.

AUDIENCE MEMBER: 1:00 She said that the teacher reads the problem to the student. They never_______.

LYNN FUCHS: They do, right. They do, Because some of these kids can read better than other kids and to the extent that they can that does help them.

AUDIENCE MEMBER: Okay.

LYNN FUCHS: Yeah.

AUDIENCE MEMBER: 1:00:30

LYNN FUCHS: Yeah, the child will decide which place to put it on the sorting mat, is that what you mean?

AUDIENCE MEMBER: No that is not what I mean. 1:00:42

LYNN FUCHS: They're shuffled. This is a little confusing. Those three problems are not together in the deck. I am just showing them to you in that way to emphasize that they are in the deck. A kid can't learn to associate the cover story characters with a particular problem type.

AUDIENCE MEMBER: 1:01:15

LYNN FUCHS: No, it's a change problem. Because there is a starting amount that changes and now there is a new ending amount.

In a difference problem, see you can't, I think a lot of us have come to think well if I subtract it's a difference between two quantities, but we are teaching kids a difference problem has to do with comparing two quantities explicitly and a difference problem has to have something like that, it's not always exactly like that. In a meaning sense it has to have something like that somewhere in the problem.

Okay, there is also a paper . . . Yeah?

AUDIENCE MEMBER: 1:02:10____ in relation to like an equation itself. _____ right? Do you know what I am saying like if it is a difference then X _____________.

LYNN FUCHS: Write the X. Well, the X can be anywhere, it can be the bigger number, the smaller number or the difference.

AUDIENCE MEMBER: So there is certain places.

LYNN FUCHS: Right, but that equation once you know it's a difference problem then you know it is B minus S equals D. Is that what you mean?

AUDIENCE MEMBER: Yes.

LYNN FUCHS: Right, and then your next task is where's the missing information in that problem. It's a different way of thinking about word problems. The problem with teaching word problems is that it's very hard to think of an instructional strategy that isn't just "read that problem and think about it." Think about what's, you know, happening and do you add or subtract to find the answer. This is different and so it's novel, and it's hard to talk about without actually through the problem and using it, going through the program and using it because it's actually giving kids an explicit structure to help them solve word problems. It's not, we haven't been taught this growing up. Even though there is a body of work going back to the 1970's that talks about how in the primary grades word problems all fit pretty much within these categories.

What we have done is use that framework of problem types and developed an instructional program that gives kids an explicit set of strategies for solving word problems. I mean a lot of kids with very easy work problems and they are good at language, they're decent with math they can solve them like that. They don't have to think too much about the story line; but most kids that we work with what they do is they grab two numbers and they just add them together.

We find that this approach to word problem solving helps everybody in the achievement spectrum except maybe the very highest achieving kids who don't need something like this.

The last part of the activity, this only takes approximately 2 minutes, I can't remember how much it is, they do 10 math facts on paper, 4 double digit calculations and 1 word problem. Okay. You have a fixed amount of time. The calculation problems are on the front side of the paper, the word problem is on the back side. After 30 seconds or if it's 1 minute, I think it's 1 minute, the tutor flips over the page and then they have the second minute to do the word problem.

Now, during tutoring, this is not true in the whole class program, students have motivation. Pirate Math has motivation program built into it. Students earn coins, this is in Pirate Math. The earn coins for listening well, working hard, following directions, and producing correct work. At the end of every lesson they trade in their gold coins for putting steps on the map. For every gold coin they get to color in a foot on the map. When they get to the treasure map then the tutor takes out the treasure chest that has small trinkets and the child can trade in the map for a trinket.

We have actually done some studies with and without this component in the tutoring and we find that we get better outcomes when we have this in here, which is not to say that every child needs it; but, all in all, kids who are low in math or have math learning disabilities need a little motivation to self-regulate and work hard on things that are hard and sometimes unpleasant for them.

Questions or comments about that?

I am going to tell you briefly about one in a series of randomized control trials that we did. We have done them at second and third grade using Pirate Math. You can see the people who are involved in their search program. It's at Vanderbilt and the University of Houston. I'm going to tell you about one study in the series in which we screening about 1,000 children, this is at third grade, it's remedial. These are children who are very low in math. We screening about 1,000 children in 63 classrooms in 18 schools, about the half the kids were in Houston and about half the kids were in Nashville, that's where Vanderbilt it.

