Office of Head Start - Geometry and Spatial Sense Math Webcast

(links for viewing and download at end of transcript)

[Music] Willa Choper Siegel: Welcome to this third webcast in our six-part series on mathematics and the young child. My name is Willa Choper Siegel. I'm an education specialist at the Office of Head Start. Thank you for joining us today as we discuss geometry and spatial sense. If you've joined us before, you know this webcast is divided into three parts. Just as in previous webcasts, you will be given the opportunity to ask questions. There are three ways to do this. Throughout the webcast, you may type a question into the "ask a question" form on the browser.

Or, you can fax us your questions or call the toll-free numbers, both posted on your browser. The phone lines will open in approximately one hour at 3:00 P.M. eastern standard time. It's that simple. You can also download a copy of our viewer's guide by clicking "download worksheet" located at the lower portion of the screen. After each webcast, we provide a list of resources for further study and we invite your feedback on this series.

Speaking of your feedback, it has been amazing. Your emails, faxes and comments help us to fulfill our goal of making these webcasts useful and helpful to you, the people who work with and train our teaching staff and parents, and ultimately, to improving the math outcomes for young children. Thank you all. I want to share with you now the major contextual learning principles for implementing a strong program for children. These principles apply to all areas of development and are equally important for early math.

We still hear that some of our teaching staff and parents are not comfortable with math. They think of it as if they have "teflon" math brains. Well, we want to change that to help them be more comfortable, and to convey to children the fun and excitement of exploration and problem-solving. We want to turn those "teflon" math brains into "velcro" math brains. We want that math learning to stick. Now, five principles of early learning that apply to math as well as other areas of child development: first, math experiences need to provide fun, shared time between adults and children.

The excitement of exploration and problem-solving and discovery will be evident. Second, children need experiences handling and working with different objects. They need to hold them, feel them, drop them, and see them from different perspectives to recognize their various attributes. They need adults to help them understand what they're seeing and doing to "mathematize" these experiences. By giving children the words -- narrating or explaining what is happening -- adults help children to understand the meaning and relationships of numbers, patterns, directions and shapes.

It's not enough to give children labels-- the vocabulary words for things they see and hear. They need hands-on, minds-on experiences, doing things and handling things to give them an understanding of mathematical concepts. Third, children need repeated experiences. Just like children enjoy and benefit from hearing the same books read over and over and over again, or singing the same songs, or finger plays, they need to handle materials or do things again and again.

They learn new things all the time, like additional attributes or features of objects and relationships between or among things. Fourth, children benefit from talking about their past math experiences, recalling or reviewing, and describing their previous discoveries in their own words, and predicting what will happen if something else occurs. We need to be aware of, and to build on or extend, things that children are interested in.

We need to follow their lead. Whether they ask questions, tell us something, move or orient their bodies so they can see the object, they are indicating that this is something of interest. We can use this as a teachable moment to mathematize by giving them an appropriate word, engaging in a conversation about what they think is happening, or explaining the event. Some of you may be familiar with the "follow-the-car" strategy from the Head Start Family Literacy training. In case you don't, it works like this.

Follow the child's lead. Whether reading a book or playing with a toy, focus your attention on whatever aspect of the page or the experience that the child seems interested in, through pointing, touching, leaning, or telling you. You comment on the object of the child's interest, and wait at least five seconds for the child to respond.

You ask a question. Again, wait five seconds for the child to respond. We want to remember that children take longer to put their words together than adults do. So weï¿½ve commented, asked, and now, we respond with a little more, expanding the child's response by adding descriptive words or some other information relative to the situation.

Later in the program, we'll see Dr. Copley put some of these strategies into practice with math. Now, the deeper content of today's webcast: focusing on geometry and spatial sense. What do you think of when you hear the word geometry? A class you had in tenth grade? Theorems and proofs? Lots of vocabulary words? Shapes? Did you even know that geometry is appropriate for young children? A few years ago, a study was done with kindergarten teachers. They were asked what geometry they taught. The typical answer was "the four shapes."

When asked what four shapes they taught, they responded, "square, rectangle, triangle, and circle, and we teach their names and identify them." Geometry is so much more. Whatever your ideas are about geometry, it is an important topic for our discussion about young children and mathematics. Hopefully, you will discover that geometry is much more than four shapes and memorizing long lists of vocabulary words. It's a wonderful topic for young children, filled with the excitement of natural exploration and discovery. In this picture, this child is exploring how his new ball moves.

From a mathematics viewpoint, he's discovering attributes of a sphere. Here, you see a young child experimenting with shapes and trying to get those shapes to go into the box. From a mathematics perspective, she's matching shapes, and problem-solving with great persistence. This is a child placing boxes inside each other so they fit. Mathematically, he's problem-solving, comparing boxes by size and shape, and experimenting so that the blocks fit from largest to smallest. This child is investigating the inside of the basket.

From a mathematics perspective, his experience helped him develop spatial sense, the concept of balance, and he experiences the difference between inside and outside. Yes, an appropriate study of geometry includes learning many vocabulary words, but we need to keep in mind the words will remain unimportant or useless to young children unless they are learned together with experiences which enable understanding of concepts. To help you as we go through each webcast, we've generated a list of terms and vocabulary.

As each term is discussed, note how the vocabulary is developed conceptually, and the specific experiences that accompany that development. As in the last webcast, there will be some new information for the teachers you work with, or even for you. This is often more true for geometry, because many of us have incomplete or inaccurate geometry knowledge. Now, let me introduce -- or reintroduce -- Dr. Nita Copley.

Dr. Juanita Copley: Thanks, Willa. I really appreciate her setting the stage for this topic. Now, why geometry and spatial sense? As Willa said, geometry and spatial sense is a topic filled with exploration and discovery. To begin, let's watch a short video of my grandson, one-year-old Ford, a child who is experimenting with balls and outside spaces. I hope you will agree with me that learning about geometry and spatial sense begins early.

[Video begins] Ready? Go get that ball. Ford. Here, go get this one. Watch. Whoosh. Carry that big one. There you go. Ball. Ball. Bring me the ball, Ford. Bring me the ball! Oh, good job, Ford. Come on, come on. You can do it. You almost did it. You came so far! Oh, come on, Ford. He looks really cute from above. Come on, Ford! Keep going. Go see Aunt Ginny. Come on. Oh, Anita, he's so cute! Look at him! You come on! You're so strong. Are you getting it? Here comes the ball. There's the -- whoa! [Video ends]

Yes, there are many reasons why we should teach geometry and spatial sense for even young children. First, just as you saw young Ford in the video clip, it is a natural part of the young child's exploration and knowledge as they move in their space. Children explore geometry and their spatial world every day. They learn to know, explore, conquer, in order to live and move.

