PAUL RICCOMINI: Thank you. Anyone from Northwest Pennsylvania? Yeah? Where? Oh, okay. Well, it's good – it's really good to be back in Pennsylvania and especially have the opportunity to talk about math. Of course, this is not the – this is the last session, right, of the second day, so, and we're talking about math. I mean, it doesn't get any better than that, right? I guess it could be the last session on the last day, but I'm very excited to be here, especially having the opportunity to talk about math at the RtII conference here, and, of course, everything now is being framed in that RtII model, but just keep in mind what I'm going to talk about, whether you are fully into RtII in math or just starting to tinker with it, this is what needs to take place regardless of what you're doing. In terms of – how many went to Dr. Gersten's session this morning? Okay. Several. So, I'm going to sort of take and more take a couple parts of what he said and do it in more of an instructionally relevant in your classroom kind of thing, and I'm going to model problem solving, a problem solving progression, and then I'm going to talk about a couple of strategies that will help.

Sort of, you know, my background is I went to Edinboro University on my like sisal set and I did most of my teaching in the Erie City School District prior to going and working a year in Raleigh, North Carolina. And I was dual certified. I was special ed certified and secondary math certified. So, I was a special ed teacher with self-contained kids and then I was a general ed high school math teacher with kids with disabilities as well. And sort of as I've seen it, I've tried to support kids in the general ed classroom and then I had kids in my classroom. So, I've sort of seen it from both sides.

And one of the things that is really happening now that I really did not have to sort of address is everybody now is being expected to learn upper level math. And it's something that's growing across the nation and it's presenting a lot of challenges, especially for kids with learning disabilities, which pretty much max out at the fifth grade level in math. Okay. So, you have your hands full. I'm not here under any sort of understanding that what I tell you will fix immediately all of the challenges that you have, but the way sort of I approach this whole aspect is there are things that teachers can do to facilitate learning. And there are a lot of things that we do that are actually counterproductive to learning and it's not that we're doing it on purpose or anything, it's just we're not tuned in to our kids that struggle.

Now, where are my elementary teachers? Raise your hand elementary teachers. Alright. Where are my math teacher – or middle school teachers? High school? Okay. One of the things at the high school level that you have to keep in mind, and even at the middle school, is why are you math teachers? Why did you become math teachers at the high school level instead of English teachers or biology teachers? You can do math. Some of us probably like it, right? Well, guess what? You wouldn't like it if you couldn't do it. And you have high school kids that quite literally have been failing math for 6, 7, 8 years. So, we have to keep that in mind.

Now, elementary teachers, what I have to say for you is although you associate yourself first and foremost as reading teachers, you also have to consider yourself math teachers. And that's something that is very, very important. What we're seeing is what you're doing in elementary school is having a major impact or can have a major positive impact later on, and it's something that if kids get behind in elementary, they're going to get farther behind, farther behind, and farther behind, and then when they get into upper middle school and high school, it becomes very, very challenging to sort of work with those particular kids.

So, we're going to – this is sort of the outline, the overview of what we're going to do. I'm going to briefly talk about the Math Panel report. Now, how many of you have – elementary teachers specifically, or in general. How many of you have read the math panel report or have a copy of it? Okay. That's a problem. Okay. For the elementary teachers, how many of you are familiar with the National Reading Panel report? Of course. Five big ideas in reading. Phonemic awareness, alphabetic principle, fluency and accuracy, vocabulary, and comprehension; right? Well, this Math Panel report is the sister of that Reading Panel report. So, I'm giving you a homework assignment. Alright? Get the report, and you have to read the odd and the even pages. I know we're math teachers, but it's the odd and the even, not just one or the other.

I'm going to talk about a couple things because there's some very important information out of that report that revolves around instruction and learning that we have to take account, into account, when we teach. And then I'm just going to pull out one of the recommendations of the RtII math guide to frame then the strategies that I'm going to talk about. And this is really about – this session is more about strategies and things to do in math than it is sort of a framework for RtII. But I'm going to talk about scaffolding, and I'm going to specifically talk about problem solving. It's something that, in my opinion, we're not really teaching problem solving; we're teaching kids to solve problems.

Then I'm going to talk about facilitating thinking aloud. This is critical and often a missed opportunity in math. If I were to go into your elementary reading classes and spend a week there, by the end of that week, I probably can guarantee that I heard every single child do what? Read aloud. That gives you – when you hear a child read, that gives you, the teacher, a whole lot of instructionally relevant information. And in math we are missing some opportunities there to hear the kids think mathematically.

And then I'm going to talk about space learning over time and this interleave strategy as ways to help foster retention, and it's really important in math that as kids learn something, they continue to what? Remember it and generalize or transfer. That's a biggie. They've got to transfer computation conceptual kinds of things to application problem solving. If they don't do that transfer, you are not becoming proficient.

So, these are sort of the things that I'm going to talk about. Feel free to ask questions. It's a large group. Just so you know, if someone asks a question, I'll repeat it back so everyone can hear it in the group.

But, just real quick, the panel – the Math Panel report, you can Google it and download it and look at it. I'm just pulling out really two pieces. The report looked at over 16,000 studies and they tried to identify the highest quality studies in terms of looking at how kids learn math.

The number one biggest problem or weakness in the United States is in the area of fractions. And my – just real quick. I'm not getting into fractions in this workshop, but for those of you that are in elementary, one very important thing you can do is spend time with fractions on a number line. If you think about how we teach whole numbers, it's all about what? A number line. And then when we transfer to fractions, we sort of forget about the number line and what are we spending our time with, with fractions? Circles, parts, wholes. And kids really have a lot of problems with fractions, and a fraction is nothing more than a number on the number line. And we need to spend a lot of time showing kids fractions are numbers on the number line.

But this slide right here, especially the second bullet, is pivotal. It's the foundation for everything I'm going to talk about. But just real quick, the whole – we've gone through this whole debate, argument of reading wars, math wars now, about well, what is proficiency in mathematics. And the argument as conceptual process, problem solving, computation procedures. And really the bottom line is, at least from my stance, is you're not proficient in math unless you can do each of those strands. You have to conceptually understand what you're doing, but you also have to execute it accurately and fluently, and then, of course, you have to be able to problem solve. And we often tend to focus on one or the other when we really need to do sort of a combination of all of them.

