TRANSCRIPT

Research-Based Strategies for Teaching Math to Young Children

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Hi, this is the webinar on *Teaching Math to Young Children.* [**Slide:** *Session Overview*] First, I am going to give you an overview of the session by providing an introduction to the *What Works Clearinghouse* from the Department of Education practice guides. And then I will talk more specifically about the practice guide on *Teaching Math to Young Children*, and also provide a discussion of strategies for implementing research-based recommendations in the classroom.

[**Slide:** http://www.whatworks.ed.gov] This is the link to http://www.whatworks.ed.gov, so I urge you to get on the site and look at the math practice guide, as well as others that the Clearinghouse has put out.

[**Slide:** *What are Practice Guides?*] What are practice guides? Practice guides provide practical, but research-based, recommendations for teachers, educators, to help them address the everyday challenges they face in their classes. The practice guide always includes concrete how-to steps, ratings of the strength of the evidence for the recommendations, as well as solutions for common roadblocks.

[**Slide:** *Structure of the Practice Guide*] The structure of the practice guide is as follows: There are recommendations, and with the recommendations come the levels of evidence, which I will discuss in a minute, how to carry out the recommendations, as well as potential roadblocks or barriers, and suggestions on how to overcome these issues.

[**Slide:** *Sample Page from IES Practice Guide*] This is a sample page from the IES practice guide for reducing behavior problems in the elementary school classroom. And, again, all of the guides follow this type of format. [**Slide:** *Sample Page from IES Practice Guide: Potential Roadblocks*] And here's another sample page that shows how roadblocks are indicated and suggested approaches.

[**Slide:** *Teaching Math to Young Children: Panelists*] So, now I am going to talk more specifically about the guide on *Teaching Math to Young Children*. The panelists include Doug Frye, Arthur Baroody, Margaret Burchinal, Sharon Carver, myself, and Judy McDowell. Sharon Carver and Judy McDowell are both master teachers who contributed to the guide, and others are experts in different areas of early math development.

[**Slide:** *Evidence Rating*] In terms of the evidence ratings, each recommendation will receive a rating based on the strength of that research evidence. A strong rating would mean that the recommendation is based on work that has high internal and external validity. By internal validity, I mean that results can be explained by the treatment, or some kind of intervention in the study, rather than something that is not controlled, such as the child's attendance or the type of teacher that the student had. External validity means that the findings can be generalized beyond the study population, in that they can be…the study can be generalized to a representative population of interest. A moderate recommendation would be that the evidence is high on internal *or* external validity, but not necessarily both, or the research is in some way out of scope. And then a minimal recommendation would be a lack of moderate or strong evidence, or there may be contradictory findings in the literature, but the panel of experts still feels like the recommendation should be included in the practice guide because there was enough indirect evidence to suggest that a recommendation can be made.

[**Slide:** *Recommendations and Evidence Ratings for the* Teaching Math to Young Children *Guide*] So, this is an overview of the recommendations and evidence ratings for the *Teaching Math to Young Children* guide. The recommendation where we had the most evidence, with a moderate rating, would be *teaching number and operations using developmental progressions*. And this is not surprising, because there has been more research in this area of early math than in some of the others. *Teach geometry, patterns, measurement, and data analysis using developmental progression;* that has a minimal rating because, again, there were not a whole lot of studies in that area, but the ones that were there suggest that this is helpful. *Using progress monitoring to ensure that math instruction builds on what each child knows*. Number four: *Teach children to view and describe their world mathematically*. And number five: *Dedicate a specific time each day to teaching math*, and then, *integrate math instruction throughout the day*.

[**Slide:** *Challenging Issues for the Panel*] The challenging issues for the panel included the lack of evidence supporting a developmental progression. We did see that a lot of the skills that we looked at in the guide are developmental, and they were…did seem to fall along this continuum. But a lot of studies didn't really look at the progression in particular. Also, some of the practices were conducted in isolation; and there were not a lot of practices, as I mentioned, promoting patterns, measurement, and data analysis.