Second, geometry forms the foundation of much learning of mathematics. Research indicates that children who develop geometric concepts and spatial sense are better able to understand number and measurement concepts as well as building understanding from informal to more formal thinking. Third, it is a subject that is recommended by national organizations, a variety of state standards, and Head Start Outcomes Framework. Let's look again at the graph published by MCTM that shows areas of emphases.

Look at the green section that denotes geometry. Please note that it is quite large in pre-kindergarten, and that it is still large all the way through to twelfth grade. In fact, it is the one constant area that continues throughout, and maintains the same emphasis. According to the experts, geometry starts early and should be emphasized throughout all the grades. Now, there is one more reason for teaching geometry. Beauty. Never thought of geometry as beautiful? Let me remind you of a person that we traditionally call the father of kindergarten: Friedrich Froebel.

He was a German educator who created a complex pedagogy in 1850 all based on his observations of children. He devised experiences he called gifts. He believed it was important for children to use the materials naturally, to use the materials in play and then to view them in their beautiful form. Froebel's gifts were sequenced, and he introduced the first set to children ages two, three, and four. Let me show you one of the gifts, gift two. Gift two contained many different three-dimensional shapes, one being the cylinder or one that looked like a can.

He would hang this particular shape on a dowel, and the child would be able to turn it very, very quickly, simply by moving the string that it was attached to. I have a sample here and I would like you to watch. Watch the beauty in the shape as I move it very quickly -- you see the neat, really beautiful way that the shape moves through space. It really gives you another idea. Let me show you one more. That's the cylinder. Let me show you what it looks like with the cube, especially if you put it at this vertex. Watch. Children marveled at the way the blocks move and really enjoyed looking at them.

Now, the second set of blocks were developed for five-year-olds and six-year-olds and I have actually one of the boxes to show you. This is gift five. If you look over here, what you are going to see is this is made up of triangular prisms, cubes, rectangular prisms, and children made it into all kinds of shapes. Do you see why we should care about Friedrich Froebel? I know why I believe we should. He believed in play. He saw that the important learning was done through play. He also believed that toys should be simple, and that less is more.

And he introduced geometry to young children as a form of beauty. Do you see why I like him now? Play, geometry, and beauty all together, and in the 19th century. Many famous artists and architects were exposed to Froebel's kindergarten system. Frank Lloyd Wright, a famous architectural designer, discussed his love of geometry and gifts in this way, quote, "Mother found the gifts, and gifts they were. Along with the gift was the system. I sat at the little kindergarten tabletop and played with the cube, the sphere, and the triangle. All are in my fingers to this day. I soon became susceptible to constructive pattern evolving in everything I saw.

I learned to see this way, and when I did, I did not care to draw casual incidentals of nature. I wanted to design." Why geometry and spatial sense? One, it involves children in exploration of objects in space. Two, it forms the foundation of much mathematical learning. Three, it is recommended by our national organizations and Head Start. And four, it opens children's eyes to beauty. Great reasons. This webcast will be divided into three parts -- the same parts as the first webcast and the same format as all future webcasts. Part one will answer the "what" question.

"What do children need to know to understand geometry and spatial sense?" Part two will answer the "how" question: "How do children learn geometry and spatial sense?" And finally, part three, we will answer your questions during "what else?" There is one important difference in this webcast. There will be more video clips of children doing geometry and spatial sense activities and many photographs as well.

As Willa stated, the vocabulary and ideas of geometry for young children are often difficult to explain using only words, and I believe you will understand it better with visuals just as children do. Now, what is meant by geometry and spatial sense? We are going to talk about three major areas: shape, spatial orientation, and spatial visualization. Let's start with shape. We will talk about three specific topics: the kinds of shapes, three-dimensional and two-dimensional.

The taking apart, or decomposing, and putting together, composing, of shapes, and the transformation or changing of those shapes. Just as Froebel did, I start with three-dimensional shapes first -- the fat shapes as my children call them. The shapes young children always begin to hold and experiment with. Let me show you the three that I work with. The first one I introduce to young children is one they've experienced a great deal. This shape looks like a ball. We might call it a ball. The geometric term is shape, and I simply -- excuse me, a sphere, and I simply call this, this looks like a ball.

I call it a sphere. The second one I use is a rectangular prism. You might call it a box. And this box, this particular box, is called a rectangular prism in geometric terms because it has a rectangular face on each the six faces. I often use the term with boys and girls where I hold my hand up and say, "Rub your hand across your face. Does it feel bumpy?" and they go usually, "Bumpy." And I say, "I have a big bump in the middle of my face, but when I put my hand on the face of a rectangular prism, it is very smooth."

Obviously, this is a Kleenex box, but of course, we could have other samples. This particular shape right here is also a rectangular prism. You may call it something -- you may call it the word "cube". A cube is a special kind of rectangular prism. We'll talk a little more about that later. One other three-dimensional shape that I show is one that looks like a can. I would call it a cylinder, and if you look at it you will see why we would say it might look like a can.

Children must be given many opportunities to play with these shapes; to hold them, to roll them, to build with them and discover their attributes. Do they have edges? Are they smooth? Do they have points? Do they stack easily? Or do they roll or slide on a ramp? The important issue is, children must have time to experiment with a variety of three-dimensional shapes to discover their attributes. Yes, they can and should be labeled. I always use the child's words to describe a shape first, often saying, "Yes, this looks like a circle, but it's a flat sphere. It looks like a ball, but I call it a sphere."

It is important that, whatever the case, that the children are allowed to play with a variety of three-dimensional shapes, and experience their many forms and attributes. This child is building with some triangular prisms. Note the shapes that are triangles and those that are rectangular. When he was describing his creation, he said he used triangles. The teacher repeated, "Yes, there are triangle faces. I call the whole block a triangular prism." Color is an attribute of these particular blocks but there also are cylinders or can-like shapes as well as rectangular prisms or boxes in this basket.