So, if this is sort of what we're – what the panel is recommending, what that means for teachers is we have to instructionally address these areas. And that what we're seeing is, in middle school, math becomes a little bit more, I don't want to say difficult, but it becomes more in depth where kids have to blend together a lot of different skills from vocabulary, language, problem solving, computation, application, and so forth. And when you're having to blend multiple things together, this leads into the second bullet. What we're seeing is kids who struggle in math have issues in their working memory. In other words, how much they can process at once.

Have you ever had a bunch of kids up at your desk asking you things and you finally go "stop." And you go, "what, what, what, what." Because they overloaded you a little bit and it causes you to sort of have a panic attack. Same thing with a computer. If you have a slow CPU, central processing unit, and you try to access heavy, heavy content, what happens? It freezes up. So, this working memory is something I want you to – when you leave here and you're teaching, I want you to take into account working memory.

Now, I'm going to show you how we all have issues in working memory in here. I'm going to do a little activity. Everyone put your pencils and papers down, except for you. What was your first name again? Jim. You're going to write down what I say. You will be my key. I'm going to say a string of numbers. When I'm done I want you to write the numbers in the order that I said them. You got that?

Okay. So, pencils down. Are you ready? Look, you're already doing your test taking skills. Focus. Okay, here we go. Ready? 15, 39, 2. Write them out. Everybody's like throwing their head to the side. Piece of cake. And the numbers were 15, 39, 2. Did everyone get that? If you did not get it, do not volunteer that information. Shake your head like you got it right. Okay?

Pencils down. Alright, here we go. 16, 59, 62, 30, 8. Okay. The numbers were 16, 59, 62, 30, 8. Now, if you wrote 38 that's fine, I'll give it to you. Raise your hand if you got them wrong? Okay, I went from 100 percent to about 20 percent.

Alright. Pencils down. Now, really focus. Okay? It's not going to help, but focus anyway, okay? Alright, here we go. 16, 32, 12, 7, 15, 80, 1. Now, some of you didn't even try. Okay. Some of you just flat didn't even try. Okay. You kind of – sort of brought back my memory when I was self-contained high school. I'm up there explaining a problem and I turn around and the kids are like huh-uh. Because I overloaded your short-term memory. Now, here's the numbers: 16, 32, 12, 7, 15, 80, and 1. Did – raise your hand if you got them Alright. Raise them up. Oh, that's pretty good. The last group there was much less. But I went from 100 percent with three pieces of information, about 40 percent with five pieces of information, and about three percent with seven pieces of information. So, we all have issues with our short-term memory.

Now, how does this relate to math? When you start thinking about some of the math we're teaching, middle school, upper middle school, you're getting into systems of equations.

Just – where are my high school teachers? System of equation, quadratic functions. How many different things are kids having to do at once to solve those problems? Now, don't think of steps in terms of what you're writing, but think about the cognitive conditional knowledge that allows you to do those steps. Take a basic math problem of finding the intersection of two lines. Okay. Basic problem, multiple ways you can do it. There's the least sophisticated way where you could graph it. Now, that's the least sophisticated because if you don't graph it absolutely precise, you'll get an incorrect answer. Then you could set the two equations equal or you could solve simultaneously. Each of those requires the blending of vocabulary. If you've got to find the intersection, well, what's the intersection? What does an intersection mean? That's where there's a point that's on what? Two lines. But you're trying to find a point, but how's a point represented? With an X and a Y. So, you have all of these things that have to be basically blended, what? Together. And you're overloading working memory. So, besides – I talked about fractions and the number line.

The next thing to think about is the principle of chunking. You've heard that term before? Breaking into manageable pieces and it varies how you chunk something. But what we're seeing, or what I'm seeing is math teachers tend to chunk within problems, but they'll explain the whole problem and then they'll go to another problem and they'll re-explain it, but the kids who struggle, they're hearing the first thing and they're still trying to grasp it while the teacher has done what? Moved on to the second. In essence, is kind of giving cognitive interference. Sometimes we need to chunk across problems. But chunking is a principle.

The other thing is this idea of practice. What we're realizing is there are certain things in math that we need to have, and I hate to use this word because it's such a bad word nowadays: memorized. So that it is automatic. And one of the things that is obviously coming to mind is this issue of basic facts. When a child has to do this in the context of a larger problem, they're spending their cognitive load on what? A basic fact. As they get older, same thing with integers. If they're not able to do integers. What we're seeing is certain things use up the kids' working memory. That includes vocabulary, other types of things. So, one of the things that we're recognizing is practice combined with instruction on certain things can help kids transfer skills or concepts.

Now, working memory is an important part. Now, this time - put your pencils down. This time I want you to not answer this question. Okay? Blank out your minds. Now, some of you are going, I got this down pat. I've been blank for two hours. Alright? Now, blank it out. Okay. Do not answer. Ready? 5 times 7. Now, the problem is 90 percent of you in here answered the question. 35; right? Okay, just checking. Even though you're trying not to, you answer. I'll try – here's a hard one. Okay, blank it out. Ready? 4 times 8. You all – I don't want to say all, but pretty much everyone in here answered that question. Now, what does that mean instructionally? Well, that means that you used no working memory or short-term processing capacity. It's free to do what? Apply, problem solve, understand concepts. And it's something we're recognizing.

Very similar with my elementary teachers in here that teach reading. You have kids that struggle in reading. How does a struggling reader read? What? They're at the word level, and in some cases they're at the sound level. So, they're focusing all of their working memory on what? Trying to sound out the words. What are they missing? Because everything's focused on what? The words. When you have kids focused so extensively on computation, it's taking away from the conceptual and the problem solving. So, there are certain things, one of which is basic facts, that we really have to try to get to, to kids to become automatic. Now, what I'm seeing is this automaticity issue has to occur after the concepts and the relationships have been developed. You don't do this in kindergarten. But you've got to get kids to that next level so that then their working memory is freed up.

Now, the other thing is this practice issue. When kids struggle in math, what's one very common technique to help them? Now, don't write it. Say effective, but when kids struggle in math, what do we do often? What? We give them more practice. Alright. Where are my elementary teachers? You have a kid that can't read, here's 10 books. Take it home and read. Is that going to help that child? Not unless there's someone there delivering instruction. So, we have to remember that practice is not instruction. It's an important part of it, but practice will help kids become more proficient and fluent if they already what? Know how to do it. So, keep that in mind. This is not drill and kill. Alright. But there has to be some very strategic practice of certain things so they become more fluent and automatic. One of the things that's coming out is this idea of computation.

