TOOL TIME! by Ellen Booth Church

The Child Who Always Argues by Polly Greenberg

Prop Boxes for Physical Play by Eric Strickland, Ph.D.

The Geometric World of Young Children by Douglas H. Clements, Ph.D.
After some experimentation, little Amy puts a square block into a square hole. It fits!

She tries again. Success is a great feeling! Watching this thoughtful exploration, we might ask ourselves: What does this child know about shapes? What is she learning? What more will she learn in preschool? What might she learn if given the opportunities?
YOUNG CHILDREN “DO” MATHEMATICS SPONTANEously in their play, in their lives. We’ve all seen preschoolers exploring shapes and patterns, drawing and creating geometric designs, taking joy in recognizing and naming specific shapes they see. This is geometry—one of the most natural and fun areas of mathematics to develop with young children!

Enriching Children’s Experiences
During the preschool years, children’s intuitive knowledge of geometry frequently exceeds their numerical skills. By building on strengths and interests that are already present, we can foster an ongoing enthusiasm for mathematics and provide a logical context to develop number ideas.

A teacher challenges two girls to use their bodies to make a shape together. They sit down facing each other and stretch their legs apart. With feet touching, they create a diamond. Another child takes a look, sees the diamond shape, and suggests, “If we put someone inside, we can make two triangles.” Immediately they ask Ray—the smallest child in the group—to scrunch in and lie across the middle. It works! A diamond divided in half makes two triangles.

Michelle says there’s a shape that has six sides and wants to try making one of those. Another child even knows that it’s called a hexagon. After a brief discussion, Michelle gets five other children together. Under her direction everyone lies down on the floor, and together they create a six-sided shape.

Building Geometric Imagination
Children learn to make mental images—pictures they can carry in their minds. Young children tend to form static images—“still” mental pic-

There are fun, imaginative ways to build on children’s intuitive knowledge of shapes. Here, two children make one shape, and three children make two!

tures they can refer to. Older children are learning to form dynamic images, which they can move or change. For example: Five-year-old Brian eyes the gerbil cage, trying to figure out if it will fit in the back of his mother’s car. He thinks so, and later that day he finds out he’s right. Building children’s geometric imagination is an important part of exploring spatial relations and experiencing mathematics. So let’s look at how we can help children learn by working with shapes, imagery, navigation, and maps.

Keep in mind that by age six, children often have stable yet limiting ideas about shapes. For
example, four-year-old Teena tells her teacher, “That's not a square. It's too big. A square looks like this.” Her classmate Charlie adds, “Triangles have to be this way. That's not a triangle. It's too upside down.” You can broaden children’s understanding by sharing and recognizing a variety of examples—squares that are many sizes or triangles that are “long,” “skinny,” “fat,” and turned in many directions. You can also encourage deeper thinking about shapes not just through hands-on activities and discussions, but through picture books. For example, in *The Greedy Triangle* by Marilyn Burns (Scholastic Inc.), a triangle gets so bored being the same old shape that it asks a shapeshifter for one more side and one more angle. Then it becomes a quadrilateral. After demanding more sides and angles and becoming a pentagon, hexagon, and so on, the shape learns in the end that being a triangle is the most interesting after all. This is an excellent introduction to making shapes with other shapes. [For additional books that further math thinking and understanding, see “Math and Literacy” on page 43.]

**Building Imagery**

How can we encourage children to continue to build static and then dynamic images? Manipulative work with shapes, such as unit blocks, puzzles, and tangrams, provides the foundation. Children should have plenty of time to explore and work with these materials. Next, have the children:

- Do puzzles where they can see only the outline of several pieces. Then ask them to find ways to fill in the outline by creating puzzle pieces using their own set of tangrams.
- Try “quick-image” activities. Draw a simple set of shapes on a piece of paper. Then give children a brief glimpse and cover the image back up. For instance, you might draw a square divided into two small squares and a rectangle. After children have had a quick look, ask them to share what they saw. You’ll hear a number of different responses, from describing the shapes to comparisons with things the shapes remind children of, like checkers or blocks. There really aren’t any incorrect responses, and the activity and discussion will get children more involved with thinking about shapes and what they see. (Ask older children to use many different ways—
Building With Blocks