Foam shapes often make it easy to build and less hazardous when they fall. Note the sphere on the top shelf. It is important that children have spheres in their play with three-dimensional shapes. That's so they can compare the rolling attributes of a sphere with those of cylinders and rectangular and triangular prisms. Note these unusual three-dimensional shapes. Dowel sticks that can be purchased from any hardware store are wonderful skinny cylinders and they make great building material, especially if there are holes in some of the blocks.

Also, note the tubing. Plastic tubing adds to many block creations and provides yet another way to compare the attributes of geometric shapes. Although difficult to see, this young girl was able to put together or compose many rectangular prisms by putting two triangular prisms together to build a more buildable rectangular one. She requested we take this picture because of her success at building this tall tower. Let me show you how she put those triangular prisms together. First of all, you will notice this is called a triangular prism because it has triangle faces -- two of them.

When I put two of those triangular faces together, especially if they are congruent faces, when I put them together, you will note that it comes up with a rectangular prism, or in this case, a cube. Malachi discovered that he could make a taller tower with fewer blocks. In this picture, you will see how he put them together as he said, "the tall way." Esmerelda builds a model of her house with the apartment houses in the back. She is using shapes to represent her home in her neighborhood.

And an important addition to any block play is a sheet of mylar, or reflective paper, paper that again comes from a hardware store. Note the reflection sheets in the foreground of this picture. Mirror images allow children to discover even more attributes of shapes, and be able to look at the shape from the other end. These one-year-olds are playing with plastic pattern blocks and balls, including the drumstick -- one that doesn't roll, because it is connected to a

skinny cylinder. Balance is an important attribute of geometric shapes as well.

This group of three students were very proud that they were able to balance a sphere on one side of the construction and it didn't roll off. Now let's watch a group of children composing and decomposing with three-dimensional shapes.

[Video begins] Ann: Do you need some more cylinders, or some rectangles? Child: Rectangles. Ann: Rectangles? You know what this is proper, say rectangular prism? That was a big word, wasn't it? Do you need something that's bigger? Is that what you said? A bigger cylinder? Oop, that's not bigger, is it? Which one's bigger? Child 2: This one isn't bigger...

Ann: Yeah. Those are little. See what else you can find, some other sticks that are like cylinders. Child 2: Uh-oh. Ann: What about that one? Child 2: It's a screwdriver. Ann: It looks like a screwdriver? [Video ends]

Did you hear Ann's words as she described -- used the child's words, and said that it looked like a screwdriver? The way she talked to children was just a wonderful way of being able to help children understand what they were doing. So what else should a teacher do while children are playing with blocks? Do you remember our word "mathematizing"? Listening and observing children as they play with blocks gives you the opportunity to assess what they already know, and to use mathematical vocabulary as you talk about what they have built.

Phrases like "that ball keeps rolling off" or "that sphere is not easy to balance" or "that looks like a very skinny can or a cylinder that you are using. Does it roll? Or does it stand up? What could you do to make it stand still instead of roll? " These are all some possible phrases that you might hear or say as children mathematize their creations. Solid blocks are not the only materials that allow children to investigate three-dimensional shapes. Frames for three-dimensional shapes can be made from pipe cleaners and straws, just as in this picture.

Let's look at just one more three-dimensional experience. In this video clip, I'm working with a small group of children and we are transforming, or changing, play dough into a variety of shapes. Please know that we had all been using play dough and using our own formations before these transformations began. We also talked about Transformers, a toy that each of these boys cherished. Now, it was our turn, and the boys were asked to make specific transformations -- geometric ones. Let's watch, and listen.

[Video begins] Dr. Copley: Mrs. Copley's going to put something down and she's going to say "transform." I'm going to put it here. And we are anything going to see if we can make your play dough look like this. Ready? Alright, ready? Transform. Ooh. That's a ball. I'm going to make a ball. So I'm going to roll it. I'm going to roll it all the way -- I want you to make a -- transform it into a ball. It's got to roll like this on your plate. Nathan, see how you have to roll like this? See if you can make yours that way. I'm going to roll mine. I've got to make mine really smooth. Really smooth and roll it around here.

Nathan, would you help me with mine? Would you help me with mine? And I'll help you with yours. Let's make it a ball, and roll it. Can you make it real smooth? I've got to kinda smooth it, just make it real smooth. Make it like a ball and put it on your plate and roll it around. See, mine is a little lumpy. Roll it around. Can you put it on your plate and roll it around? Does yours roll, Nathan? Look. Oops. Mine came off too. I've got to make sure and not roll it too hard. You've got a good one. You've got it rolling. Does yours roll? Make it as smooth as you can. Whoops. There yours went, Josh. Do you want to help with yours?

Or you can help with mine? You can help with this one. Here is what I kind of do. I roll it on here. Can you roll it on there? Roll it there, Nathan. Yours is rolling good, isn't it? Did you roll it good if really roll it -- Okay. All right. Are you ready for another transformer? Josh: Yes.

Nathan, I'm going to give you this. Now lets see, whoï¿½s was this one? Was this yours, John? Yours was orange, wasn't it? And that's one's mine. Are you ready for the next transformer? Here we go. This next one's harder. Are you ready? One, two, three, transform. Nathan: I'm making -- Dr. Copley: That's what you are kind of making, like a can. Watch how I'm rolling it this time, like with my flat hand. Nathan: It's like a bone.

Dr. Copley: It does. Look, Nathan. I've got to make it flat on the bottom. Like this. I've got to make it flat on the bottom, don't I? Flat like this. Flat like this. Oh, man. Would you help me with mine? Would you help me with mine? Let me help you with yours. Child 3: I made mine flat. Dr. Copley: You've got to make it flat like this. That's good.

Yours is really good. It's got lots of -- oh, Nathan. Look how Nathan is doing his. That makes it like that. Then, Nathan, make it flat like this on the bottom. Can you do that? Make it like this. Oh, that's good. See how this is flat on the bottom? This one's a fat one. Ah. Transforming. This is really -- oh, that's good. Very nice. Then I better roll it again. Roll it again. How are you doing on yours? You want to work on mine and I'll work on yours? You want to do that? This one, I'm going to make it -- making it flat. See how flat on the bottom and it rolls? This is what this one does. [Video ends]

I hope you saw how much I enjoyed that activity, and the children did as well. Two-dimensional shapes are the names that many children already know. Again, the primary focus of geometry is that children should know and learn the attributes of shapes so that they can compose or decompose them and they can also transform them. To help children discover the shapes, I first introduced two shapes. "Circle" is the first one. Let me show you how I introduce it to children.