About 10%, the lowest 10% of these 1,000 children met our inclusion criteria, which meant that they were low both on math calculations, math word problems, but they were not low on IQ; and we had a pretty liberal cutoff on IQ. We gave the two sub tests WASI, which has vocabulary sub tests and matrix reasoning. They couldn't score below 80 on both sub tests, they could score below 80 on one or the other. The average IQ of these kids is low average; but we're not talking about kids with mental retardation in this study.

The students were randomly assigned to either be in a control group, which meant business as usual, whatever the school was giving them, or to participate in Pirate Math or to participate in tutoring that was exclusively focused on math facts. What we were trying to do in this study was evaluate the efficacy of Pirate Math and gauge that against sort of maturation with typical instruction but also gave it against another tutoring program, so we were controlling for the one-to-one interaction, the amount of extra math instruction that the children were getting. Both tutoring programs, we developed both of them, were delivered individually. They are both in 48 sessions that I told you about. They are both 20 to 30 minutes per lesson, both programs were scripted. They both used the same motivational system that I told you about, and we audio taped every session. We went back and sampled the tapes to evaluate whether fidelity to the tutoring program was high, which it was.

By the way, as an aside, if you're in schools and you're using uncertified tutors and you're supervising tutors we find that audio taping is an effective training mechanism, because we can listen to tapes, which we do right off the bat, and provide feedback to tutors about what they're doing well, what they're not doing well, and it's a pretty inexpensive way to make sure that there's quality in the secondary or tier II prevention program that you're using.

Math Facts, like I said, was exclusively on math facts. We taught them the counting strategies but the got in addition to that conceptual instruction like we taught decomposition strategies and other kinds of conceptual information about math facts and they had a lot of practice on Math Facts.

In Pirate Math, as you now know, the primary focus is on word problems, but we also have to remember, and when we look at the results of the study that did address some foundational skills. We taught them counting strategies for math facts and they had that math flash card activity every session. They had procedural calculations, we had a lesson reviewing procedural calculations, but remember they did procedural calculations within the context of the word problems they solved plus they had that last activity practice with procedural calculations and they had some focus on algebra.

On the math facts, we pre- and post tested kids and we looked to see how much they grew over the course of the 16 weeks of the tutoring program. Pirate Math and the math facts tutoring program grew comparably; but they grew more than the controlled group. Now, on math facts what would you have expected the outcome to be?

AUDIENCE MEMBER: 1:12:59

LYNN FUCHS: We expected that to happen. We were actually pretty interested in the fact that we could get the same, we estimated that kids were spending across the program an average of about maybe 5 minutes on math facts and we could get the same outcome for that as we could get for the 20 to 30 minute per session lessons. We actually have become very big fans of the counting strategies and learning to use those fluently. Did you have a question?

AUDIENCE MEMBER: 1:13:36

LYNN FUCHS: We had a variety of tests, and if you're interested in the article or these series of articles I can give those to you, they're published, but for math facts we had an addition and subtraction, I think it was 1 or 2 minutes for addition and 1 or 2 minutes for subtraction and there are 20 problems on the test. They answered as many as they could in a minute.

For word problems, for procedural calculations we used our own measures that were addition and subtraction 5 minutes and 5 minutes, a mix with and without regrouping. For word problems we had a variety of measures including the key math and the Iowa Test of Basic Skills Problem Solving. For algebra we used out own experimental tasks as well.

AUDIENCE MEMBER: 1:14:34

LYNN FUCHS: No, we don't. We don't. I mean, if somebody were interested in using our tasks they could. On some of the word problems you could use key math if you wanted to. You could use the measures that we used if you wanted to but the program is not disseminated to include a pre- and a post test.

AUDIENCE MEMBER: 1:15:04

LYNN FUCHS: Well, if you were interested in progress monitoring then, this afternoon we will talk a little bit about this. I think that there is progress monitoring tools that you can use to assess a student's development to see if they are responding to that particular program. If I were a teacher using this program I don't think I'd want to wait to the end of the 48 weeks to know whether or not they responded to it. I would want something across the implementation to help me evaluate whether they were responding.

AUDIENCE MEMBER: 1:15:44

LYNN FUCHS: No, we did not. What do you have in mind?

AUDIENCE MEMBER: I was just curious, I mean, if you heard of anything like connecting math concepts _____ or one of the other types of stratigists to _____ problem solving.