Now, the other thing is when kids sort of become automatic with certain things, then they're able to transfer that knowledge to other situations. For my special ed teachers, I'm sure you recognize the child can do it here, and then when it goes into a little different problem, it's like they have what? No clue to what you're talking about. So, this is a very pivotal piece that when you leave here, you want to think about what you're teaching and what is the cognitive load being put on students. I want to talk about how you can sort of help kids through scaffolding with this working memory. But certain things should become automatic.

Now, just so you know – not to scare anyone. I almost fell off of this stage in the previous session. So, if that happens – are there any doctors in the office? In the house?

Now, with the instructional practices, that was the learning. Now, remember, I'm just pulling out some pieces relevant to this session today. There's a lot of information in there that's – that you need to pay attention to, but this idea of instructional practices, you know, there's competing approaches out there. Student center, teacher directed, inquiry, discovery, direct instruction, explicit and so forth. In math there really is a time and a place for both all of the time. Okay. One way is not supported in the research. There needs to be a blend. Now, when you're talking specifically about these three subgroups of kids, and these are the ones that keep us up at night. Alright. Low achievers have difficulties in math, or have learning disabilities, they need these bulleted approaches on a regular basis. In other words, they need to have regular methods of explicit instruction. They need to have clear problem solving models.

One of the things that I spent a lot of time. Remember, I grew up in Edinboro, worked in Erie, but I've spent since 2001 in South Carolina. So I've been doing a lot of work in South Carolina, Georgia schools, and Tennessee. And what I've sort of come to the conclusion of is we're not teaching kids how to solve problems. We're teaching – or, I'm sorry, we're not teaching kids how to be problem solvers, we're teaching kids how to solve problems. Everything is focused on getting an answer. We need to pay attention about the examples and the sequence that we use, or I like the term progression. Think in terms of progression. From here to there.

Concrete objects, I'm not really going to get into this, but this is really getting a lot of attention that we're not doing a good enough job connecting abstract with concrete. Really, after fifth grade everything in math is pretty much at the abstract level, just numbers. And we need to do a better job of transitioning kids through there.

And then this last bullet is really – this is one I'm really going to try to demonstrate today is this thinking aloud. We need to model that for our kids, which I think teachers are doing a really good job of, but we're not giving kids enough opportunities to think aloud in math class. Now, how does this – what, you know, what are the implications for this in terms of RtII, Response to Instruction and Intervention? Well, if these three subgroups of kids need regular access to this, where must it take place? Where must these strategies or approaches take place? In the core math program, which is tier 1. If you reserve all of these things for tier 2, in essence you're not doing anything in tier 1 for those struggling kids. Now, is anyone at a school district that has no kids that struggle in tier 1? No. So, in tier 1 we need to do some of these things regularly.

Now, we're going to transition here into sort of some demonstration of what these things look like. And I've picked an eighth grade problem, problem solving, that we're going to show this scaffolding and how you do explicit, clear problem solving, and then this think aloud.

Now, from the IES Response to Intervention Math Guide, that eight recommendations, one of – the third recommendation here is that intervention should be explicit and systematic, so what we need to do is provide verbalization of the thought process. That is a biggie. With guided practice. So, these are the four areas that I'm going to talk about primarily with problem solving, and then at the end I have two specific recommendations that apply for this cumulative review. One of the things that teachers often tell me is that the kids don't remember what I taught them a month ago, two months ago, or in some cases what I taught yesterday, and this retention issue is causing some problems. So, we're going to sort of get into these particular strategies here.

Now, when you're looking at RtII, you – you know, pulling away all those levels, the three main pieces that you have to look at are your curriculum and interventions. And just a real sort of side note. For my special ed and general ed folks in here. In the past, when a child had to go to an intervention, if I said Johnny's getting an intervention, what did that mean? What? That's right. He was leaving the room to go somewhere and what? Get an intervention. That also meant that Johnny was having problems. Right? Well, intervention now, because of the tiered system, intervention is becoming a broader term where the tier 1 teachers have to start doing some interventions in that tier 1. Now, that doesn't mean you're delivering a program as an intervention, but you're doing scaffolding instruction, extra instruction, those types of things.

Then you have your green circle, which is, you know, your assessment. Formative, summative, end of year assessments, progress monitoring, universal screening, diagnostic assessments. All of those things fit in there. And, we have to remember that that green circle is directly connected to both the lighter blue and the darker blue. That that assessment is supposed to inform curriculum and instruction.

And then we have the blue circle. This is where I primarily focus most of my efforts, and that's the teacher. And what we're realizing in math, and I don't think this should be a surprise to anyone, is the math teacher is the number one variable in terms of kids' math performance. And this is especially true at elementary school. Now, I've not been in any of your schools, I don't know you, but most of the time, elementary teachers prefer to teach reading over math. And it's not really your fault. That's because you've been trained to be a what? Reading teacher. It's all about reading. Reading, reading, reading, reading, reading. And that's true. If kids can't read, they're in a whole lot of hurt. But now we have to be math teachers as well. And, therefore, we have to embrace math just as much.

Now, the middle school and high school, that's where the math teachers tend to be the most content savvy. And I sort of – where are my high school teachers? Raise your hand. Any of you teach calculus? No, but upper level math? We kind of have, and I'm saying we because I was a high school math teacher. We have what I call content arrogance in that we know upper level math. What is anybody going to tell me. Alright. And sometimes high school math teachers are more resistant to strategies than other teachers. Alright.

Now, you're here today so I've got a skewed population. But we have to recognize that elementary teachers have to focus on math. Make it a priority just like reading. Elementary teachers will do any strategy you ask. Middle school and high school teachers, they have to recognize that yes, you're the content experts, but you have to begin to look at how you're teaching.

