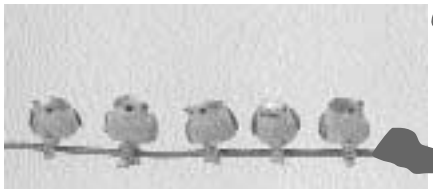
Contents

CHAPTER 5



More Math Manipulatives

Willy eagerly played an elephant stacking game with his teacher. Each time he rolled the dice, he counted the dots and then stacked an equivalent number of small blocks on the back of a plastic elephant. As the stack grew higher and higher, a crowd of spectators collected around the math table. Whenever the teacher or Willy rolled the dice, the watchful children squealed with delight as they too computed how many more blocks the players must attempt to balance on the elephant's back. The stack of blocks began to sway and teeter. Suddenly, as Willy placed one more block on the elephant's back, the entire tower crashed onto the table. Willy and all of his friends roared with laughter. Then everyone began to collect the blocks and return them to their basket so that another game could begin.

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Math manipulatives give children the opportunity to repeatedly think about math concepts as they respond to the play challenges posed by the materials. Frequently, other children are drawn to the excitement of the games, and collective negotiation and problem solving emerge. Children are challenged to broaden their thinking as they listen to the ideas of their peers and discuss the ramifications of each roll of the dice or spin of the spinner.

Teachers' Questions

What are math manipulatives?

Math manipulatives are games or activities that combine intriguing counters or manipulative pieces with the challenge of creating mathematical sets. In some manipulative games, children roll a die, spin a spinner, or select a playing card to determine the quantity of counters they must take. Other math manipulative materials combine quantification with interactive charts or counting books.

Why are math manipulatives important?

Math manipulatives allow children to create sets with movable objects. They also encourage children to quantify and to compare sets. When playing with math manipulatives, children can handle the counters or manipulative pieces as they attempt to assemble the amount required for each turn of the game. This allows each child to use a mathematical strategy commensurate with his or her level of thinking. For example, children at a global stage of quantification can take many counters or just a few, depending on the quantity the die, spinner, or game card selected appears to indicate. Children at the one-to-one correspondence level can align counters with the dots on the die, spinner, or card, and children at the counting stage can count the required number of manipulative pieces. Children must constantly compare sets as they attempt to assemble the necessary number of counters to correspond with the quantity indicated by the game. They also frequently compare amounts with one another as they monitor the progress of the game.

What concepts emerge as children use math manipulatives?

Children construct equivalent sets, discover one-to-one correspondence relationships, and begin to explore addition and subtraction concepts as they interact with math manipulatives. As children attempt to decide how many manipulative pieces to put on a chart or how many counters to take in a game, they must constantly create and compare sets. They form one-to-one correspondence relationships as they learn to carefully align one counter with each dot on a die or say one counting word each time they take a manipulative piece. Gradually, children become interested in accumulating totals as they add game pieces to their collections. They may also begin to roll two dice and discover that they can count all the dots together to find the total. Thus, concepts of addition begin to emerge. As children try to figure out how many more pieces they need to reach a designated amount, they begin to think about subtraction. Games that encourage children to take away counters (activity 5.11) also foster the emergence of subtraction concepts.

What guides teachers in choosing or creating math manipulative materials?

Teachers often select or design math manipulatives to build upon children's interests or to coordinate with other curriculum materials in the classroom. Teachers constantly evaluate children's levels of mathematical reasoning and select math manipulatives to reinforce or extend children's thinking. Good math manipulatives are highly

motivating to young children because the game format is exciting and the movable pieces are intriguing. When the manipulative material relates to a topic of special interest to a group of children, it is even more motivating. Teachers often find that coordinating math activities with other curriculum materials in the classroom heightens children's interest in all of the materials. For example, children immediately want to play a math game that corresponds with a favorite book. They may then wish to reread the book. Suggestions for integrated curriculum materials are included with each activity.

What are some unusual math manipulatives?

Math manipulatives that incorporate physical-knowledge experiences, such as stacking and balancing, offer new challenges for children who are accustomed to the more typical die and counter math games. Activities such as the "Elephant Stacking Game" (activity 5.1), "Twin Towers" (activity 5.2), and "Teeter-Totter Tips" (activity 5.9) all integrate both physical-knowledge experimentation and mathematical reasoning in a game format. The physical-knowledge component adds an element of excitement to math games.