LYNN FUCHS: There aren't a lot of explicit strategies for teaching word problems. There's sort of a body of work on what people call cognitive strategies, which are more like Metacognitive, like they have these acronyms. You first read the problem, some of them are very long.

AUDIENCE MEMBER: I was thinking of __________ 1:16:32

LYNN FUCHS: Yeah. No, we haven't done that. That would be a good study.

Procedural calculations interestingly Pirate Math beat the Math Facts, which was the same as the control group, which I think was kind of interesting because a lot of people think that math facts is a critical deficit for children with math disability, and they do have, it's very hard for kids with math disability to commit math facts to memory. That has been well documented, and people wonder whether that problem is a bottle neck for being able to be good in math generally and I think there's increasing evidence that that may not be true. This is only one source of evidence that it might not be true here. If that were true, we would expect that because this group who improved in Math Facts was stronger on the control group on math facts then we would also expect them to be better on procedure calculation where they are using those Math Facts with in the context of the procedural calculation. That is just sort of an interesting aside.

On word problems, as we would expect, Pirate Math beats both Math Facts and no tutoring and as we would expect on our measures algebra Pirate Math again beats Math Facts and no tutoring. I mean algebra is kind of interesting because everybody talks about algebra these days, about how it is a gateway to higher math, how it's a stumbling block for some many kids. A lot of schools now, a lot of states, require you pass an algebra course to graduate.

I want to explain for a minute what we mean by algebraic cognition. Take a minute and read that problem and I just you as you read it know that it is a problem, this is a problem on our post test by the way that combines two problem types. Take a minute and read it, and that's actually a child's work. Try to decipher what the kid is writing, what his little notations mean.

Tommy has 4 red checkers and 3 black checkers. Jacob has 9. How many more checkers does Jacob have than Tommy? That is a very hard problem. We have taught the children in our program to think of this as a total problem and a difference problem. First we have to figure out how much does Tommy have, and that is part 1 and part 2, and that's what the child has done here. He's labeled those and he's then added those into a total. That's his total. Then the difference problem. He has to find a bigger number and a smaller number that are being compared in that problem and he's actually labeled them. There's where he does his difference problem and he labels his answer.

AUDIENCE MEMBER: 1:21:09

LYNN FUCHS: Like, how, what kind of problem?

AUDIENCE MEMBER:

LYNN FUCHS: No, but that would be kind of interesting whether it would be helpful if we called it the "bigger" number and the "minus" number. The problem is that conceptually within a difference problem there is a bigger and a smaller number. I think it would be probably disorienting to children conceptually to think about the numbers as the bigger number and the minus number. Because we are teaching these story lines conceptually. Now, to all of our children do that? No, but enough of them do that we feel pretty good that they can do a very challenging problem like that and we score the kids work, and when I talk about algebra, we score the kids work in terms of are they setting up problems to represent, are they setting up algebraic equations to represent the underlying structure of the problem? Here the answer would be yes that that child did that.

Now, there is an incorrect representation, so take a minute and read that. What kind of problem is it? What's the gist of what's happening in that story? Change, okay. What's missing in this change problem? The change amount is missing in that story and what the child did here was totally wrong. They just grabbed the two numbers that he figured out were relevant, it's about soldiers, so he grabbed the number near soldiers and the soldiers and he added them, and that is a child in our study, too. He was not getting it.

Why do we have this study in both Houston and Nashville? Well, we had developed this tutoring program in Nashville but we wanted to understand how transportable the tutoring program was. We got the same effects. The site did not moderate the efficacy or the program. It was comparably effective in Nashville and Houston.

We think that for a reasonable amount of tutoring time, Pirate Math enhances a lot of different things, word problem skills, fluency with math facts, procedural calculation, and algebraic reasoning and that can be accomplished the way we do training on Pirate Math. We do 1-day training. We do have ongoing supervision on non-certified staff, so we have somebody who's in charge of those tutors. The tutor study scripts before delivering the lessons and we have periodic meeting with our tutors where if we are beginning to introduce the first word problem unit we have a training session where the site coordinator reviews what's going to happen in the next 3 weeks of the program.

Okay, questions before we move on? I said we are going to get to alignment between the tiers of a multi-tier prevention system with respect to word problems and we're going to move there next, but what questions do you have?