And where I come about is facilitating of the learning. And we look at this. We're not sure what it is about effective math teachers. Whether it's our content knowledge or their instructional approach. It's a combination of both, in my opinion, because you know what? I'm sure some of you had some very brilliant college professors that were experts in their area, but could not teach their way out of a wet paper bag. Okay. That usually happens at like Pittsburgh, University of Pittsburgh, Temple – I'm kidding. But then, instructional knowledge, you don't have to know calculus to teach it in the elementary school, but you really should be very versed, comfortable, and knowledgeable of three grade levels above, but more importantly, three grade levels below. In math, you're going to have to just – you have to recognize that you're going to have to go back and re-teach some things. It's just, you have to do that or you end up with kids with major gaps in their learning and then at some point it becomes an issue where they can't even sort of access it. But, blue is where I'm going to focus most of what we're going to talk about from this point forward.

Now, of course, in this tiered sort of model that everyone is applying, whether it's a three or a four tier model, what I'm talking about needs to be – needs to occur more frequently in tiers 1 and absolutely in tier 2. And why it's so important for tier 1 to begin to incorporate some of these, the area of RtII is to deliver effective instruction to capture the kids that are struggling before it becomes a what? A major issue. And if you don't do that in tier 1, tier 2 will become overwhelmed. In other words, too many kids are getting bumped into that tier 2. So, we're going to focus on more and better, sort of in these tiers, 1 and 2.

Now, I'm here, we have an hour – what do we have? Like an hour and a half? What do we go til, six? Six? No, five? An hour? Four o'clock? 4:30? Okay. 3:45? Alright. I round up. Okay. I'm a college professor. I have to round up. My students. If one more student comes to me and says, "I have a 68 or a 75 percent in your class. What do I need to get on your last test to get a B?" Okay. And I'd say to them, "You know that I used to teach math, right? Now, go back and figure it out." These 10 principles are really the foundation, what should be the founding principle within tier 1. Obviously, in our limited time, I'm only going to hit on this scaffolding and then sort of connecting it to this instructional explicit piece.

But when we look at scaffolding, instructional scaffolding, I actually prefer this term over differentiation. The idea of scaffolding instructionally is – it's really anything you do as a teacher that will enhance learning. Now, generally speaking – where are my special ed teachers? Are there any special ed teachers? Raise your hand. We generally do too much scaffolding. We come from it as we will do anything we can to keep the kids' head above water. Then when they leave our circle of power, what happens? And then you end up – then you have this conversation with the general ed teacher. Well, he could do it when I was there. And the idea is we do a little bit too much. The general ed teachers, we generally don't do enough scaffolding or we do one for everybody. Now, there's a lot of reasons. Thirty kids in the classroom, a lot that you have to teach.

So, the idea here is, is this scaffolding piece. This is much more of an art than it is a science. But this is really looking at three things: What you have to teach, the content, because that will, that will change the scaffold, depending on what you're teaching. Then you've got to look at the teaching – the student characteristics. The scaffold will change based on students. And then you got to look at a way or a progression to fade away your scaffolds.

Now, the best analogy to scaffolding that I can come up with is when, in real life, is that when we teach our own kids to ride a bicycle. Now, how many of you had the opportunity to teach your own flesh and blood to ride a bicycle? Raise your hands up high. Keep them up high. Now, some of you don't have your hands up. Those of you that don't have your hands up, look around at everybody with their hands up and just recognize that you're looking at cold-hearted, bold-faced liars. Okay. Now, what? What do I mean by that? Well, once you got your kid on the bicycle, that trusting 3 or 4-year-old that trusted everything you've ever done, looks at you in the eye and says, "Don't let go." And we look at them right back and say, "Oh, honey, I won't." Knowing full well we're going to let go. Okay? And that really is scaffolding in that so once they get on the bicycle, you demonstrate to them that they can't fall; right? Another lie. You shake the bike and they don't fall. Then, as they start riding, you slowly what? You just go, let go. You slowly loosen your grip and then they start to shake a little bit and then the lying starts all over again because when they start doing this, what are they saying? "Don't let go, don't let go." "We won't, we won't." And as – when you think they're ready to let go – when you think they're ready to go, we very carefully do what? We tell – do we tell them we're going to let go? No. We like secretly let go. Some of us continue to run, pretending to hold onto the bicycle. And then eventually we stop and the child rides away just fine until what? And then they crash. That really in essence is scaffolding.

Now, we need to try to do that with our instruction. And it's a lot harder than it – you know, it's a lot harder than just scaffolding. It's very – you really got to pay attention to the content. Your kids' learning – learner characteristics and sort of the progression piece. But that's what we're sort of going to do. Keep in mind it should be temporary. And we're trying to start simple and get to the more complicated or complex things.

Now, there are three types of scaffolding. Now, don't think they're like concrete, this, this, or that. It's either this or that. There's lots of combinations and so forth. What I have seen is teachers are doing a rare – a fairly good job at task and material scaffolding. You do a pretty good job there. Where I think we have the most room to improve is in this content scaffolding, and that's where I'm going to focus on in here.

But task and material. Task is trying to get the kids to do the steps. Material is like cue sheets, posters. Do you all have posters around your room? Math focus posters. If you're in middle school you probably have order of operations, and elementary school you probably have shapes or whatever. In high school you have the trig functions, or whatever. Why do you put those up there? So you can get checked off on your annual evaluation for having a conducive learning environment? No. Why do you put them up there? What? Reminders. So, how would that, how would that poster function as a reminder? Okay. So you could prompt or cue the kid to look at the poster. That's a scaffold. Okay. You want the kids to refer to it. What generally happened to those posters the day before or maybe the morning of the PSSA test? Gone. Right? In essence, there and it's gone. Now, many kids do internalize it, but there's – and you know how you know the kids who haven't internalized what's on that poster? Because during the PSSA they're, they're looking to where those posters were. Now, I'm not saying don't get rid of those posters, but you have to do some things for them to commit that to memory, because eventually we want it committed to memory. But those are sort of task and material.

But where I want to focus on is this content piece. And the whole premise of content is trying to remove initially things that are distracting within whatever it is you're trying to teach. And I'm going to demonstrate this with a word problem. But you're trying to remove things are distracting so that they can focus in on what's being taught. Now, I'm going to give you 30 seconds for you to discuss at your table what is the most distracting thing about a word problem. Okay. Go ahead. Thirty seconds. Go. Okay. Thirty seconds. Well, really 20, but.