Math manipulatives that utilize materials not usually found in the classroom are also highly intriguing to young children. For example, the downspout used in "Itsy Bitsy Spiders" (activity 5.3) immediately draws children's attention. While they may have noticed downspouts on houses, they have typically not had the opportunity to handle one. Thus, adding spider magnets to the downspout as a math activity may be more interesting for some children than just collecting toy spiders.

Coordinating math activities with favorite songs or interactive charts increases their appeal for some children. Children who are more comfortable with books or language activities may readily gravitate towards a math manipulative that involves a book, song, or chart. "Crunchy Cookies" (activity 5.6) is one example.

What are the easiest math manipulatives?

The easiest math manipulatives incorporate a large die or spinner with relatively large counters that are easy for young children to handle. Quantities on the die or spinner are limited to three. Extensive observations of children in our classrooms indicate that young children can first process quantities of one to three items. Anything beyond that is viewed as "a lot." Teacher-made dice and spinners can limit amounts to correspond to the mathematical reasoning levels of young children. Quarter-inch round file stickers mounted on one-inch cubes make excellent dice for young children.

What types of math manipulatives are more challenging for older or more advanced children?

Math activities that utilize two or more dice and larger quantities of counters or manipulative pieces are more complex. Using two dice introduces children to the concept of adding two sets of numbers. At first, many children count the two dice separately before selecting their counters, and they do not understand that they could get the same total by counting all of the dots together. Once children arrive at this realization, they need many opportunities to experience the results of adding two sets. Counting errors are common. Eventually, children solidify their counting skills and begin to remember addition combinations. At this point, some children may wish to add a third or fourth die to their games to further increase the complexity. Special dice, such as ten-sided or spherical dice, also add interest for more experienced children.

How should teachers guide children in their use of math manipulatives?

Teachers should encourage children to use their own thinking strategies to solve math problems. Telling children how to get the correct answer, such as moving the child's finger while counting, does not help children learn to think logically. Instead, it imposes the adult's thinking on the child and teaches children to look to adults to solve math problems. Children need many opportunities to think about mathematical relationships in order to develop their sense of number.

Teachers can encourage children to discuss mathematical problems that emerge as they interact and play games together. Discussion and disagreement among peers do not inhibit children's autonomy and willingness to think about solutions to problems. Often, as children try to explain a viewpoint to another child, new ways of thinking emerge. Children learn from one another because they think and evaluate as they argue and discuss.

Teachers can subtly guide children by modeling mathematical reasoning at a stage that is just above the thinking level of the child. Thus, if a child is at a global level of quantification, the teacher might model one-to-one correspondence; if a child is at a one-to-one correspondence level, the teacher might model counting. Modeling is not the same as correcting errors. It simply offers an alternative means to solve a problem.

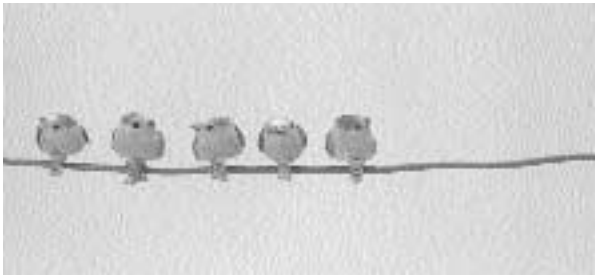
What if the teacher is involved with other issues in the classroom and is often not available to play math games with children?

The potential for mathematical learning is imbedded in the materials and in the interactions among peers as they play with math manipulatives. Dice and spinners naturally encourage children to quantify and to create and compare sets. Due to the game nature of many of the materials, children frequently play them with a friend. As children discuss the progress of the game, they fuel each other's thinking. Data collected in our classrooms over a period of many years strongly affirms that children make substantial progress in their mathematical thinking even when the teacher is not a prominent part of their interactions with math manipulatives and games. This observation is not meant to discourage teachers from interacting with children in the math area, as teacher modeling and questioning strategies can be very valuable. However, it may serve to reassure teachers that learning occurs even when they are not directly involved.

