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April 1996

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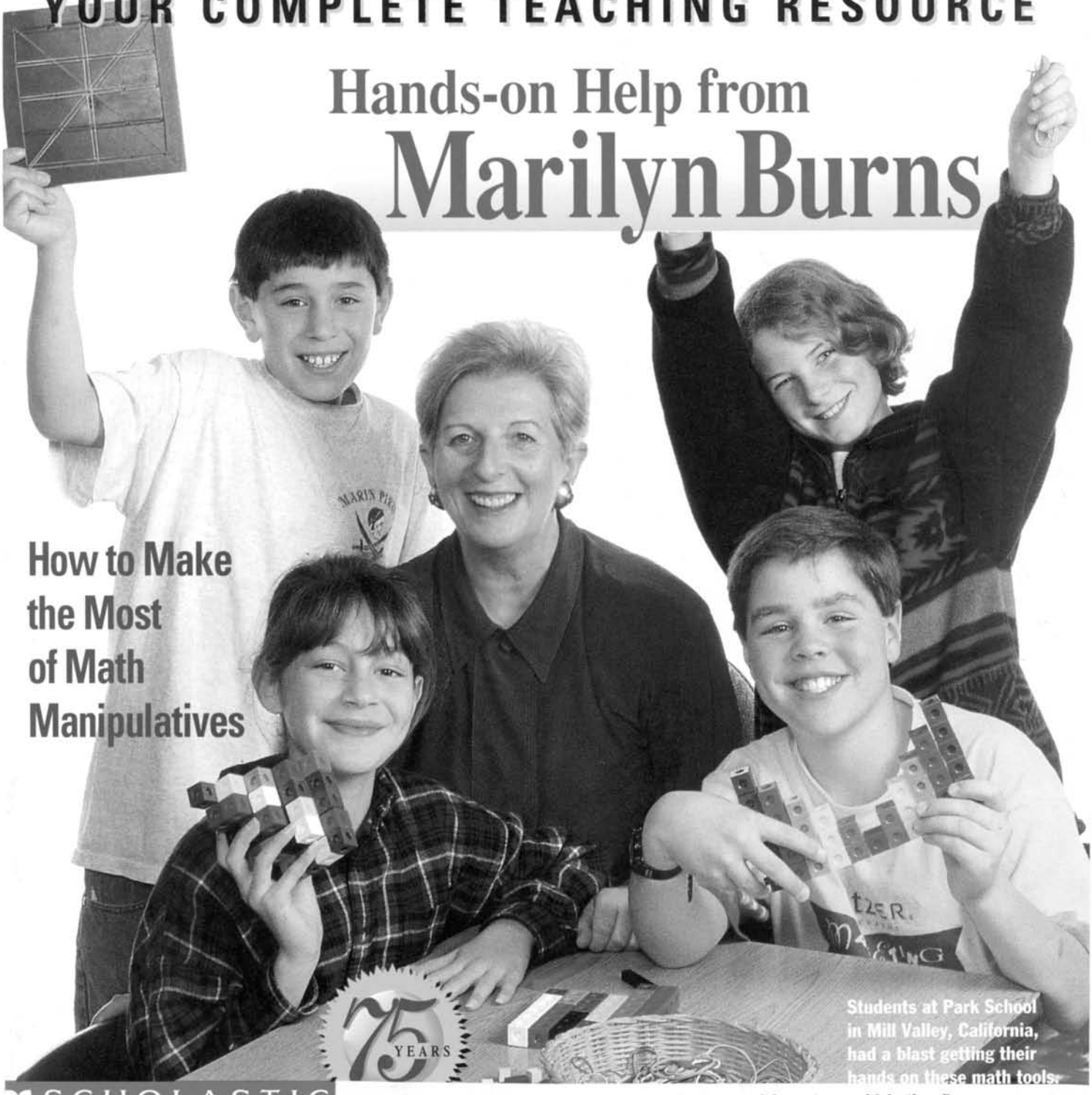
Hands-on Help from Marilyn Burns

How to Make the Most of Math Manipulatives



75 YEARS

Students at Park School in Mill Valley, California, had a blast getting their hands on these math tools.

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HOW TO MAKE THE MOST OF

Math Manipulatives

A fresh look at getting students' heads—and hands!—around math concepts

Marilyn helps Mira and Kyle decide which manipulative tools to use to solve their problem.

Photos: Bob Adler

by Marilyn Burns

You find them in classrooms across the nation—buckets of pattern blocks; trays of tiles and cubes; and collections of geoboards, tangrams, counters, and spinners. They've been touted as a way to help students learn math more easily. But many teachers still ask: Are manipulatives a fad? How do I fit them into my instruction? How often should I use them? How do I make sure students see them as learning tools, not toys? How can I communicate their value to parents? Are they useful for upper-grade students, too?