I simply -- we all have circles, and, of course, it's something that they usually know what it is, but I want to make sure they get the attributes, so I will ask them to hold their finger like this and I will simply go around the shape. Now, we all say it in that very elongated way because I want them to know that it's all the way around, and that actually, when they say round, it does make their mouth round. Now, the formal definition is, it's a -- a circle is a closed curve with all of its points in one plane and the same distance from the center.

The one they know most is "round", and they get that. The second shape I would like to show you and that I introduce is "rectangle". Now, with young children, the way I introduce it is, we hold the corner and we go, "side." Please note how I'm tracing the whole side. Side. When we reach this very important 90-degree angle or right angle, we say, "corner." It's a very formal way of saying "corner", because it's a very special corner. So here's what we do. We go, "side, a corner, side, a corner, side, a corner, side, a corner."

Now, the formal definition for "rectangle" is that it's a four-sided polygon, or quadrilateral, with two pairs of congruent sides and four right angles. For children, the definition that I use most often is that it is a shape that has four sides and four corners. Please note that these corners are all exactly the same size. Let me talk about one other type of very special rectangle and that is a square. Please note that a square is also a rectangle. Let's check it with our definition. It has four sides. Side. Corner. Side. Corner. Side. Corner. Side. Corner.

The difference is that it's a special rectangle because the sides are equal in length -- special rectangle because the sides are equal in length. I would like to quickly tell you a story about sides. Many times I have asked children to tell me how many sides a particular shape has. In most cases what they do is they say it has lots of sides and they do this kind of routine.

And I say, "Can you show me a side?" and they go -- they really don't understand the meaning of "side". I'm going to show you what I do with that when we talk about the idea of a triangle, and the method I'm using is really one that's helpful. Well, after children are introduced to the rectangle and the circle, in the way that I've just demonstrated, children went in groups of two or three with a teacher to identify rectangles and circles in their environment.

I gave each group a pack of rectangles -- little sticky notes -- and I gave each group a stack of colored dots. When they found a circle, they were to place the sticky colored dot on the circle. In a similar way, when they found a rectangle, they placed a sticky rectangle on the shape. The rule was they had to make sure they did the "round" and the "side, corner, side, corner, side, corner, side, corner" before they could place the sticky. The following video clip shows a few groups finding the shapes and labeling them.

The end of the clip is what happened when we came back to the classroom and shared our results. I wish you could have been there when they came back just, "We used all of the forms. We used all of the dots, Miss Copley. They are just everywhere." As you will see, we were all quite excited about the shapes we saw.

[Video begins] Children and Teacher: Corner, side, corner, side, corner, side, corner. Teacher: You found another one. Good for you. Teacher: Why did you put this? Child: Round. Children and Teacher: Side... side, corner. Side, corner. Side, corner. Side, corner.

Dr. Copley: Oh, that clock is a circle, isn't it? The flag is a rectangle, isn't it? Oh look, look... look up over. Even my watch. Ah. This is so much I can't hear it all. Everybody sit down where you are. Donï¿½t get up. Just move up around your head. Don't get up. Do you see any rectangles? Oh, my goodness. Oh, there is more than I -- ah. Do you know? I think -- I think there is even more than I can count. Don't you think?

As you can see, we found lots of circles and rectangles. In the picture that you are going to see, we found a circle on the lock. See the red dot? And the door was a rectangle so we placed a green rectangle on the rectangular-shaped door. The door to the fire extinguisher was a rectangle and the screw top to the door shield was a circle. Believe me when I say that when we went around our school, we saw little dots and rectangles all over the place.

Now, after children have investigated circles and rectangles, I introduce triangles. A triangle is a three-sided polygon. As this picture illustrates, we look at many different varieties of triangles and I place them in many different orientations. Let me tell you a quick story about a triangle. I had brought a young child, I was doing some assessment and I asked her if she could tell me what this shape was, and she said "triangle." I said can you tell me what makes a shape "triangle"? And she said it has three sides and three corners.

And I said, "Could you show me that?" and she indeed went around and said, "Side, corner, side, corner, side, corner." And then I said, "What if the triangle was like this? What if the shape is like this? Is this a triangle?" She said, "Oh, no, Mrs. Copley, it's not a triangle, it just isn't. I know triangles." And I said, "Well, why isn't it a triangle? It has three sides and it has three corners", and in fact she had just told me that. She said, "Well, it's because it doesn't look like one." I said, "I don't understand." She said, "It's got to look like a girl, Mrs. Copley."

I wasn't really sure what that meant, but I went on, and as we walked out of the door, right outside the door there were two bathroom doors, and one bathroom had a circle and a rectangle for the boys' bathroom. The girls' bathroom had a circle and a triangle, so she was using that emblem and thinking that made a difference. Please note that she thought what it looked like was the most important. Well, to really develop the concept of triangle, it is critical that children identify why a particular shape is not a triangle.

Please note that these are not triangles because of one particular attribute. The shapes on the left-hand side of your screen all have four sides, not three. The shapes on the right-hand side all are not closed figures or polygons. Oops, I just realized that I left out one important term. I should define "polygon" especially so you know how I define many of the other subjects. A polygon is simply a closed figure formed from line segments that meet only at their end points. Quadrilateral is the word that describes any four-sided shape or polygon.

Children love to learn big words, and this is especially one that they find fascinating. It's always exciting to hear them say "quadrilaterals," and it's helpful to have a word that describes any four-sided shape. This visual shows what we have already discussed for definitions. The blue circle represents all rectangles, and the smaller blue-dotted oval represents squares, those very special rectangles. As you can see, a square has four corners and four sides, so it is a rectangle. It's a special kind of rectangle because it has sides that are of equal length.

In a similar way, this visual shows another type of quadrilateral. A rhombus is any four-sided shape that has four sides that are equal in length. Children often will say, just as in this -- using this particular shape, they will often say, "It's a square like this, and now it's a diamond." Please know it's a square no matter what the orientation is; it's also a rhombus. A square is a special rhombus. It has four equal sides and it has four corners. Putting both of those ideas together would look something like this.

As you can see, a square belongs in both ovals because it is both a rhombus and a rectangle. Before we go any further into the slides, I want to show you one other way that I work with "triangle." And when we talk about sides, if you would please look at this triangle, in helping children understand what a side is, I often will use teddy bears who are

pulling up to a triangle table, if you will, and there is one teddy bear at each side. This helps children understand that these are sides, and the teddy bears help them decide how many sides there are on a shape.