What – who would like to share something they discussed? Go ahead. Okay, so if there's a name in there and there happens to be that person in the class, then everyone's laughing at that person, right? The names can be distracting. Okay. Yes, I agree. I don't think that's the most distracting. Yeah, you can't get past it, I agree, but I don't think that's the most distracting. Remember, distracting to working memory. But that is distracting. The what? So, reading. Yeah, sure, I think that could be – if you can't read the word, how are you going to solve the problem. In math that also brings in vocabulary. Because if you can read it, but you don't know what it means. Yes. But I think there's even something even more distracting than that. That's – I mean, irrelevant, irrelevant or extraneous information is distracting, but I think there's even something more distracting than that. When you give kids a word problem, what are they immediately trying to do? Yes. Why are they doing that? They want to get the answer. That's the most distracting thing. They see a word problem. All they want to do is get a what? An answer. And notice, I'm not saying a correct answer. They want to get an answer. And they'll say 36, and you'll look at them funny and they'll go, 34? 32? Well, how do you think you got – multiply? Add? Multiply and add? They're just what? They just want to get something. And that's just distracting. Now, all of what you said is part of the issues with word problem. Names, irrelevant information, reading, vocabulary. All of those, but they're all – if you ask kids what's problem solving, they're going to tell you it's to look at the words and get an answer. So, one of the things with scaffolding is, that's actually taking away from learning problem solving.

I was spending a lot of time in elementary classrooms, fourth grade, in this one particular district everybody did a POD. A Problem of the Day. And it was a word problem. And I would go in and the teacher would usually give the kids a couple minutes to solve the problems and then they would start to go over it. Well, as soon as the teacher opened his or her mouth to begin to explain it, you had kids doing what? Twelve. They were yelling out the answer. They were not wanting to pay attention to the teacher's what? Instruction of how we got it.

So, with content scaffolding, you're going to try to remove the irrelevant information, like you just said. Anything that could be distracting, such as the answer. So, in this problem, Robert planted an oak seedling, it grew 10 inches the first year, every year after it grew an inch and a quarter, how tall was the oak tree after nine years? That's right out of the book. Now, that's actually not too bad because usually that would be like on January 31st, Robert was 5-foot-7 and he planted an oak tree at 3:15 in the afternoon. And these poor kids are going, well, if it's in there, I have got to use the numbers. Okay. It's kind of like when the – your spouse or your – the males in here, we put together the entertainment system and there's extra parts, and we're kind of like, let's just, you know, we just put it somewhere. They feel they have to what? Use it.

So, what I did was I re-wrote the problem with a content scaffolding. I took out Robert. There's your name. I took out the fraction. Now, why would I take out the fraction? For my middle school teachers in here, as soon as kids see a fraction, they immediately don't want to what? "Oh, I can't do that. Get away from me." So, take it out, because they disengage. Then if they've disengaged, it's going to be very difficult to get them to what? Re-engage back into the instruction. And then the last thing I did, and this is key. This is a strategy you could do tomorrow if you were teaching. Everyone's done with school, right? The kids are out here? No? There's still some in school? In South Carolina they've been out of school for like three weeks, but they also start much earlier.

In the bottom problem there, an oak seedling grew 10 inches in the first year. Every year after, it grew one inch. After nine years, the oak tree was 18 inches tall. Now, the answer's in the problem. The kids are not going to be distracted by trying to what? Get an answer. They can now focus on what? The problem solving process. And I don't think the field in math is recognizing how much of a distraction getting the answer is. Think about everything we do. It's literally about getting a what? An answer.

So, what we're going to do here is I'm going to take you through this progression with this word problem, and I'm sort of going to demonstrate some of the think aloud and how you get kids to do this in a very explicit and systematic approach. So, first thing I want you to do is everybody needs to put their pencils down. Now, this is important. That right there is a strategy. Having kids taking notes while you're talking can actually prevent learning. Because they're missing 90 percent of what you're saying. They're so focused on trying to do what? That they're missing the whole explanation. So keep that in mind.

Now, I'm going to sort of model this thing aloud. This is sort of what you want to do. So, now, the answer's in there. There's no issue. So, an oak seedling grew 10 inches in the first year, so in the first year it grew a total of 10 inches. Every year after, it grew one inch. Okay, so in the first year it grew 10 inches, and then every year after that first year it grew just one inch. After nine years, so a total of nine years. The first year it grew 10 inches, that leaves eight years that it had to grow one inch. At the end, the oak tree was 18 inches tall. So, it grew a lot in the first year, and then it leveled out and grew the same each year after, and then at the end it was 18 inches tall. So, how much did it grow in the first year? Ten inches. How much did it grow each year after? One inch. How many total years did it grow? Nine years. And in the end, how tall was it? Okay.

Now, the word grew, if you're growing, that usually means you're getting what? Larger, bigger, taller. So, in math, what generally – now, notice you can't say what? Always. In elementary, addition always gets larger, but not later on. In general, what will give you a bigger number in math? Addition and multiplication. So, we might be adding or we might be multiplying. Now, this problem can be rewritten three different ways. Algebraically, with multiplication, and with just addition. We're going to do just addition right now.

So, let's pick up our number - our pencil, and let's write our number sentence. We're going to do it with addition for right now. So, we're going to write 10 because 10 is how much it grew when? In the first year. So, we're going to add. Now, after that first year it grew one inch each year. So, it grew for nine years. In the first year it was 10 inches. There we have our 10. That leaves us eight years that it grew one inch in each year. So, we have to add one how many times? Eight times. So, let's plus one 8 times. And then that equals 18 inches.

Now, let's make sure we have our number sentence here. We have 10 because that's how much it grew in the first year. Then we have to add one 8 times because it grew for nine years, the first year being 10 inches, so we have to add one 8 times, and that equals 18. Do we all have that?

Now, what I want you to do is to your partner, turn to your elbow partner, and I want you each to take a turn in explaining your number sentence. Explain why we just wrote that. Go ahead. Now, the idea here is, I don't want you focusing too much on the math as much as the progression here. How many times did you get to hear the think aloud of this problem before we even wrote it? There was at least three or four times. Then we wrote it. Then I went back and said, "Is this what we have?" So, you heard it five to six times, the think aloud of this problem, before I gave you an opportunity to what? Actually get to practice the same think aloud.