I've used manipulative materials at all levels for 30 years, and I'm convinced I can't—and shouldn't—teach without them. Here I look at every side—and corner, color, and shape—of manipulatives and share:

- **7 Musts for Using Manipulatives**
- **A Letter to Parents**
- **Answers to Your Questions**
- **How I Introduced the Geoboard in My Classroom**
- **Pattern Block Activities**
- **PLUS: An *Instructor* Giveaway**

MARILYN BURNS, Instructor's *math editor, is the creator of Math Solutions, inservice workshops offered nationwide, and the author of numerous books for teachers and children.*

My Manipulative Story

How I introduced the geoboard in my classroom

I remember the first time I introduced a manipulative to my class. At a workshop, I had learned how students could use geoboards to explore the areas of shapes, a standard textbook topic. I was excited and ready, but nervous.

I gave a geoboard to each student, distributed a cup of rubber bands to each pair, and gave time for exploration. Within a minute, chaos reigned. The cups were empty; every geoboard was full. Some students slouched in their chairs waiting for instructions. A few strummed the rubber bands as if the geoboard were a guitar. Several students, attempting to remove rubber bands from the geoboards, instead sent them flying. Others disappeared under their desks to retrieve lost rubber bands. This wasn't what I had envisioned.

Since then, I've changed how I set the stage for learning with materials. Here are some ways I've learned to introduce geoboards.

For Intermediate and Upper Grades

◆ **Step 1:** I drew a model on the chalkboard of a geoboard's 5-by-5 array and distributed one board to each student (no rubber bands yet). I asked, "How many pegs are there?"

When I did this recently with fifth graders, I gave students time to think and then called on Sarah.

"Twenty-five," she answered.

I responded, "You're right. How did you figure that out?"

She replied, "I counted five in a row and there are five rows, so I did 5, 10, 15, 20, 25."

"Did anyone figure it out a different way?" I asked.

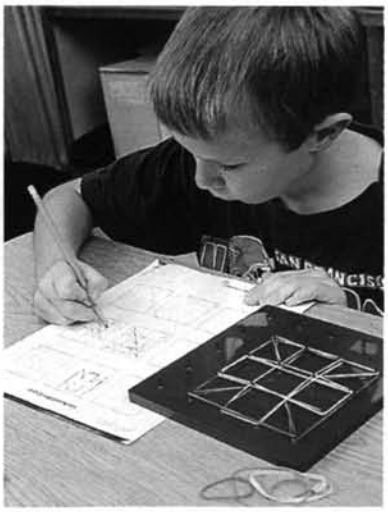
Kyle answered, "I did 5 times 5."

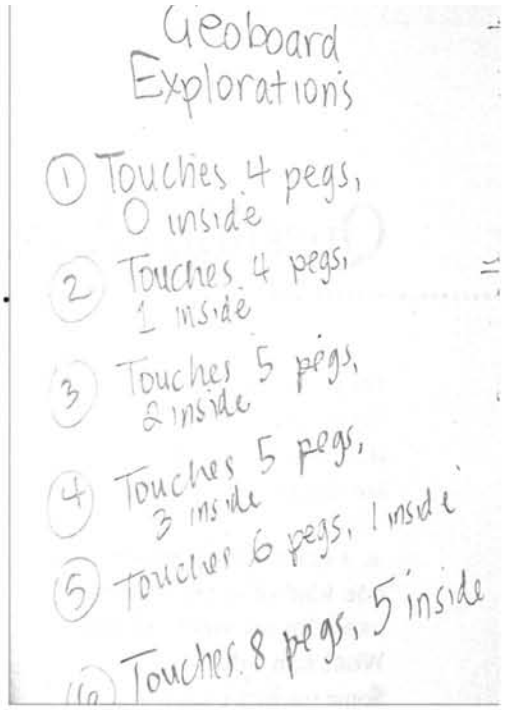
I continued until all students had a chance to report their methods.

◆ **Step 2:** I made a shape on my geoboard using one rubber band and drew it on the chalkboard geoboard. (This helped introduce students to the geoboard dot paper.) "Does anyone know this shape's name?" I asked. Several hands shot up, and Mike said, "Quadrilateral."

I then said, "Listen to my question and raise your hand when you figure out the answer: How many pegs does my rubber band touch? Count not only the corner pegs, but any peg that touches the rubber band." I waited until practically everyone's hand was raised.

Pat transfers the shape he made on his geoboard to dot paper.





"Let's answer together," I said.