Another thing I often do is have the teddy bears sit at the corners of the table. So when I want to know how many corners there are in a shape, we again count the teddy bears. Well, definition of shapes is often a difficult task, and at a recent workshop that teachers developed, the teachers were asked -- they developed their understanding of geometric terms by cutting shapes that would be inside the circle, indicating that they were quadrilaterals. In addition, they put shapes outside the circle, indicating they were not quadrilaterals.

They continued the process by adding rhombi and rectangles. In all cases it was equally important that they put shapes that were inside the circle indicating that they were that particular shape. It was equally important that they placed them outside the circle indicating that they were not that particular shape. As you can see, children need many experiences putting shapes together to make other shapes. In a similar way, they need practice taking shapes apart and transforming a shape from one shape to another.

The words that can be used to help children are as follows, and I would like to model them so that you could see them. If I have two triangles, and I slide them together, like this -- in fact, I usually use sound effects. I'm going to do the same thing right now. Slide... clunk. They simply -- this particular example took two triangles and made a square. Another word that is often used is the word "turn," so I want you to watch carefully as I turn around this point, and let's see what new shape shows up.

[clicking noise] As you can see, I now have a larger triangle formed from two smaller triangles, and you need to know it's a lot of fun listening to the children as they turn around shapes. Those sound effects are something they usually remember. In the next one, another word that's used for transformation is the word "flip." Watch this shape as I flip it, and listen to my new sound effect. Just from that simple flip, you now have a new shape that could be defined as a quadrilateral. Please note that these methods can also be used to see if the shapes are the same in size and in shape, or congruent.

One of the things I often enjoy about those words are words that I used when the children are doing puzzles. I will often walk up and say "slide that piece into the next place" or I'll say "flip it over" or I'll say "turn it and see if it fits." This next group shows a group of children using congruent rectangles. Children are putting eight rectangles together to form a quilt square. Then, these squares are put together to form a class quilt that is -- well, just beautiful. Remember Froebel? Watch as children make this quilt and I think you will agree with me that the result is beautiful.

[Video begins] Dr. Copley: I'm going to put it right up there in that corner. Did you see what I did? And I'm going to paste it. I'm not going to put it here, Cody. look, I'm not going to stick it here, I'm not going to put it all -- I'm going to make sure it matches the corner. Then, I'm going to decide maybe I want a piece of pink -- oh, pink would be cool. After I glue that one on, I'll try to -- what am I going to do with the paper? I've got to make it skinny. Got to fold it up. You are right. Match the corners and then go "zip".

Then I'm not going to put this one anywhere down here. What am I going to do? Put it in a corner. Right? I don't want any white stuff to show, because when we get done, boys and girls, Mrs. Copley's going to put all these together like that one we just saw. Remember the one in the office that we just looked at, the quilt? We will put them all together. Won't it look cool?

Teacher: I like the way you're doing this, the corner. Some of them -- Oscar... Very nice. Do another one. It's so nice. If you put it in the -- That's good. That's fine. Will you do another one? I'm done. Put it in a corner somewhere. Good. Perfect. Another one? [Video ends]

I wish you could see how proud those children were of that quilt. After they were finished, one little girl looked at the quilt and just in great awe said, "Isn't it just so beautiful?" One thing that happened while the children were making the quilt that I really, really enjoyed. Most of the children, when they made those quilt squares, put their pieces in the four corners and they would have a lot of white material, or "white stuff" as I called it, left over. What was exciting was to hear a little girl complain, "I'm all out of corners. I've used all my corners."

And a little boy next to her said, "Every time you put down a rectangle, you make a new corner." It's a geometric piece of information that I think is neat for children to have discovered by themselves. Well, this rectangle quilt was made up by four year olds with nonongruent rectangles, including squares and rectangles -- much harder to do than we saw on the video clip. These were put together into a square using eight congruent triangles -- a very difficult task. These five-year-olds had to often turn or flip their shapes so that all the white stuff could be covered.

This quilt was made by five-year-olds with congruent triangles. To quote one of the five year old designers and really, me as well, "Wow, we did good." Let's talk about a second aspect of geometry and spatial sense -- spatial orientation. If you have spatial orientation, you can describe where an object is in space by location, direction, and/or position. You can also tell where an object is in relation to other objects. As adults, some of us have more spatial orientation than others. Do you have difficulty describing where you are when you are lost? I need to confess something here.

I have looked back at my report cards and I found out that in kindergarten, first and second grade, all of them said basically the same thing. "Nita is a very good student. However, she still cannot tell her left hand from her right hand." Unfortunately, that's carried through to my adult age. When my husband and I were involved in square-dancing, the caller would often yell out in front of everyone, "Nita, it's your other right hand." Spatial orientation is not my strong suit, as you can tell, and I'm lost frequently, but that doesn't mean I don't teach it.

It is important for young children to develop spatial orientation -- to develop ways of telling where objects are in space. There are many ways to develop spatial orientation: hiding objects and finding objects using clues, moving and labeling specific movements, singing songs that use spatial vocabulary, focusing on position words and books, and acting out stories that involve locating objects. They're just a few of the experiences that will help them develop their spatial orientation. There are many words that can be used to describe an object's position, location or direction.

The list that you see represents just a small portion of those words. Let's look at a short video clip now of a game my students love to play: "Whereï¿½s the bear?" Although the numbers don't show on the video, please note that one cup is labeled with one number, one to ten. Listen to the vocabulary that includes the location words "before", "after" and "between." You will also hear the ordinal numbers, "first", "second", "third," and so on. Please note how position words used are modeled throughout the lesson.

[Video begins] Dr. Copley: Cup number two. Have a seat! That's called the second cup. That's kind of a weird word too, isn't it? Cup number two. The second cup. Let's watch carefully. Are you ready? Child: Not there. Dr. Copley: Not there. Okay. now, let's see. Let me give the clue. Are you ready for the clue? Child: Yeah.

Okay. here's the clue. It's after two. It's not here, it's not under cup one. That's before. It's after cup two. Would you like to guess? Come over and show where you think it might be -- it's after. Do you want to try that one? Okay. Why don't you pick up the cup? That's the tenth cup. Pick it up and let's see. No, not there. Very good guess, though, because it was after. Here is my clue. Are you ready? Because you're going to guess again.