This is something that we rarely do in math. What generally happens is the math teacher explains a problem like this, does everything I did, explains it just like this, and then what's the next step in that lesson? We give them six more different problems. And they're not getting guided practice or a little repetition in the think aloud. And that's something that we can, you can begin to incorporate is that they're hearing us say it, but we're having them do it before we give them an opportunity to what? Practice or check.

So, in that progression, I was doing it the very explicit, clear modeling, which is what teachers are doing, in my opinion. But what I did differently is I let the kids, or you all, not really kids, but I let you get an opportunity to what? Repeat what I just did. Alright. So this is sort of the idea of content scaffolding.

Now, teachers always complain to me about problem solving and that "Well, they don't know their computation." Did anyone have to compute yet? When the answer's in the problem, the computation is scaffolded out of the picture.

Now, we did that top one with repeated addition. If kids are knowing multiplication, they may do the middle one or more of the algebraic representation would be that third one, and what's the algebraic representation is that nine minus one. The total years minus the initial growth. So, there's another point where you're teaching in elementary school has extensions all the way up through high school. It's just done a little differently at the high school or at the upper grade levels.

Now, here's the next step in this progression. Now it's time for you to do it on your own, but what's different or the same of this word problem I'm now giving you? It's the same story line. So the kids are not being distracted by a new story. A lot of times it's the tree's growing and then it's I bought this on sale and then I went to this movie, a train left Harrisburg heading… It's all these different contextual stories that for some kids can actually what? Detract away. So go ahead and write your number sentence. Now, this time I want you to do it, if you're elementary and your kids only know addition, just do addition. If you teach kids that know multiplication, do multiplication, and if you're at the high school level, do it algebraically.

Now, there are a lot of extensions or things you could do. If you have kids that need more concrete, you could bring out the base 10 blocks and you could concretely represent your one, your two, and your three. You could draw figures, pictures, there's a lot of different extensions you could do here. But the idea is by sort of focusing in on one problem type, so to speak, you're sort of lowering the load placed on the children's working memory and they're more focusing in on the process. Plus, the answer's in the equation already. Therefore, that's not a distraction.

Now, what we're going to do now is something that most teachers, even at the high school level – oh, yes, go ahead.

AUDIENCE MEMBER: ____________

The next, in this progression you will work your – you will bring your kids to the more sophisticated problem. Does that make sense? Now, I'm just sort of doing it slowly, but the last step in this progression is you want to get back to the more sophisticated problem. But when we start with that problem, that's where we have – we're creating challenges because we're starting with problems that kids – that the most sophisticated problem, that for some kids that will just automatically disengage them. So that's sort of the idea here.

The other thing, and I'm not sure if I said this, nothing that – nothing – I almost did it. Nothing that – don't interpret anything I'm saying as this is how it needs to be done all of the time every day. It's really based on your kids and the content. But this is what I did not see a lot of when I was working with teachers in schools.

So, now, what we're going to do now is we're going to rewrite. We're going to bump down to our algebra, and 25 plus 5 times the quantity 4 minus 1 equals 40. We're going to bump – everybody's going to be on that one. What we're going to do now is we're going to rewrite our number sentence with all variables. Okay. Now, what's a variable? It's not a letter. Because in elementary school it's a box or a circle or a blank. What is a variable? It's an unknown quantity. Alright. It's usually represented by what? Letters. Now, we're going to use X, Y, and Z. We're going to rewrite this. As soon as we put a letter into our number expression it has to have a what? It has to mean something. I call it a tag or a definition. So, if we put in X for 25, I want you to tell me what that X represents. Now, here's the catch. In general terms, not specific to this problem. Who wants to give it a go? What does X represent for – what does 25 represent? We're now putting an X in there. Who wants to give it a, give it a go? Go ahead. Okay. What were you going to say? Okay. Those are all too specific to that problem. What if it was, it grew 25 feet in the first three months. Now, what you said wasn't wrong, it was just specific to what? This problem. So, let's rephrase that. What is 25 in general? Okay. I mean, that's fine. Go ahead. What would you say? Starting value. How about – those are all fine, but I think I might say initial growth. Does that make sense? Now, all of what you said isn't wrong, but some were to specific. So X is the initial growth. Is that what 25 represents? Okay.

Now, I'm going to put in Y for five. What does Y mean? What is five? Now think. Not specific to this problem. Go ahead. Additional growth. Did you have something? Consistent growth. Got to be general. Repeated growth. Change in growth. I mean, these are all acceptable. I think that for this one, what's really the math concept is this is the growth after initial growth. Growth rate after initial growth. Now, all those are fine. You could go with any one of those. It's not that you have to do exactly what I say, it's how you make sense of it.

Now, this is a little challenging, isn't it? Did you know that you've already done this? In order to write 25 plus 5 plus 5 plus 5 equals 40, you've already had to do all of this. It's just now we're doing it a little more formal and it's causing us to have to think. So, what is four? What are we at? X, Y, Z. Four. What's four? Go ahead. Duration of growth. Total growing duration. I think that's fine. Any of that would be fine. So X, Y, Z. Now we're, let's see. For the one, let's use M. What does one represent? First initial growth. Close. I think, I think you have to put a parameter in there. Initial growth time? Is that what the one represents? And then we'll call 40 T. What's T? Total growth. Now, in order for you to have written your number sentence, you had to determine what we just did. You had to say, okay, 25, because that's how much it was in the first year. Then how come we did, added five. Well, you knew that there was four total years, but after the first year there was three and it was five in each of those three years and then it equaled 40.

So, in this scaffolding, now, I'm not saying do this with elementary kids with X, Y, and Z, but this is a dialog that needs to take place. We went from a word problem to numbers, back to what? Words. This is really exploring this whole problem solving solution. Now, like she was saying, the next step I'm – eventually you're going to have to introduce word problems that what? Have a question.

So in this progression, here's your word problem that has a question in it to answer. Go ahead and answer it. Same problem, different what? Number. So go ahead and answer that. No, again, the focus is not on getting the answer. What's the answer? Sixteen meters. You got to give me one more word there. Sixteen meters tall. It's the tall that gives it the context. So now I worked into where there's a question. Now, the other thing I just want math teachers to begin to explore a little bit more is we answered the question. We often go on to the next question. That word problem can be asked in multiple ways. In this case it's asking what is the what? Total growth. But you could very easily say an oak seedling grew some in the first year. Every year after, it grew two meters. After seven years the oak tree was 16 meters tall. How much did it grow in the first year? Or you could have done for how many years. I mean, there's lots of different ways to answer. We need to explore these versus just answer, moving on.