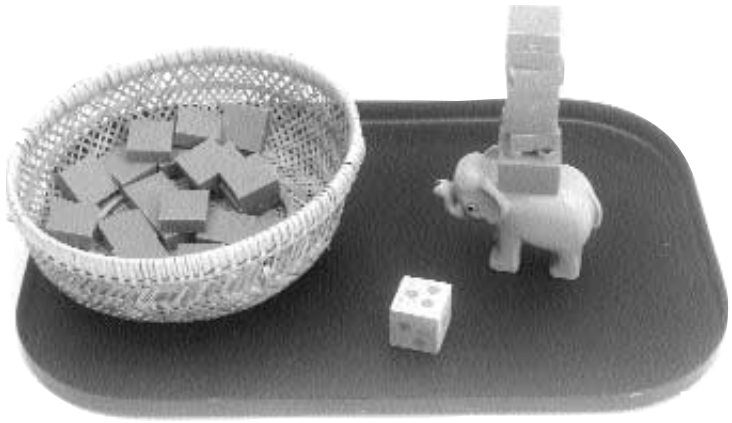
How can teachers assess children's mathematical thinking through their use of math manipulatives?

Teachers can carefully observe children to determine what mathematical concepts they are exploring and their level of mathematical reasoning when quantifying. Over time, teachers can watch for a progression in each child's thinking. When interacting with children, teachers may ask leading questions to explore children's reasoning and problem-solving strategies. Each activity in this book offers suggestions for questions that teachers may use to extend children's thinking. Teachers may wish to record their observations anecdotally or use the assessment form in the appendix.

More Math Manipulative Activities



5.1 Elephant Stacking Game



Description

This is an exciting manipulative game for children of many ages. Children take turns rolling dice and attempting to stack an equivalent number of small blocks or disks on the back of a toy elephant. Each player tries not to be the one to topple the stack. The game combines the physical-knowledge challenge of balancing the tallest stack of blocks possible with the math concepts of creating and comparing sets.

Math Concepts

▲ quantification
▲ creation and comparison of sets
▲ addition

Materials

▲ Duplo elephant, or other toy animal with a flat back
▲ small blocks (¼-inch-thick plastic blocks, called Rainbow Counters, were used in the photo)
▲ 1 or 2 dice

Child's Level

This activity is appropriate for both preschool and kindergarten children.

What to Look For

Children will try to create the highest possible tower of blocks.
Children will quantify the amount on the die and try to add an equivalent number of blocks to the stack.
Some children will stack blocks without regard to the number shown on the die.
Children will discover that a large number can be a hindrance because it increases their odds of knocking over the tower.
Some children will roll two dice and add the sets together to get the total.

Modifications

For younger children, use a 1–3 die and 1-inch cubes for stacking. You can make the die by applying ¼-inch round file stickers to a 1-inch cube. One-inch cubes may be easier for young children to manipulate than thinner blocks.
For older children who can handle larger quantities, use two dice and poker chips for stacking. Since poker chips are thin, many more can be piled on the elephant's back before they fall.

Questions to Extend Thinking

How can you tell how many blocks to put on the elephant's back?
Do you think Katrina can balance six more blocks on the elephant's back?
Should I hope for a big number or a little number when I roll the dice?
How many blocks do you think we can balance on our tower?

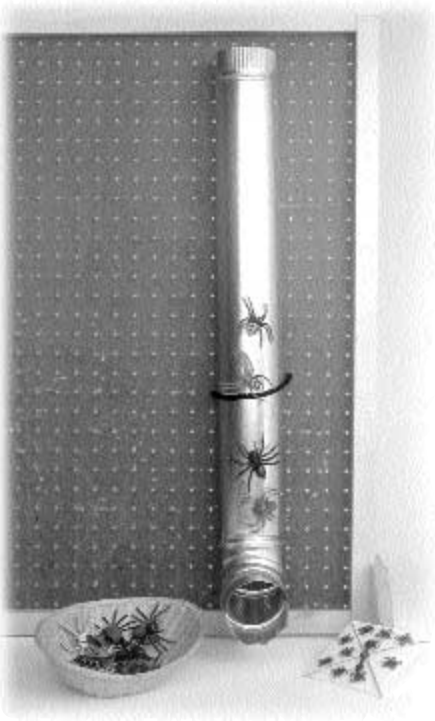
Integrated Curriculum Activities

Include zoo animals in the block or manipulative areas.
Provide other types of materials for stacking.
Read books about zoo animals, such as *Dear Zoo,* by Rod Campbell (Washington, DC: Four Winds, 1982).