It's after cup two. So it's in one of those, and it's before that one. It's not there. It's not there. It's not there. It's between those two. It's one of these cups. Where do you think it might be? Okay. you think it's cup eight. That's the eighth cup. Look at Mrs. Copley's mouth. That's the eighth cup. Isn't that a funny way to say that? Child: yeah.

Can you say that with me? The eighth cup. Okay. Go ahead and pick up the cup and see if it's there. Not there. Not there. Are you ready for another clue? Look. It's after this one. And it's before that one. So it's in between. It's one of these.

I think it's -- It could be here, it could be here, it could be here, it could be here, it could be there. Would you want to come and show us where you think it might be? You guys are such good detectives. She thinks it's there. Are you ready to turn it over? Under the third cup. There it is. Very good. Give her a hand. She found it. Very nice. Very nice. That cup was under -- that teddy bear was under the third cup. The third cup. [Video ends]

As you can see, we found the bear. Did you hear and see me demonstrate the words "before", "after", and "between?"

When we first play this game, children are just guessing where the bear is hiding and they show their guess by just pointing at the cup. As the months progress, however, children began to use the number words or even the ordinal words as they select a cup, and most exciting, they use the "before", "after" and "between" clues to make their choices. Spatial visualization is the third area involved in the topic of geometry and spatial sense.

To visualize an object, young children must be able to see the shape in their head, and then make or draw what they see. It is a skill that can be developed in preschool, and one that should be practiced frequently. "Look, Make, and Fix" is a game that young children love to play. First, children look at two, three, or four shapes in a particular configuration. Then the shapes are covered and children make the picture based solely on what they remember in their head. Finally, the picture is revealed again, and the children fix their shapes to match the picture.

The child in this video clip has already completed three perfect puzzles. She was really good at spatial visualization, and she continued to request, "I want more." She kept saying, "Miss Copley, I need a hard one, a harder one." Watch as she tries a very hard one.

[Video begins] Dr. Copley: We'll start with the triangles. Ooh, this is going to be tricky! Two triangles, making a big rhombus! I'll put this one like this. Ooh. That's going to be hard. Really hard. We're going to put this one up here. I don't know. I don't know. Yeah. I think I'm going to put this one down here. This one's in the bottom corner. A circle. An orange square. Two green triangles and a purple rectangle.

Alright, you ready to look? He's thinking that's hard, huh? Are you ready to look? You think you've got it? Okay. Okay, go ahead and get your triangle. This one is really hard. Okay, it's all right. This one's really hard. Think you can do it? All right. Let's see. Put it wherever you think and I'll let you change it if you want to. Go ahead and put everything else you think. Don't remember where that one goes?

Okay. this one's hard, isn't it? You want to look at this one and see? Go ahead and put that one there somewhere. Okay. you did good. Are you ready to look? Okay. Go and see if you can fix it to make it look just right, because you've got all the right pieces. Can you fix it to make it look right? Did you put the purple one where it goes so it's just like this? Yeah. Very good. Where does this one go? Wow. Very nice. [Video ends]

As you can see, this child uses the best problem-solving strategy. She simply looks and tries to check the teacher's face to see if she's right, but she definitely showed she had some good visualization -- spatial visualization skills. At a recent work shop, pre-kindergarten teachers practiced their spatial visualization and formed as many shapes as possible using five connecting cubes for each shape. Each shape was to be different and could not match another shape, no matter how it was turned or flipped. There are many possible shapes.

Do you see any that are the same? Although this group found many of them, they were not able to find all of them. Teachers were then asked to represent the shape they made -- a difficult task, but one that required visualization as they produced a two-dimensional picture from a three-dimensional shape. These shapes are excellent representations. Please know that some adults are quite natural with this activity. Others need a great deal of support. This activity always results in teachers helping each other. It is truly a collaborative piece of learning.

Children were asked to do a similar task. Using blocks, they made of construction. Photos were taken and labeled with the child's name. Then, these pictures were put in the block center and children used the representations to make each other's buildings. The colored blocks are easier to see in this activity. This child used a picture of a skyscraper to create her own skyscraper. Mark created a perfect example of the pictured building. This picture is not quite the same, but Nathan used the same pieces.

Well, is geometry more than knowing four shapes? I hope you can see that, "Yes, it certainly is." We will be going to break in just a few minutes, but let's review, first, "What is geometry and spatial sense?" It involves two and three-dimensional shapes, spatial orientation and spatial visualization. Yes, there are many vocabulary words that are involved.

Hopefully, you saw the many experiences that are necessary if children are to develop their understanding of those

words and the concepts involved. Well, we'll be back in just a few short minutes, and we're going find out how we can best facilitate children's learning of geometry and spatial sense. [Music]

Welcome back. Part two of this webcast outlines how we can best facilitate children's understanding of geometry and spatial sense. As in previous webcasts, there are three questions that we will answer. "What should children learn?", "Where do they learn it?", and "How does the teacher intentionally plan for that learning?" The Head Start Outcomes Framework is consistent with the National Council of Teachers of Mathematics pre-kindergarten focal point. Both groups talk about shapes, their parts and attributes.

The Head Start Outcomes Framework specifically addresses decomposing and composing shapes. As we made the rectangular quilt, children had to put shapes together, match them to the corners, and then take them apart to try to make them fit. The Head Start Outcomes Framework suggests that children begin to determine if two shapes are the same size and shape, while the focal point discusses the relationships between shapes. The turning, sliding, and flipping that children and their teachers do provide some methods for matching shapes according to size and shape.

Spatial relationships are described specifically as an understanding of directionality, order and position of objects by the Head Start Outcomes Framework. The "Where is the bear?" activity certainly required children to use their spatial sense to find the bear. Please note that, as they have been in each of the webcasts, the approaches to learning are listed for geometry and spatial sense as well. Solving problems and applying reasoning is always an important outcome in mathematics.

The active exploration in many of the experiences already discussed is especially evident in geometry and spatial sense. Finally, the language and literacy domain certainly relates to geometry and spatial sense. Children need to communicate and represent their ideas using an increasingly complex and varied vocabulary. These skills are important to the interactions necessary to learn mathematics, and specifically for geometry and spatial sense. Well, where do children learn about geometry and spatial sense? So many places.