Unit blocks provide a window into the geometry of young children's play. They allow children to explore a world where objects have predictable similarities and relationships and inspire children to create forms and structures that are based on mathematical relationships. For example, children have to struggle with concepts such as length relationships to find blocks that will work in making a roof for their building and equivalence when substituting two shorter blocks for one long one. Children also consider height, area, and volume as they build and explore important intuitive ideas. Here are some suggestions on how you can foster this growth:

- Encourage children to discuss their thinking and help them put words to their actions. For example, three preschoolers were making towers and arguing about whose was the biggest. Using gestures as well as words, their teacher asked them if they meant whose tower was "tallest" or "widest" or whose building used the most blocks. A small crowd gathered to listen and give their opinions, and everyone was surprised to find that the tallest tower did not have the most blocks. In other words, you are utilizing children's building experiences to help them begin to distinguish between different quantities such as height, area, and volume.

- Engage children in discussions that challenge them to think about similarities and differences among the blocks they use and
Getting in Shape

Children actively explore shapes throughout the day—posing and solving geometric problems using their bodies, toys, manipulatives, and computers. Learning is further enhanced when they are given opportunities to discuss what they are doing and thinking about. Engage younger children in:

- using blocks and other materials to form pictures and buildings.
- identifying shapes they see in the classroom, outdoors, everywhere!
- sorting shapes and describing why they believe that a shape belongs to a specific group.
- creating a building that replicates the shapes and structure of someone else’s, then adding to it in their own way for the other person to replicate.

Talk to children and encourage them to talk about the shapes they see and use. Have “shape days,” where crackers, fruits, and vegetables are cut in a specific shape, and a multitude of pictures, photographs, and materials feature the shape of the day.

Encourage older children to:

- measure, color, fold, and cut out shapes (or pictures of shapes).
- describe why a figure belongs or does not belong to a shape category.
- match the shapes they make to shapes they see.
- play “Guess My Shape” using attribute clues they give to each other. (“My shape has three sides and three corners.”)
- make as many different shapes as they can by combining other shapes.
- build squares and shapes using toothpicks (for the sides) and marshmallows (for the corners).
the structures they make.

- Look for opportunities during block play to suggest that children try a variety of challenges, such as: putting square and rectangular blocks in order by length; using "shorter" blocks to

---

**What Children Already Know**

What do preschoolers know about math? Our research has shown that children as young as three and four know quite a bit about mathematical ideas and vocabulary terms.

Here's what they can do:

- 82–92 percent of preschoolers, given a mixed grouping of shapes, can pick out all of one type—rectangles, triangles, squares, or circles.
- Preschoolers are accurate at naming squares, even when the squares are tilted.
- Many preschoolers also recognize rectangles, even when they are tilted.
- The frequency of opportunities to learn math and the nature of the activities determine how well a child learns geometric concepts. A three-year-old with great hands-on experience with shapes can actually "out perform" a six-year-old who hasn't had the same opportunities.
- Talking about their thinking helps children process and lets us understand which points they are grasping and which they are trying to figure out.

Surprise! After a great start, statistics show that, as children get older, their knowledge about shapes doesn't necessarily increase. That tells us we're not doing an effective job building on children's good beginnings.
make a wall as long as the longest block; making as many differently shaped (rectangular) floors as they can; and making a square box out of four blocks.

Keep in mind: These activities and others like them are not meant to determine children's aptitude for math or see how many right and wrong responses they come up with. They are, instead, opportunities to explore the properties of math and encourage children to participate in logical, creative, and critical thinking. Everyone will be in a different place on the continuum of math learning, so our job is to make sure everyone feels capable and no one feels inadequate or left out.

Mapping and Navigating the World

Young children learn to get around early—as all adults responsible for their care will agree. What, however, can they understand about place and movement mathematically? Is it reasonable to think of preschoolers making and using maps? Although this may seem developmentally inappropriate, research has shown that it is not. Here are the facts:

- Many three-year-olds can build simple, but meaningful, maps with landscape toys such as houses, cars, and trees. Some threes can even replicate a room in miniature using blocks, toys, and other props.
- Many older preschoolers know about relative distances between landmarks. For example, four-year-old Andrea knew that it was farther between her house and Grandma's than it was between her house and the stop sign.
- Many children can also place locations in a route. For instance, you take a walk to the store with a child. You leave your house, turn right, go down the street one block, turn right again, and walk one more block to the store. Back at home, ask the child where the store is. Without ever having walked the route “as the crow flies,” the child points diagonally in the direction of the store.
- When challenged to learn a route through a
playhouse that had six rooms, four-year-olds who examined a map beforehand learned a route more quickly than those who did not.