Now, in this progression, this is, this is where it really depends on your kids and the content. Eventually you want to get to the more complex problem. Because, you know, this is the problem that they're more than likely going to see where? On that end of your test. Okay. But you eventually want to come back to the more complicated problem.

Now, this is a good time also to think about this. What is a very common activity that math teachers use to start off math class? What? Back practice if you're in elementary. Reviewing homework. How about before that. Is there something that you use called a warmup or a bell ringer? Never heard of that? Yes? No? I'm kind of getting the blank look here. I know it's almost time to go. Well, you have warmups. Very common. Where there is three or four problems on the board, right? And the kids come in and they have to what? Solve the problems. And then that, usually five minutes, and then what happens? You go over them. Where are those problems coming from? What? Yeah, you make them up, but they're problems that you – the kids had already what? They've already theoretically learned. I like how you phrased that. That's good. So, here now – so those are the problems.

Now I want you to think of this. Are there – your kids. I want you to picture your kids now. Are there a group of kids, maybe it's small in some classes, that come in and pretty much every day they're getting 90 percent of those problems correct? They come in, they get them right. Is there a group of kids that it's kind of 50/50? The dimmer switch kids. Sometimes the switch is on, sometimes it's not. Right? You never know. Then, is there a group of kids, the forget about its. They come in and they never get the openers right or 20 percent of the time. Sometimes they're like getting their paper out when you're ready to go over it. Are there some of those? So, if that, if you, if you sort of said yes, you just differentiated your class into three groups. Every day they're getting it, 50/50, forget about it. What do we make all of the kids do? Same problems every day. My question is, why are you making a kid do problems that you're telling me, because you just told me, they never do and can't do it; why are we doing that? Do any of you put different problems on the board? Moderately difficult, what everybody should do, more basic. If we're making every kid do the same thing, that's an area where we have to begin to focus in terms of scaffolding. But if you're saying, "I make all the kids do it because they have to do it," in essence, that would be like me taking someone who can't swim and dropping them in the deep end and say, well, they got to do it. And when we do that, one of two things happens. The kids will either do it and practice it what? Wrong. And that's not good because now they got to unlearn it. Or, two, they will disengage and either sit there or cause a problem. So keep that in mind there. This is where that scaffolding piece needs to come into play, but eventually you get back to the more complicated problem.

Now, that's sort of content scaffolding. That sort of progression. Now, the other types of scaffolding that I just want to quickly touch on is task scaffolding. And this is where you're trying to get the kids to go through the logical steps in solving of a problem. So, and your kids never like to do that, right? They just want to get an answer. So, how can you develop an instructional activity that will kind of force the kids into doing this? This is sort of the steps in problem solving. Reading it for understanding, paraphrasing, visualizing, or drawing a diagram, hypothesizing, estimating, and so forth. So, one of the ways you can do this is try to structure learning sheets that force the kids to go through the steps. It's kind of like when, if any of had one of your own children that wouldn't brush their teeth when they were younger. Did you have any of those kids, they didn't like to brush their teeth? We just have said, well, okay, you don't have to brush your teeth, right? No. We forced them to brush their teeth. But we can't force kids to think problems through logically, but we can help guide them.

So, let's look at this here. Who or what was involved in this, in this action? So, in that word problem with Robert, who was involved? What was the action that was most important? Was it Robert planting? Was it planting, even? No. It really was what? The growth. Alright. Now, math vocabulary, there's technical terms and then there's phrases that mean things mathematically. In that word problem, there was one little catch phrase that if the kids don't pick up on is really going to throw you the loop, and it's, it's that every year after. For some of you that when I put this problem up originally with 18, and you thought to yourself, well, I think he made a mistake. That really should be 19. You didn't catch the "every year after."

Now, who wants to paraphrase what that problem was asking? What was it asking? The growth of the thing? The tree? How tall was the tree, basically? How tall was the tree after the nine years? Can someone say it in less than eight words? Tree growth after nine years. Can someone say it in less than five? Total tree growth. Can someone say it in less than three? Final growth. We've already done it. That's what's so funny. What did we call T? Total growth. Alright. Now, that exercise in paraphrasing now, now what was funny about that was we need to do more of that in math. Elementary teachers, do you spend a lot of time having kids paraphrase stories that they're reading or predicting? We need to do more of this in math. But what was funny about that at 4:15 in the afternoon, I got a bunch of teachers in here actually engaged in trying to paraphrase something in less than five words. Because I turned it into a little bit of a game. Alright. But we need to spend time doing this with kids. Then these other three things we've already done, so I'm not going to get into them, but this paraphrase the question, I don't think we're recognizing kids are having problems figuring out what the question is asking.

I was observing an eighth grade classroom. They were doing a coach's practice book. The problem was, involved a trapezoid. And two angles were given, 30 and 60, and then the other angle was twice as large as the fourth angle. So, I watched these kids go okay, if this is twice as large as this, I'll call this X and I'll call this 2X. And then I watched them while all of those angles in that trapezoid have to add up to 360. So they set it up just like that. So, conceptually they set it up. Then they executed the computation and they got X equals 40, which was done correctly, and that was choice C, so they bubbled it in, and they all missed it. Because the question was, what's the larger angle? They're so focused on getting the what? The answer, that it's taking away from problem solving.

Now, the material scaffolding, these cue sheets, thinking maps, concept maps, graphic organizer, these are things that teachers are doing a good job with already. It's that content scaffolding that teachers can benefit from.

Here's some upper level concept maps for algebra. The only – the idea of this is it helps organize kids' thought process.

Now, I want to get to, there's an activity we're going to do, but since most of you do not have the materials in front of you, take a look at handout 11. It's learning sheets that are scaffolded with 11D being the most scaffolded and then working backwards. I want to spend the last seven minutes here talking about this right here. Everything I've done up to this point, that whole scaffolding sequence, has been explicit. But notice, there was thinking aloud, there was problem solving, there was group work. Explicit instruction does not mean a teacher is standing there and lecturing to the kids. There's a continuum of that process. But I want to just – the two strategies I want to leave you with hit number six. This weekly and monthly reviews. And this whole idea of helping kids to remember.