These children in this picture are making clay prints using the wooden faces of the blocks in the art center. This is a beautiful picture made from shapes. Notice that each shape stands alone and forms its own representation. Children learn geometry concepts in a game with the teacher as they build towers with the number of blocks shown on the die. Here we have pictures of shapes in the environment found in many books. "Architecture Shapes" by Michael Cosby and Steven Rosenthal contain pictures of photos of shapes naturally found in architecture.

Well, how does the teacher intentionally plan for learning geometry and spatial sense? As in the first webcast, we will talk about how the teachers planned experiences and the importance of mathematizing language. Using Ari Karl's book, "The Secret Birthday Message," children were introduced to a map that required the reader to find a puppy using spatial clues, as well as geometry concepts of shapes. This map on the last page of the book shows how the puppy was located.

After we read the book and I reviewed the map, I explained that I had hidden a puppet from them, and it would be their job to get clues about where it was hidden. Watch as you see them -- the children in this class -- find their new puppet.

[Video begins] If I look in this book for just a minute. Look at this book -- this shows the map or the picture of how he found his puppy. Let's see if we can figure it out. First he started where -- oh, where the moon was. Then he went and found the star higher. And then he went under the -- the -- it looked like an egg, but we said it was kind of like an oval.

Then he went through the triangle, and he looked in the hole, the circle, and then down the stairs which looked a little like rectangles, maybe, and then to the big rectangle door. He goes in the door, and he goes up the door and looks in the hole -- remember, that was a rectangle -- and then he found the puppy. Isn't that cool? Now, here is what I'm going to tell you. I have -- "the end," that's right. I have hidden something in your classroom that's a surprise from Mrs. Copley, and I paid a whole lot of money for it, and it's one of my most special things.

But you've got to be able to find it, and you can't find it just by looking -- running around, looking. You've got to use my clues. Clue number one says it was on top of the rectangle, and Kimberly saw that card. There are lots of rectangles, right? But she had to find the card. Clue number two says, "under, under circle". You can see it from where you're sitting. But we're looking for a circle, and we're looking for a card. A circle. And we're looking for a card. Oh, you can see -- Mark, you are exactly right. Pick up that wastebasket. And there it is.

Did you find it too, Isaac? Did you see it there? Bring it to me. That is clue number three. Oh, it was under a circle. Sit back down. Let's see what this one says, everybody. This one says -- here is our clue number three -- both of you found it. I agree. This says inside a rectangle. This is the last one. Stand up and let's see what it is. Child: It's a bear. Mrs. Copley: No, it's not a bear. It's a -- it's called a -- look at it. Look. We found it, guys. Everybody, come over and look. This is not a duck. It's called a platypus. [Video ends]

They were excited to find the platypus, and the children enjoyed having him in their classroom for a week. The nicest part was the next week, when I went back to the class, the children had written me a letter with clues, and I was not allowed to find the puppet until I could read the clues and use my spatial sense to find the puppet. Well, we have discussed many vocabulary terms during this webcast, and I know you have been noting your observations as we have progressed through each section.

Because there are so many geometry terms, let's analyze how the words were introduced and used in the webcast by focusing on one instructional strategy at a time. First, introduce any new vocabulary words with any experiences in the child's context. As we said at the very beginning of this webcast, simply repeating a shape word and saying what it means is not enough. Children must experience what a shape feels like or how it moves in space, or where it is in the environment. Second, use the child's language and identify shapes using "looks like" terminology.

For example, when a child looks at a triangular prism and states that it looks like a roof for a house, say, "You are right, it looks like a roof. I see that it has a triangle on its face." Third, use correct geometric terminology. After you use the child's words to describe a particular shape or orientation, use the phrase, "I call it" and complete the phrase with the correct geometric word. Fourth, use "not" vocabulary and give reasoning. For example, "This is not a circle, because it has a corner." Or, "This is not a triangle, because its three sides don't connect to make a shape."

Finally, children use new vocabulary and ask questions to assess their new understanding. One last story -- I had just been teaching the word "rectangular prism" to a group of five-year-olds. We had been exploring with all kinds of box-like structures and suddenly, at the end of the class one of the -- another teacher came in and said, "Boys and girls, what have you been learning today?" I was so expecting to hear the word "rectangular prism", and instead a little boy looked out and he simply said, "We have been talking about jail."

it took me a few minutes, but I soon realized that what he thought I had been saying was, "rectangular prison." I had to have a little lesson about the difference between prison and prism, but it certainly does illustrate the idea that it's important to really check their understanding about what they know about the vocabulary.

We are now ready for the third part of this session. What else? Remember, this is your opportunity to respond to my questions or ask your own. Please consider submitting your questions by email, phone or fox as indicated on your screen. What questions do you have for us? Back again to help with today's Q and A session is Willa Choper Siegel. Willa?

Willa: Thank you, Juanita. Our phone lines are open. Please do not use your speakerphone, and once you ask a question, please hang up, but wait until you get to ask your question. If you experience a long wait time, you may prefer to ask your question online or by fax. Our on first question is from Ramon, in Texas, and Ramon would like to know, he says, "I love the examples of assessment. How does that help you know which children are ready for more?"

Dr. Copley: I love to hear -- to watch children do activities, and many -- if you will notice, my assessments are activity-based. What I do is I watch what they do and where they are confused, and that particular moment of confusion, or what they have difficulty with, helps me know where to go from that point. I always start from their strengths and what they know how to do, and then work on what they've had difficulty with. Really good question.

Willa: Okay? Our next question is from Dione, in Arizona, and Dione asks, "Do you think there are ways to add more movement, gross motor use, to math experiences?"

Dr. Copley: Oh, I think it's an essential question and one that's very important. Movement is something four year olds do all of the time, and it's something they need to know how to do. Three year olds, two year olds, one year olds. In this particular one on geometry, there were so many ways to incorporate movement, and I did many of those when I teach geometry, but in the next two webcasts especially, Measurement and Patterns, we're going to do all kinds of movement activities, and so I hope you will watch that, because movement is an important part of any mathematics teaching.

Willa: Great. Thank you, Nita. Ah, this question is for me. This is from Marcus in D.C., and Marcus says, "It seems like 'Follow the Car' can be appropriate with older infants and toddlers. Do you agree?" I definitely do agree. You have to ask questions and comments that are in line with the child's developmental status, so you would ask a simpler question to an infant or a toddler, but it definitely can be used if you know where the child is, and take advantage of the kinds of vocabulary that the child is able to handle. So thank you, Marcus.