This isn't to say that young children are natural map readers, but it does mean that they possess impressive initial abilities that can be fun and exciting to explore. Here are some activities to do just that:

**Where Are We?** Offer children cut-out felt shapes of items in their outdoor play environment, such as trees, a picnic table, a swing set, the sandbox, and so on. Encourage them to lay out the shapes on a felt board to make a simple map of the outdoor area. (The same can be done for your classroom.) Engage children in a discussion of how moving an item, such as a table, would change the map of the environment. Provide felt shapes of children and encourage them to place themselves on the map near the place they most like to play.

**Which Way Is Up?** Many young children are ready to learn environmental directions, such as "above," "over," and "behind," and develop navigation ideas such as "front," "back," "going forward," and "turning." To foster this learning, help children represent these

---

*Even very young children can enjoy playing with cut-out shapes of their environment and using small landscape toys such as houses, cars, and trees.*
Math and Literacy

Here's a list of great books about math to share with your class.
- As the Crow Flies by Gail Hartman, illustrated by Harvey Stevenson (Simon & Schuster, 1993).
- Baby Bop Discovers Shapes by Stephen White, illustrated by Larry Daste (Lyric Studios, 1993).
- Changes, Changes by Pat Hutchins (Simon & Schuster, 1987).
- The Shape of Things by D. A. Dodds (Candlewick Press, 1996).
- What Comes in 2's, 3's, & 4's? by Suzanne Aker (Simon & Schuster, 1992).

concepts on simple maps. For instance, ask children to use masking tape and help you mark a path from the door to the wastebasket. Then, work together to create a map of your path. You can take photographs of the door and the wastebasket and together decide where to glue each one on a large sheet of paper. Then look for and list the items that appear along the path, such as a table and easels. Together, illustrate each on the map in its appropriate place. Children can also use unit blocks and various props and toys around the room to create visual maps of sections of the class, the whole classroom, or your outdoor play area. As children get the hang of map making, some may want to work on more complicated maps.

What's Your Perspective? Provide opportunities for children to explore perspective. Take some photographs of your school building from various perspectives and leave them out for children to look at and think about. Choose a few play structures outside and take pictures of each from varying perspectives. Mix the photographs up and let children sort them by structure. Encourage each child to draw another child's block structure from various views. Post the drawings so children can observe and compare. You might also take pictures of the structures from various perspectives and challenge children to find the viewpoint from which each photograph was taken.

Can You Find It? Hold simple outdoor scavenger hunts so children can practice giving and following directions and clues.

Keep in mind: Geometric ideas are being taught all around us. Materials in toy stores, teacher supply stores, and catalogs, as well as programming on TV, attempt to teach children about shapes. As you seek out resources, look for those that introduce children to a wide variety of shapes, not just triangles, rectangles, and squares. Show varied examples of each shape.

Geometry can be the most fun and the most natural mathematics to explore with preschoolers, building on their existing strengths as they learn about the structure of shapes and space. But we must all keep in mind that children learn these ideas most effectively through active engagement with toys, blocks, puzzles, manipulatives, drawings, computers—and you!

Douglas H. Clements, Ph.D., is a professor of early childhood education at the State University of New York at Buffalo. He has also taught preschool and kindergarten.

Author's Note: Time to prepare this material was partially provided by National Science Foundation Research Grant NSF MDR-8954664, "An Investigation of the Development of Elementary Children's Geometric Thinking in Computer and Noncomputer Environments" and National Science Foundation, grant number ESI-9730804, "Building Blocks—Foundations for Mathematical Thinking. Prekindergarten to Grade 2: Research-based Materials Development." Any opinions, findings, and conclusions or recommendations expressed in this publication are those of the author and do not necessarily reflect the views of the National Science Foundation.

OUR THANKS TO THE STAFF AND CHILDREN AT THE RHINELANDER CHILDREN'S CENTER, CHILDREN'S AID SOCIETY, IN NEW YORK CITY, FOR LETTING US SHOOT THE PHOTOS FOR THE COVER AND COVER STORY.