Now, at the end of a chapter, or a unit, what do you do? You give a test, right? I haven't been in your classes. The day before that test or quiz, what do you do? You review. What are you reviewing? What you just taught that's on the test. What's the purpose of that review? To get the kids to pass the test. Okay.

One of the things that we're going to talk about, this space learning over time, is a review activity to foster retention. What you're doing reviewing for the test is to get them over that test. You can keep doing that, but this is set up to foster retention. Now, in the materials there's a chart that looks like this. It's no magical chart. It's just basically an organizational chart. This is best done in grade level teams. So all the fourth grade teachers complete this chart. Basically, you want to chunk your year into four to six-week intervals. What this research found was, you will get a better bang for your buck if you go back and review things that were taught four to six weeks ago instead of reviewing what you just taught. That that will foster retention. Retention is long-term memory. If kids remember more of what you taught through the course of the year, what is also likely to increase at the end of the year? Their test scores.

So, what you want to do is chunk it. What are the big ideas covered? Second, what are the problematic areas, and then try to prioritize. Look at your, any formative, summative, progress monitoring data, last year's PSSA results, whatever it might be, figure out, prioritize. Then as a grade level team, everybody decides on this fourth Thursday after we taught X, we will revisit it instructionally, not here's five practice problems from what we did a month ago. It's literally, hey, remember when we did this? This is what we did. It's a mini lesson. If you're in a 90-minute block, 30 to 40 minutes. If you're 60 minutes, 10 to 15.

Now, this is one of the more supported ways in the research to foster retention. Now, when I work with schools and they do this, the biggest issue that teachers have is when they get up in front of the class and say, "Remember when we learned this?" What do the kids do? They look like deer in headlights. And then you have one going, "I swear you did not teach us that. That's when you were out that day." And then the teachers get what? Mad. Okay, be honest. We get mad that they don't remember it. And I just have to remind you why did we target that? Because you predicted that the kids what? Wouldn't remember it. So, the idea here is, an instructional review to revisit, reawaken, keep it in the kids' minds. So that's a space learning over time.

Now, the – and I said everything that was on those slides. This other thing, this is another biggie that I think should change a lot of how math teachers do business. But there was this research that was done, and they used this strategy called Interleave Worked Solutions into the student's homework. So, what this research did was half of the kids got a traditional homework. Ten problems to solve. Now, this was done with seventh, eighth, and ninth grade students in algebra. There's not a lot of things you can say with that group and content. So, the traditional homework, they had to do 10 problems. The other group got 10 problems, but every other problem was solved. That's interleave. Alternate. So, the kids in the first group, how many problems did they actually have to practice? Ten. This group only practiced five. And they studied the other solutions. This group outperformed the other group.

So, what this research was showing was, number one, we need to give kids more access to worked out solutions as an instructional tool. Two, by having kids study problems, that alleviates their working memory because they don't have to do it; they're studying it. And that helps foster learning. Now, I think, when I first read this I was like what? How? And I was kind of like perplexed. And then I started thinking back to how I studied for a math test when I was in college. So, I got a calculus test coming up. How do you think I would study? I went back to my notes and what did I look for? Worked out problems.

And what did I do? Studied them and tried to what? After I studied them, then I did what? Tried to solve them. Same principle.

Now, this has implications for that opener. So those kids that can't do it or won't do it or never do it, maybe instead of giving them five problems in that opener, the first problem you give is a worked out solution. So, you teach the kid. Now, you got to show the kids what you want them to do or little Johnny's going to see a problem solved and he's like, "Sweet, I don't have to do it." And then that defeats the purpose. But maybe by having them study a solution first before they actually try to solve it, that might increase their 50/50 to maybe 80/20.

But this is that differentiation piece or this scaffolding that we need to do a little bit better job of in math in that we're so focused on solving problems. We explain something, do six or seven. And that we really have to try to support their learning by some of these particular strategies.

Now, this was not done with kids with learning disabilities. Alright. So, maybe they need more explanation along with the solution. But this was done with sixth, seventh, eighth, and ninth grade students, so it is rather supported in terms of facilitating the learning.

And this has implications for the classroom. A lot of times you're seeing group work where you give the kids a problem and they have to work in a group to do what? Solve the problem. So, instead of giving a problem, a problem for them to solve, work together to solve, give them a problem that's already solved and they work together to what? Discuss the solution. Then give them what? A problem to solve. We have to remember that in essence, when you, when you put a problem in front of a kid to solve, that in essence is an independent practice activity. And we're doing too much of that without these intermediate steps.

So, you know, sort of summarize what I was talking about. We want to try to work smarter, not harder. If we just keep giving kids who struggle more practice problems, they're going to keep what? Struggling. And that what we're starting to realize in math with some convergence, that kids who struggle need some access to explicit instruction. Scaffolding, three types. Content is where I think we can do, we have the most room to improve, in terms of instruction that's being delivered. And then two ways to foster retention is space learning over time or this idea of interleave worked out solutions.

And just a personal example. I used to, you know, you know my background. I have a math degree, I taught high school math. If someone were to put a calculus problem on the board right now, there's three things that I could guarantee. Number one, at some point someone taught me how to do it. Number two, at some point I could do it. But number three, cold right now, having not done it for the last 10 years, I would probably what? Struggle. I would have to what? Revisit it, reawaken it, study it. And that's the whole idea of this space learning over time and this interleave, and that interleave is a form of scaffolding. They're all connected. It's not separate things.

So, I'll leave you sort of with this phrase. If you always do what you've always done, you'll always get what you've always gotten. In essence, that is RtII. If we just keep doing what we're doing, then we're going to keep getting what we're getting. I personally like the definition of insanity, which is doing the same over and over and expecting different results. I could use a football analogy there, but I won't.

So, I'll open it up to questions. If, you know, I know, if you ask a question, you'll be shunned by your peers. But you have my e-mail. I'll be up here after. I believe Cecil has to give you a secret code or something before you're left out. But feel free to e-mail me. My e-mail that you have is pjr146@clemson. In two months that will turn to pjr146@psu.edu. So essentially you have that e-mail. I will, I will do my best to direct you to any resources that I might have. But I enjoyed my afternoon session with you. That wasn't too painful. Now, I wish you the best of luck and I'm going to turn it over to Ceicil.