Okay, our next question is from Mary in Tennessee. Ah. "Would you please explain the benefits of the mylar reflective sheets?"

Yes, I wish I had that to show you, the mylar pieces, but what is nice about them is they are reflective sheets that are movable so the child can move them as they look at shapes, and look at the back of a shape or the other side, but more importantly, they're not like mirrors. They're not going to break. And number two, the plastic mirrors often get scratched very easily, and it's hard to see. So the mylar reflective paper are just a benefit to the child as far as safety, but I think most importantly they really allow them to look at geometry figures from a variety of places, so I would encourage you to use them.

Willa: Thank you. Another one here. "Are there other shapes we should teach beyond those you shared today?" This came from Anna, in California.

Dr. Copley: There are so many names of shapes, and I have only touched on just a few. Again, I want to reiterate over and over again that the most important thing is that children learn to experience them, they learn to put them together, they learn to decompose and compose those shapes. The names are important, but certainly not the most important thing. The word "quadrilateral", remember, is a word that describes any four-sided shape, so if you don't remember all of the particulars about -- or even additional ones, you can always use the word "quadrilateral", and it fits a lot of different shapes.

Willa: Great. Thanks, Nita. We have a live question from Barry in Wisconsin. Hi, Barry. Barry: Hello. I'm very intrigued with the quilt activity. Would that work as well in smaller groups, or is that best to do that activity with the whole class?

Dr. Copley: Oh, the quilt activity, yes. I'm very -- very -- I think it's very important that the class as a whole has a project of some sort. This was a class project, and we made it together. Now, ideally, I would like to always explain any of -- how to make the quilt in small groups and in fact, that's normally how I do it, into a small group. I tell them how to make the quilt pieces.

Putting it all together -- I hope you can see at the end when that video clip went and they quickly, quickly made the quilt, it didn't happen that quickly, as I'm sure you knew, but the fact is when they saw it all come together and they got to choose where they put their piece, it really was an appropriate activity for a whole group to see and to watch.

Willa: Good. Thank you. Okay. This question is from Diane in Florida. "Are there other historical theorists, like Froebel, that can help us learn more about teaching young children either math or just generally?"

Dr. Copley: Of course, there are lots of theorists that I like, and not just because they teach mathematics, but for

instance you know of Carolyn Pratt, who was the block lady, as I think of her -- blocks are so critical to children's geometric understanding. Maria Montessori, of course, believed so strongly that children needed materials, and good materials, to manipulate and explore. But I think the most important part I want you to see when you think about these historical figures is that we are not just starting to do geometry.

Friedrich Froebel, in 1850, introduced these really good geometric concepts to young children. Mathematics belongs with young children and it's a great place to start, and geometry just makes sense. Willa: Thank you, Nita. This just came in from Iris. Iris wants to know, "What do you teach first? Letters or shapes?"

Dr. Copley: An excellent question, and I think one that really reviews the idea that we are all teachers. Children come to school or come to a family child care center or they are working within the family center. The fact is that children learn everything in all different orders and that we need to know where they are, what they've learned and then go from there. One of the things, I think, that this question just prompts me to mention is that when we think of letters, like the letter "b" and the letter "d", it makes a difference what the orientation is.

It's a "b" if it's written in one way. If it's flipped over, it's the letter "d". And often, children confuse that understanding with the idea that if I take a triangle and flip it in a different way, it's no longer a triangle. So I think there can be some confusion with that. The fact is, the shapes are something that children can easily identify. And I simply teach children wherever they are. I think there is no particular order for whether you teach letters first or shapes. The kids need to know letters. They're in their environment, and they need to know shapes.

They're in their environment. It's just wonderful, as you know, what young children can learn and how we should be teaching them. Willa: Ok, we have one last question came in as an email from Joan in New York. "How young can a child be when we introduce directional words such as before and after?"

I used to spend a lot of my time deciding what was developmentally appropriate for a child. What I have come to believe is if I can couch -- if I couch things in their experiences and I use -- mathematize the vocabulary, it's up to the child what we learn. That "Whereï¿½s the bear?" activity -- I played that with two and three-year-olds. They may love to look where the bear is and find where it's hiding. What's so exciting to me is all I do is simply add the vocabulary, and I add the vocabulary by acting out where those are.

I don't know when the child is going to learn those words, but there is nothing wrong with them playing a game or doing an activity and then using the -- me taking the words and using those words to identify what happens. Those are really good questions, Willa. Thank you.

Willa: Great. Thank you, audience. Okay. now let's recap. In part one, we discussed three areas: shapes, spatial orientation, and spatial visualization. In part two, we observed many different methods for facilitating learning. In part three, we discovered what else we could learn. Our key to insuring that children have the experiences they need to build conceptual understanding as well as the vocabulary about things is adults being intentional.

In math, as in other areas of early childhood education, children need to have concrete experiences and they need adults to intentionally help guide their development through words and conceptual understanding. Children need to make experiences their own. One way to remember how children's experiences build their concept development is, "See it, hear it, say it, touch it, move it, play it." Now, do you remember the question we asked at the end of the last presentation? The question was, "How many people help us with each of the webcasts?"

No one knows the exact number for sure, but just to give you a rough idea, there are teachers and children who provide so many wonderful examples for us. There are script writers, graduate students who film the classroom examples, there's the federal math team members and the consultants we work with, there are people who film the webcasts, man the help desk, prepare the materials for the Early Childhood Learning and Knowledge Center, handle the scheduling of the studio when the webcast is taped, and very, very importantly, all of you in our audience, which means our numbers may be in the thousands.

We're thankful to everyone involved in making these webcasts a success, and for helping to improve child outcomes in

early math. This concludes our third broadcast in our six-part series, "Emphasizing Mathematics in Head Start and Other Early Childhood Settings." Here are some questions you may want to think about before the next session. What vocabulary did you hear used during this session? What materials would facilitate learning? How intentional are your teachers about teaching geometry and spatial sense?

What one thing could you do tomorrow to help teachers facilitate children's learning? We look forward to being with you again in February as we address measurement for young children. In the meantime, please visit the Head Start Early Childhood Learning and Knowledge Center for additional information. As I hope you know, the ideas in this webcast are created from a large variety of programs. Some of these resources are listed on the Early Childhood Learning and Knowledge Center. See you next time. Thank you very much.
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