AUDIENCE MEMBER: 1:25:53

LYNN FUCHS: They don't. What they do have to have is, they have to know their number names and they have to be able to associate a name with a number, and they have to have some number sense. I mean if they have no sense of numerosity, like which number is bigger than which other, and we have children like that, then they have to sort to go back to our first grade program and deal with basic numerosity issues. Most children, even kids with math learning disabilities, by the time they get to the second grade and third grade they've got that basic sense of numerosity and all I mean is numbers from 0 to 20, which are the larger ones, where are their number names, things like that, but if they do not have that then I think that they need a different kind of program before we even start worrying about word problems.

AUDIENCE MEMBER: 1:27:03

LYNN FUCHS: Right. Right. Right. Yeah, I think that it's very hard to work on Math Facts without having a basic very low level that is required but sort of your basis understanding about the sequence of numbers, being able to count, you have to count to count up you have to count. Recognizing the numeral associating the number a number name, you have to have those skills to be able to do that. We have a 4-year study running right now looking at our first grade tutoring program. What we are trying to do is contrast 25 minutes of conceptual with 5 minutes of games that are also conceptual and 25 minutes of conceptual with 5 minutes of drill and practice that includes more simply counting strategies than these. They're actually confusing to me because I know these better, but the first graders learn these more simple counting strategies better and more easily. We find an added value for the 5 minutes of drill and practice over the games.

For the children who don't get, you make very little progress on improving their math concepts than they are basically non-responders still, and we have a very hard time. It's a small percentage of kids but we have problems with those kids.

AUDIENCE MEMBER: 1:29:21

LYNN FUCHS: Yes, Yes. We sell those manuals. We have not given . . .

AUDIENCE MEMBER: 1:29:29

LYNN FUCHS: It's scripted and has all the material. I think it costs $40.00, but you would have to ask the person at Vanderbilt who's in charge of . . .

AUDIENCE MEMBER: Is there a website?

LYNN FUCHS: I think on the last slide you have the woman's name, Flora Murray, and her email address.

AUDIENCE MEMBER: 1:29:50.

LYNN FUCHS: It's not at the end?

AUDIENCE MEMBER: _______

LYNN FUCHS: Flora Murray (sp) is just Flora.Murray@Vanderbilt.ed.

AUDIENCE MEMBER: For the tutors, who __________1:30:22

LYNN FUCHS: Well, we have not used, when we do whole class Pirate Math in second grade the first part of the lesson is teacher directed and after the teacher directed lesson they do partner work, and we pair a higher and a lower performing student together, and then the last part, well the first part there is partner work, which is the middle part of the lesson and then there is independent work so the kids are accountable for their own learning, but we do rely on partner work; but not exclusively. We have never, I think this is what your question is, we've never used these manuals having kids tutor other kids because the tutoring manuals are not set up in a way where that would work and also because the higher performing kids who would be the tutors haven't been taught this approach to word problems. It wouldn't work so well.

Any other questions? Okay. I'm just going to set this up. I know that people in Pennsylvania know a lot about RTI, but basically what I'm talking about here in the vocabulary that I'm going to use 'cos I'm sure when people come in from out of state and talk to you about RTI everybody using words in different ways.

I'll talk to you about, in this work that I'm going to describe . . , we are talking about using Hot Math, which is our third grade whole classroom program. It works on harder problems than difference, change and total. I'll talk to you about what those are; but basically we are looking at primary prevention or tier 1 where whole class instruction using Hot Math is going on, and we're also looking at kids who are designated as at risk in the screening process that you would use are also getting a second level of prevention, which is small group tutoring. In Pirate Math I was giving you an example of one-to-one tutoring. We have whole class, we have small group tutoring. Here I'm going to be talking about the combination of whole class and small group tutoring, and we're thinking about the study in terms of two levels of a multi-level prevention system.

Any questions about that?

We were interested in examining the math problem solving learning and exploring the prevalence of math disability as a function of whether children got whole class validated instruction, which is Hot Math in this study, tutoring, whether they got both whole class and tutoring or whether they just had business as usual, whatever the school was providing.

This work in this study is a little different from what I was telling you before because those kids in Pirate Math are the bottom 10%. Many of those kids have IAPs and those kids are very low performing in math. Here we're talking about something different. We're talking about beginning with a regular classroom of children screening at the beginning of the year to identify kids who are at risk of poor outcomes on word problems and evaluating how important having validated instruction or whole class or just tutoring or both to their learning, and these are kids who are more like at risk than kids with real math learning disabilities.