[**Slide:** *Recommendation 1*] So, recommendation 1: *Teaching number and operations using a developmental progression.* According to the panel, it was determined that a developmental progression includes starting with easier, more basic skills and moving on to ones that are developmentally more challenging. So, here is an example where, first, opportunities could be provided for children to practice recognizing the total number of objects in small sets, such as one to three items. And so they see that set, and they are able to immediately label that set with a number word. So if they see three objects, they don't have to count; they just know right away that there are three objects in the set.

Next, once the child learns…can do that, it's important to promote accurate, one-to-one counting as a means of identifying the total number of items in a set. So, now the child can recognize immediately what is in the set, and now the child will learn to count 1, 2, 3, and know that there are three items in the set.

Once children can recognize and count small collections, then provide opportunities for them to use number words and counting to compare quantities. To look at 3 and 4, to think about why 4 is bigger than 3, or 3 is smaller than 4. Encourage children then always to label their collections with number words, add numerals—and by numerals, we mean written symbols for numbers. And then, once children develop these fundamental skills with small numbers, you can encourage them to solve basic addition and subtraction problems with these small numbers; for example, of totals of five or less.

[**Slide:** *Sample Developmental Progression*] So here's more a specific example of the developmental progression for the skill of number knowledge; again, just basic understanding of number. First, we talk about the skill of subitizing, or small number recognition. This comes from the Latin term *subitus,* meaning sudden recognition. It's not a term that you could probably even find in the dictionary, but it's used a lot in the developmental and psychological literature. So again, when a child is presented with different examples of quantity, such as two hands or two socks, they would know to label those quantities with the same number word. And then in non-examples, such as three cars or three toys, or whatever, they can label those as three. And then, through these kinds of activities, they construct precise concepts of 1, 2, and 3. And then they are ready to move on to the next step, when, for example, they can see one, two, or three stickers immediately without counting, and then state the correct number of stickers. So, this then moves them on to the next skill, which I mentioned before, which is meaningful object counting. That they count in a one-to-one fashion, and they know each item is counted once and only once. And they recognize…they come to recognize that the last word used while counting is the same as the total, which is known as the cardinality principle; that final number in the count has special meaning. So, they count small sets such as 1, 2, 3; and then they would know that when they are finished counting, that indicates the number of objects in the set. And when a child can do this up to five, then they are ready to move on to the next step.

[**Slide:** *Examples of Common Counting Errors*] These are some examples of common counting errors that the research literature has shown. For example, some children say the number sequence out of order, and they might skip numbers, or they might say the number more than once. Here is an example of having trouble with the count list—1, 2, 3, 6, 10. The child might also go 1, 1, 2, 3, 4, and so on. A remedy for this type of error would be lots of practice reciting, or even singing, the single-digit sequence to 10, focusing again on the sequence up to 10. And then, of course, later, moving on to numbers more than 10; that can also create particular problems. For example, sometimes children have trouble with the count sequence past 12, because the numbers can be confusing; even 11 and 12 sometimes are confusing for children, because they don't have any particular meaning, like we don't say 10-1, 10-2. We go to 11 and 12, and then we move on to saying—and the child might see 1-10-3, or 1-3, but they say 13 and 14, which are little more logical. But then when they get to 15, it's a little bit harder, because it's *fifth* instead of *five*. And actually with 13, too; the *third* instead of *three-teen* are irregular and sometimes create problems.

And so, these kinds of issues would need to be highlighted for the children, and they just would need to have a lot of practice repeating the list. And then sometimes the child, when they

get…when they start counting higher numbers, they will stop at a certain number; like they get from 1 to 20, and they don't know what to do next, so they might just start counting again, maybe even starting from 1. So children really learn…need to learn the decade words, and to understand that each new series or each decade—it's a very regular, logical process—involves combining a decade and then the single-digit sequence, such as 20 plus 1, 20 plus 2, and so on; so the counting cycle repeats.

[**Slide:** *A Number List*] We have found from the literature that a number list, starting with 1, can help children compare quantities. So it allows them to see that each number is exactly one more than the next one, and it helps children think about lesser and greater cardinal values on the list. [**Slide:** *Number List Example*] So, sometimes it's confusing for children to start with a number *line* starting with 0. We prefer a number *list*, because we do start counting at 1, and that helps children use the list to do a problem like 3+1=4, because if you started at 0, it starts looking like it might be 4+1, and it can confuse the child. So, the literature does suggest that it is better to use a number list starting at 1, rather than a number line starting at 0, at this point for young children.