Helpful Hints

Put a square Duplo block on the back of the elephant before stacking the blocks. This creates a flat surface to support the block tower.

5.3 Itsy-Bitsy Spiders



Description

For this game, children spin a spider spinner to determine how many magnetized plastic spiders to place on their metal downspout. Children can quantify how many spiders they have at the end of the game and compare the results.

Math Concepts

- ▲ quantification
- ▲ creation and comparison of sets
- ▲ addition

Materials

- ▲ 1 or 2 metal downspout sections, each with a 90-degree elbow joint
- ▲ plastic spiders, with pieces of magnetic tape glued to them
- ▲ spider spinner, made by adhering spider stickers or confetti to a blank spinner in sets of 1 to 4

Child's Level

This game is appropriate for both preschool and kindergarten children. Older or more experienced children may choose to play the game like a path game, as suggested in the modification.

What to Look For

Some children will spin the spinner to determine how many spiders to put on their downspout.

Some children will compare how many spiders they each have.

Some children will initially stick spiders to the spouts without regard to the quantity. They may be more interested in the magnetic properties of the spiders than in how many they have. Later, they may begin to quantify the spiders.

Modification

For more advanced children, create a path on the downspouts with horizontal strips of plastic tape. Children can move the spiders up the spouts as in a short path game (see chapter 7).

Questions to Extend Thinking

Do you have as many spiders as Lucy?
How many spiders will you have if you get two more?
If one spider falls off the spout, how many will you have left?
How can we find out which spout has the most spiders?

Integrated Curriculum Activities

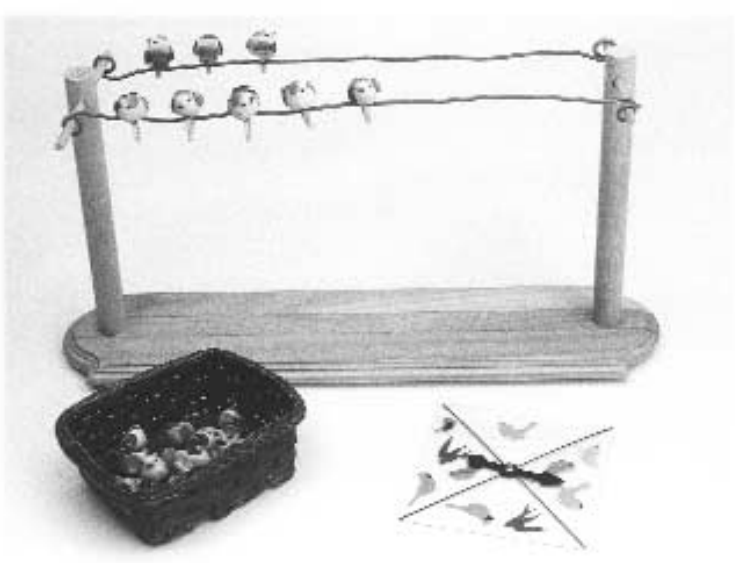
Sing the "Itsy-Bitsy Spider" as children play the game.
Read books about spiders and insects.
Put a large model of a spider and an insect in the science area so children can compare them.
Take a nature walk and look for spider webs. Spray the webs with water to make them more visible.

Helpful Hints

Downspout pieces can be purchased from hardware or building supply stores. They can be taped to a room divider or the back of a shelf to hold them in place.

Use a hot glue gun to mount the magnetic tape to the spiders.

5.10 Birds on a Wire



Description

Children often observe birds sitting on telephone wires. For this game, each child has a telephone pole and wire frame made from wooden dowels and wrapped wire. They also have small birds to clip onto the wires. A spinner or die determines how many birds each child can add to the wire with each turn.

Math Concepts

- creation and comparison of sets
- quantification
- addition

Materials

- telephone pole frame (see directions below)
- small wooden or flocked birds, secured to small pinch clothespins with a hot glue gun
- bird spinner, made by adhering sets of 1 to 4 bird stickers to a blank spinner

Directions

To make the telephone pole frame, cut two 8-inch lengths of ¾-inch-diameter dowel. Drill a ¼-inch hole through each dowel near the top. Insert and glue a 5-inch length of ¼-inch dowel in each hole. Drill a ¾-inch-diameter hole at either end of a wood base (15 by 4 inches). Glue the ¾-inch-diameter dowels into the holes. Stretch plastic-wrapped wire between the crossbars of the telephone poles.