I think I'm going to go back to the slide for a minute. I think that everybody believes that if a kid is getting small group tutoring in a prevention system he needs to be also in the whole class program, that's what everybody says. We were trying to evaluate if that was in fact the case, whether there was an added value for the kid remaining, you know he's at risk, is it enough to provide small group tutoring or is it important for him to be participating in both levels of the prevention system.

We had four problem types that we work on in Hot Math and you can see what those problem types are. There is a shopping list problem type. I'll let you take a minute and read it. You can just go through it. Basically, we're using schema broadening instruction in this study very much like what I described before, but here we have classrooms within schools are randomly assigned to either get business as usual what they're teachers are normally doing or Hot math.

In all of the classrooms, by the way, we did 3 weeks of this general problem solving word problem kind of intervention in both control and Hot Math classes, but then the core was we had 13 weeks of business as usual or 13 weeks of Hot Math.

From both kinds of classroom, okay, from both controlled classrooms and Hot Math classrooms we identified kids who are at risk. We screening and identified kids who are at risk for poor math problem solving outcomes and we randomly assigned them either to receive tutoring, Hot Math tutoring or not. That way you see a child, all children in the classroom if they were not at risk, either got their teacher's instruction or the Hot Math instruction; but if you were at risk you might get Hot Math tutoring with your teacher's conventional instruction. You might get your teacher's conventional instruction with no tutoring. Here you might Hot Math classroom instruction either with no tutoring or with tutoring. I have explained a lot of this as we went through Pirate Math.

I'm not going to go through all the details of this 'cos I think you're probably not interested in them and it's getting close to lunchtime, but this is a very large study. We have 120 classrooms, all in third grade. One teacher dropped out the study very early in the study. We have a sample of about 1300 kids whom we use to evaluate our research questions. That gives you an idea of the sample generally. We had at risk and not at risk kids in the study. That gives you an idea of what they're average scores were, what their demographics were.

We identified of the like 1320 kids in the study, we identified 288 as at risk for poor outcomes and we assigned at risk students like I said regardless of what their classroom treatment was to receive tutoring or not. That just gives you some of the numbers of the kids that we ended up after kids moved over the course of the study.

Any questions about what's going on in the study? I see some head nodding and I see some confused looks. Anybody want to ask questions?

Teachers were comparable in the control and the Hot Math group in terms of their demographics and the number of minutes of math instruction they provided, not at risk students, Hot Math vs. control, work comparable and demographics and their reading math and their cognitive performance, and the same with at risk students in the various groups that could be in.

Okay. We had three kinds of measures, which I think might be interesting to you of word problem solving. The first kind of measure was what called was a media transfer. They were very much like the problems that we taught, kind of the basic shopping list, buying bags, half and pictograph problems that you read, but they were new cover stories. They were sort of in their basic kind of format.

We also had a near transfer measure where we introduced things like novel looks, novel questions, the kinds of transfer features I talked about right at the beginning of the presentation and none of those transfer features have actually been taught during any of the lessons, so they were all novel. And then we had a far transfer measure, which is very different from the immediate and near transfer because it was really pretty far away from what taught in Hot Math but it was more like a real life application. All of the skills and transfer features that we taught in Hot Math were included in the far transfer measure but in a very unfamiliar kind of task. This was the first page of the test where it provides sort of this little story about what's going on. I'll give you a minute to take a look at the story, the narrative. It is obvious that this is a shopping list problem. Somewhere in here is embedded a buying bags problem. There is also a half problem and a pictograph. It is sort of taking a real life kind of problem solving task and imbedding into it much of what we taught plus other things that are taken from the third grade curriculum. This was our far transfer task. How much money do you have for school clothes? That's a very basic, it's a total problem. We did not teach that in this Hot Math problem, but you know, you've got two pots of money and it's going to make a total for you. That's a very long cumbersome question to answer. You have take information from a lot of different places and operate on that and do the shopping list kind of problem.

Question three is kind of interesting. I'll give you a minute to read it. Now what the children have to do in that problem is actually invent information that is reasonable. They have to buy other things. Well what is it that you'd like to buy and what's a reasonable price for the other things that you plan to buy on the shopping trip that you get to control. In this part of the problem, by the way, we were embedding a task that we didn't teach but is part of the third grade curriculum. We had a kid who answered this part of the problem by saying that he was going to use his credit card.