[**Slide:** *Cardinality Chart*] The cardinality chart visually underscores this increasing magnitude principle; again, that each number is one more than the next, and they can see the clear linear representation here with the cardinality chart.

[**Slide:** *Recommendation 2*] So, recommendation 2, which is *teach geometry, patterns, measurement, and data analysis,* also using a developmental progression. Help children recognize, name, and compare shapes, and then teach them to combine and separate shapes, such as circles, squares, rectangles, and so on. Encourage children to look for and identify patterns, and then teach them to extend, correct, and identify patterns. Promote understanding of measurement by teaching children to make direct comparisons of sizes, and to use both informal, or nonstandard measures, such as the child's hand or foot, and formal and standard units, such as a ruler. Help the child to collect and organize information, and then teach them to represent that information on graphs.

[**Slide:** *Combining Shapes and Identifying Patterns*] Here are some examples of combining shapes and identifying patterns. For example, the child should learn that two identical squares can be combined to make a rectangle, and children could then talk about what's the difference between a square and a rectangle, and why my two squares equal a rectangle. And, of course, moving from simple to complex patterns that involve numerosity also is very important. So here you can see the pattern going from two hands up, two hands down, or two boys, two girls, and so on. And then those patterns can become increasingly complex, but they should involve some type of number.

[**Slide:** *Using Math Vocabulary to Make Comparisons*] Math vocabulary is very important to help children think about comparisons and to talk about comparisons. So again, vocabulary words for different types of measurement should be emphasized—long to longest, short to shortest for length. For temperature—warm to warmest, cold to coldest. And then weight could be heavier to heaviest, light to lightest. These types of vocabulary words really help children describe their world mathematically.

[**Slide:** *Recommendation 3*] Recommendation 3 is to *use progress monitoring to ensure that math instruction builds on what each child knows*. This can start by using introductory observations or assessments to determine where the child is in terms of his or her math knowledge, and to try to understand where the child might be on that developmental progression. Is the child still at that level of being able to recognize small quantities, or can the child count, which would allow him then to engage in simple operations. The instruction should be tailored to each child's needs, and relate new ideas to the child's existing knowledge. And then, of course, the child's progress should be assessed, and recorded, and monitored in an ongoing way during the instruction. And the goals and methods then can be adjusted as needed.

[**Slide:** *Using Progress Monitoring to Plan Instruction*] Here is an example of using progress monitoring to plan instruction. You can see it's a very, kind of, iterative or circular process that you use. It's the progression to choose an activity, and then you assess and record, plan activities on what has been determined on the assessment, and then implement the instruction, and then as the child…and then monitor progress and go back to the assessment, and so on. [**Slide:** *Using Checklists to Monitor Progress*] It can be very helpful to use a checklist to monitor progress; for example, here is an activity that was used, such as *how many stars are there?* You can see there are 5. You could ask the child to point and count how many stars there are. Sarah, at the beginning of the year, she could count sets of stars, but she could only get up to 5 like this one, and when she got to 6, she started having trouble with the sequence. Bill did better with counting stars. He could get up to 10 stars, but he wasn't completely accurate because sometimes he double-counted a star, which might suggest that he has a shaky understanding of one-to-one correspondence and would need a bit more practice.

[**Slide:** *Recommendation 4*] Recommendation 4 is *teach children to view and describe their world mathematically*. Encourage children to use informal methods to represent math concepts, processes, and solutions. Help them link formal math vocabulary, symbols, and procedures to their informal or everyday experiences. And it's very important to use open-ended questions to prompt children to apply their knowledge. [**Slide:** *Beginning with Informal Methods and Terms*] These are some informal terms that teachers and parents can start with to represent different number concepts, such as *whole number*, just the number word for 3; to indicate *equal*—it's very important that the child understand the concept of *same number*, *same as*. *Unequal*—informal language would get children to think about *more than*, *fewer than*, of two or more sets. *And* and *more* are informal terms for helping children learn addition skills, and *take away* or *fewer* would be informal terms to help children start talking about and thinking about subtraction. And for operations, you could start with sets, and add more items to make the sets larger, and then ask the child *how many* when items are added or items are taken away. And these processes could be described with words as they are taking place. [**Slide:** *Moving to Formal Method and Symbols*] Then the formal; this will help—the informal language will then eventually help children link familiar concepts to formal symbols, which would be the formal symbols for operations. The *equal sign*—and again, it's important for children to know that the *equal sign* means *the same as*; sometimes children misinterpret *equal* to mean the correct answer, because they think the equal sign always has to be at the end of an equation. But if children start learning that *equal* means *same as*, they can think

more flexibly about math concepts. And then, of course, the *unequal*—the formal symbols for *larger than* or *less than*.