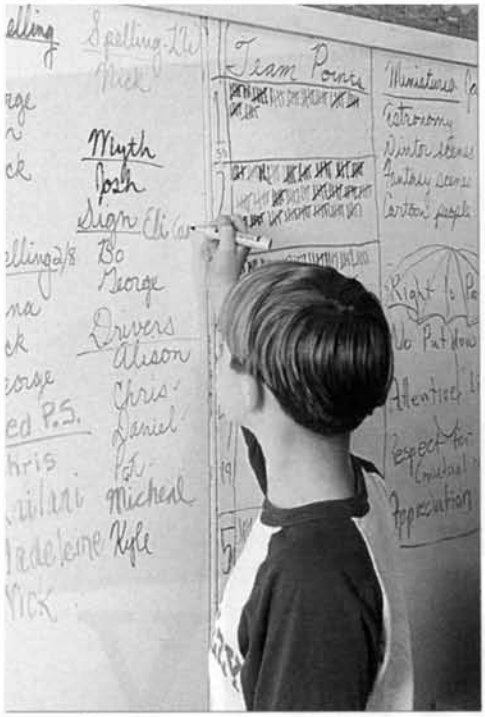
"Five," students responded.

"And how many pegs are inside my shape, not touching any side?" Again they said the answer in unison. I repeated this for several shapes.

◆ **Step 3:** I gave students directions to come up with nine shapes with rubber bands touching different numbers of pegs and with different numbers of pegs inside. I also gave pairs of students geoboards, rubber bands, and geoboard dot paper. I said, "First make any shapes on the geoboard. Then construct shapes to match my descriptions. On the dot paper, record one shape that matches each description."

The atmosphere was much different than my first experience. Some children still strummed the rubber bands, but the overall feeling was one of productivity.

◆ **Step 4:** The next day, I asked pairs to create as many shapes as they could that touch four pegs with two pegs inside. Students recorded their shapes on the geoboard dot paper. Later, they exchanged papers and checked each other's shapes.



Eli has just completed the activities in steps 3 and 4, opposite.

Finally, I asked students to write the names of the shapes.

For Younger Children:

◆ **Step 1:** I give children time to explore with the geoboard. (They enjoy this, and some need the practice putting the rubber bands around pegs.) Then I say, "Remove the rubber bands on your geoboard and start again, this time making a shape of something that can fly."

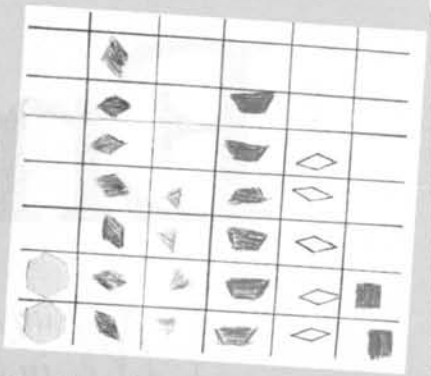
◆ **Step 2:** When everyone has made at least one shape that flies, I show them how to transfer their shape to geoboard dot paper. I use dot paper with only two geoboards to a page so their drawings are large enough for display.

◆ **Step 3:** Finally, I have students post their recorded shapes—kites, rockets, butterflies—on a huge graph with a different column for each object. We discuss how many of each shape we have, how many more of one shape we have than another, and how shapes are alike and different. ■

Pattern Block Activities

Pattern blocks fit together to make intriguing and beautiful patterns, and they help children learn math in a multitude of ways. Here are classroom activities of all levels—plus homework assignments that extend learning and bring parents into the loop. (The last problem may even challenge you!)

SCOOP AND SORT (K–2)



Step 1: Have children take a two-handed scoop of pattern blocks, sort them by shape, and place matching shapes in separate columns on 18-by-24-inch newsprint. It helps to draw a grid.
Step 2: Ask students to trace and color the blocks, or paste construction paper shapes onto the grid. Post one of the children's graphs and have children talk about what they notice. Over several days, repeat for all of the children's graphs.
Homework: In class have students write three sentences about their graph. Send home their graphs and ask parents to help them write three additional sentences.

BUILD THE YELLOW HEXAGON (GRADES 3–5)

Step 1: Have students work in groups to find all the different ways to re-create the yellow hexagon using different assortments of blocks.
Step 2: After they think they've found all the ways, have children record them using fractions, with the yellow hexagon assigned the value of 1. For example, if they build the hexagon with one red trapezoid and three green triangles, they'll write: $1/2 + 1/6 + 1/6 + 1/6 = 1$. (Show students how to shorten that to $1/2 + 3/6 = 1$.)
Homework: Send home the student work with a sampler of pattern blocks.

BUILDING LARGER SHAPES (GRADES 4–6)

Step 1: Ask students to investigate which of the pattern blocks they can use to build shapes that are larger but similar—such as four or nine squares to make a larger square. To get children started, ask: Can you use green triangles to build a larger green triangle that is still the same shape? How many do you need?
Step 2: Send the problem home with a sampler of pattern blocks.