Then finally the fourth question. We also gave the Woodcock-Johnson applied problems test, which actually if you're familiar with it does not have a lot of word problems on it, it's got some, but its got things like counting, telling time, reading thermometers and some word problems as well.

Here are our findings. A cross of not at risk and at risk children. If you were in Hot Math classrooms then you learned more than if you were not in Hot Math classrooms and the affect size was about a standard deviation. You performed about a standard deviation better than the control group, which was a large affect size. If you were an at risk student, comparing just if you were in tutoring vs. if you were not in tutoring, again a big affect for tutoring, and the affect size was about a standard deviation.

Then there is the issue that we were talking about of alignment. What if you just got secondary prevention tutoring? What if you got, I'm sorry, just secondary vs. tier 1 and tier 2 together. So what's the value added of having primary prevention if you're also getting tutoring. Well, it turns out there is a pretty good benefit. If you got both secondary tier 1 and tier 2, whole class, Hot Math and tutoring Hot Math you grew better by more than a standard deviation than if you just got tutoring, which I think is interesting. I mean it suggests that having two tiers operating together, especially when they're aligned with each other, because Hot Math tier 1 and the Hot Math tier 2 were very much aligned. They were not only conceptually the same form of approach to problem solving but they were also sort of on the same page. They worked. The lessons were timed so that they were occurring at the same time. We think that two levels of prevent are better than one; but in terms of moving kids out of the math disability category, if we look at the Woodcock-Johnson applied problems if you were below the 16th percentile we called you MD. If you were above it we called you not MD. If you had just controlled classroom instruction and no tutoring and you were an at risk child, of the at risk children about 28% of those children at the end of the study fell in the MD group. If you just got the whole class instruction you were at risk. It was about the same. If you just got tutoring without Hot Math and the whole classroom it was cut in about half. If you got both it didn't move very much.

In terms of moving children around that sort of cut point release that we used of the 16th percentile, it looked like most of the benefit was coming from secondary prevention even though on average at risk children scored reliably higher if they got both tiers of the prevention system.

We do think that there's a need for validated instruction, both at tier 1 and tier 2. At risk students who get both levels of those two levels of the prevention system do better than if they get one or the other, and in this study we have to remember that the classroom and the tutoring programs were very much aligned. We looked at this question in a reading RTI study where we found that very little added value for kids who are at risk and were considerably behind their peers. Very little added value for them being in the tier 1 program that whatever benefit they got from the multilevel prevention system was coming from secondary prevention. In that study there was no deliberate kind of alignment between what was going on in the tier 1 and the tier 2 program and sometimes that's wrong and other times if the classroom is moving on to reading material that the at risk kids, which is not appropriate for at risk children who are getting or maybe on different forms of reading instruction when they're in tutoring. Sometimes it's hard to coordinate the alignment between tier 1 and tier 2. These are things I think that schools need to be thinking about and worrying about.

Questions?

AUDIENCE MEMBER: 1:52:04

LYNN FUCHS: Well, the question is whether this could work for people with dyscalculia, which refers specifically to arithmetic, Math Fact kind of deficits. I would say yes, and with a child like that you might want to have them using a calculator because I think it's a shame to have kids who, you know, just really struggle with Math Facts not be able to move on and grow with their peers in the curriculum. That said, you know, I think it's important also with kids who have those kinds of problems to try to be smart about how we're intervening to give them some facility with Math Facts.

The second part of the question was can this be used with somebody with reading disability, and the answer there is yes. We read all of our problems to everybody, to the at risk or not, they have them available there, but we're trying to just not conflate reading with math problems, math difficulty. We are always reading problems to kids and we find in our studies, and we actually did this in Empire Math, but I didn't talk about this, in Empire Math Research Program we identified kids with just math disability and kids with math and reading disability and we looked to see whether the program was more effective for one than other and it was not. Kids grew comparably in the program whether they had math disability alone or math disability with reading disability.

Do you have a question?

AUDIENCE MEMBER: 1:53:59

LYNN FUCHS: You know a calculator can be used for so many different things. I guess if you were my child, and I'm not answering as a researcher, but I think if you were my child I would want him to be able to move on in the curriculum. After I felt that I had tried hard using a variety of intervention approaches I would introduce, it wouldn't be third grade vs. fifth grade it would be after I've tried hard to intervene and I would introduce it after that.

Other questions? This is a long session. You guys have been a great audience. And I know we're like encroaching on when people normally eat lunch.