[**Slide:** *Using Open Ended Questions as Prompts*] Using open-ended questions as prompts; here's some examples. Instead of having a child just indicate whether it's…something is the same or different; rather, ask them to say, *How are these sets the same or different*? and really try to get them to focus in on *number* in particular. You can ask children, rather than just to say whether the pattern's the same or different, you could ask them to talk about what patterns they see. Or, *How does this chart or graph show us what we know?* and have children think and describe other ways that they can show similar types of information.

[**Slide:** *Recommendation 5*] Recommendation 5 is concerned with teaching math during preschool and kindergarten, and it's important to dedicate a specific time each day to teach math, in addition to the more informal instruction that would occur throughout the day. Just like we do with literacy now, in preschool and kindergarten, it's important to plan daily instruction targeting specific math concepts and skills. And that would be in addition to the general activities, such as calendar time. And then, of course, the math ideas can be integrated throughout the school day, where, you know, math can be highlighted within topics across the curriculum. The environment in the classroom should be math-rich, where children can recognize and meaningfully apply math. And games, especially board games, are really great for teaching math concepts and skills in a really friendly way.

[**Slide:** *Counting Up and Down*] Here is an example of a game—a very simple game—that can be used to help children to learn to count up and down a number list, and to see how numbers are represented linearly. It's kind of the same idea of what you might see in board games like *Candyland* or *Chutes and Ladders*, which are also really great to use, but it just deals with going up one or two on a number list to 10. So, the child might start on…would have a marker, and the child might start on 2, and then he will spin the spinner, and go up one. So, the child will go 2 and 1 is now 3, rather than just going 2, 3, and then they would go up one more, which would be 3, and one more makes 4, and so on.

[**Slide:** *Matching Games*] Matching games also can be really helpful to kids, and these would involve partner dot cards. So the child is seeing some dots, and can see how these dots can be separated, like 4 is also made up of 3 and 1, and this corresponds with the number sentence 1+3=4. And then they can see the number sentence 2+2=4, and make the corresponding sentence on the partner dot card, to help children really understand what these simple combinations mean.

[**Slide:** *Linking Math to Other Subjects*] Also, in terms of linking math to other subjects—books and literacy—there are just so many books out there that do use and take advantage of a lot of number concepts in a very motivational, rich way. And our practitioners on the panel came up with these books—ones that are used very effectively to teach these different math concepts. For example, *Mouse Count* could be used to help with number and operations, and *Spence Is Small* maybe for measurements. Also, in science class there are many, many ways to help children apply their basic number concepts; for example, they could count collections of natural objects, describe objects, talk about pre-cut shapes to see how they could make

animals, graph the amount the classroom plant grows each day. There are just all kinds of way to integrate math concepts in science class.

[**Slide:** *Creating a Math Rich Environment*] And creating a math-rich environment in the classroom is very important. Often…or it's pretty clear now that teachers do make their classrooms—their preschool classes and kindergarten classes—very literacy rich, with lots of words and letters and literacy-type symbols all over the classroom. But it's also important to emphasize number concepts. Of course, the conventional clock is still very important for helping children think about the number sequence. Labeling art stations, such as Art Station 1, Art Station 2. The cubbies could have shapes on them, so the child will know his cubby is the diamond, and another's cubby is a triangle, and so forth. Classroom rules should be numbered. Just very simple common sense things that help children see that numbers are everywhere, and they are really important for helping us think about our world.

[**Slide:** *Using the WWC's FREE Resources in Schools and Classrooms*] So I encourage you, again, to use WWC's free resources in schools and classrooms that will help you learn.