Child's Level

This game is most appropriate for older preschool or kindergarten children, who can more easily manipulate the birds.

What to Look For

Children will spin the spinner to determine how many birds to put on their wire.

At first, some children may clip birds to the wire without regard to the spinner. They are exploring the physical properties of the clips and balancing the birds.

Some children will compare how many birds they each have on their wires.

Some children will quantify how many birds they each have at the end of the game.

Modifications

Switch to larger birds and clothespins for younger children. They may find the larger size easier to manipulate.

For more advanced children, use one or two standard dice.

Questions to Extend Thinking

Do the wires have the same number of birds?

How many birds will you have if you get one more?

How many birds could sit on this wire?

If one bird flew away, how many would you have?

Integrated Curriculum Activities

Switch to a subtraction game ("Birds Fly Home," activity 5.11), after children have had many experiences adding birds.

Put bird nests in the science area (see *More Than Magnets,* activity 2.8).

Include feathers as a collage material in the art area.

Sing songs about birds (see *More Than Singing,* activity 2.2).

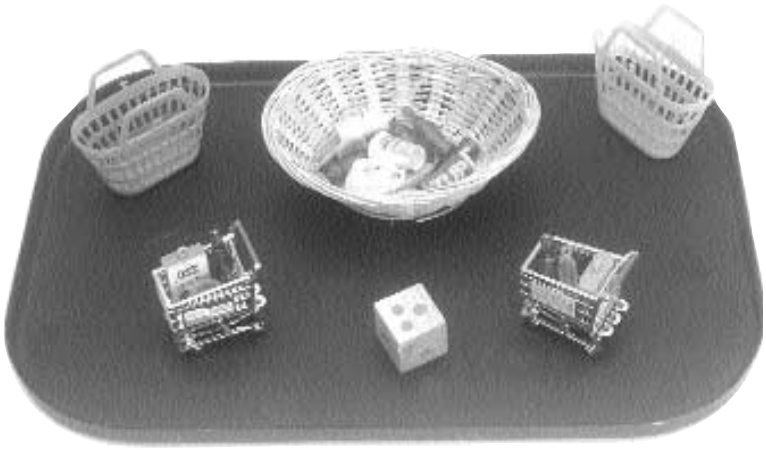
Read books about birds, such as *Good-Night Owl,* by Pat Hutchins (New York: Macmillan, 1972), *Owl Babies,* by Martin Waddell (Cambridge, MA: Candlewick, 1992), and *Flap Your Wings and Try,* by Charlotte Pomerantz (New York: Greenwillow, 1989).

Helpful Hints

Drill the holes in the dowel to hold the wire before gluing the dowels to the base.

To further secure the wire, wrap it around the dowels and then secure it in place with plastic tape.

5.12 Shopping Cart Bonanza



Description

For this game, each player has a dollhouse-size shopping cart. Players take turns rolling a die and selecting tiny plastic foods to put in their carts.

Math Concepts

▲ creation and comparison of sets
▲ quantification
▲ addition

Materials

▲ 2 novelty shopping carts (approximately 3 inches long)
▲ tiny plastic foods
▲ a 1–3 or 1–6 die

Child's Level

This activity is appropriate for either preschool or kindergarten children.

What to Look For

Children will roll the die to determine how many items to place in their shopping carts.
Children will select a quantification strategy (global, one-to-one correspondence, or counting) commensurate with their level of thinking.
Some children will sort the food by categories and compare how many of each type they have.
Children will try to fill the shopping carts.

Modification

For kindergarten children, create a set of cards with a picture of a food and the name of the food written on each card. Children can draw a card to determine what type of food to take and then roll the die to find out how many they need to take. Some children may wish to graph the results.

Questions to Extend Thinking

How many pieces of food do you think will fit in your cart?
What kind of food do you have the most of?
Is there a way to find out which cart has the most food?

Integrated Curriculum Activities

Set up a grocery store in the dramatic play area.
Create a gross-motor version of the game with child-size shopping carts, plastic fruits and vegetables from dramatic play, and a large die to roll. Paint lines across the sidewalk to create a path (activity 1.16).

Helpful Hints

Look for tiny food items in novelty or party supply stores. The shopping carts may be found in the same type of store or with doll furniture in craft stores.