A CHALLENGE (GRADES 6 AND UP)

You can easily compare the areas of some shapes of pattern blocks. The red trapezoid, for example, is half the area of the yellow hexagon and three times as large as the green triangle. How do the areas of the orange square and tan parallelogram compare?

Try this yourself! If you get stuck, you'll find the answer in next month's Math in Action column and on our World Wide Web site: **http://scholastic.com/Instructor**

7 Musts for Using Manipulatives

1 I talk with students about why manipulatives help them learn math. These discussions are essential for first-time users and useful refreshers to refocus from time to time. (If you haven't talked with students yet, share the parent letter—opposite.) I precede discussions by giving children time to explore a manipulative. Then we talk about what students noticed and I introduce the concepts they'll learn with the material.

2 From day one, I set ground rules for using materials. We talk about the similarities and differences between using manipulatives in class and playing with toys or games. With toys or games, children can make up their own rules. With manipulatives, they are given specific problems and activities. I do make clear, however, that they're free to make discoveries and explore new ideas.

It's also important for students not to interfere with one another. I step in when I hear a howl of protest as a student who needs one more yellow tile takes it from another group's table. Sometimes I open up the discussion to the entire class. These impromptu reminders help keep students on track.

3 I set up a system for storing materials and familiarize students with it. It's important for students to know where and how to store materials. A clear system makes the materials more accessible. Some teachers designate and label space on bookshelves. Others use zip-top plastic bags and portion materials into quantities useful for pairs or groups. Still others place a supply of each material at students' tables so they're always within reach.

Third graders can't wait to get their hands on these well-organized manipulatives.

4 Time for free exploration is worth the investment. Whenever I introduce a new material, I allot at least one math period for this. Teacher demonstrations alone are like eating a papaya in front of the class and expecting children to know how it tastes.

Free exploration time also allows students to satisfy their curiosity so they don't become distracted from the assigned tasks. Expect children to see if tiles can fall like dominoes; build tall towers with rods; or construct rockets out of cubes.

After children have explored a material, I ask what they've discovered and record their observations on a chart so their classmates can get insights from their ideas. Then I assign a specific task.

5 For easy reference, I post class charts about manipulative materials. Charts not only send students the message that I value manipulatives, but also help students learn materials' names and how to spell them. In September I post a chart that lists all the materials we'll use during the year. For some materials, I post separate charts to list their shapes and colors. And I leave posted charts of students' discoveries about materials.

6 Manipulatives are a natural for writing assignments. In the April 1995 issue of *Instructor,* I described the benefits of having students write in math class. Manipulatives provide concrete objects for children to describe.

7 I let parents get their hands on manipulatives, too. It's important for parents to understand why their children are using materials (see the parent letter, opposite). Follow up by having children take home materials and activities to do with their families. (Hint: I wait until students have had some experience.)

A Letter to Parents

Marilyn Burns, a teacher and the nation's leading math innovator, answers the pressing question: What are math manipulatives and why is my child using them in school?

For more than 30 years, I've been teaching math, writing books about mathematics for children and teachers, visiting schools like your child's to help improve math instruction, and informing parents about what—and how—their children are learning.

Math classes today may look different from what you remember when you were in school. One difference is that teachers are using materials such as spinners and cubes—called manipulatives*—to teach your children math. Solving problems with manipulatives may not be the way we learned math, but current research and classroom results show that they are solid learning tools that give children a clear advantage. Experiences with manipulatives help children see math as a subject to be understood, not memorized.*

Manipulatives in Today's Classroom

Have you ever visited a new city and felt confused about finding your bearings—even if you had a map and directions? After a few days you probably got a feel for the area, and even if you became lost from time to time, you could count on familiar landmarks to help you on your way. And with enough exploring, most likely you ventured with more confidence wherever you needed to go.

We can think of the value of firsthand experiences for learning mathematics in a similar way. Math has many areas—patterns, measurement, geometry, statistics, probability, and more—and they're often unfamiliar, abstract, and confusing to students. We need to help children develop the ability and confidence to find their way around in each of these areas, see how they connect, and know what to do should they forget a fact or procedure. Here are five reasons manipulative materials do just that:

1 Manipulatives help make abstract ideas concrete. A picture may be worth a thousand words, but while children learn to identify animals from picture books, they still probably don't have a sense about the animals' sizes, skin textures, or sounds. Even videos fall short. There's no substitute for firsthand experience. Along the same lines, manipulatives give students ways to construct physical models of abstract mathematical ideas.

2 Manipulatives lift math off textbook pages. While we want students to become comfortable and proficient with the language of math—everything from the plus sign to the notations of algebra—words and symbols only represent ideas. Ideas exist in children's minds, and manipulatives help them construct an understanding of ideas that they can then connect to mathematical vocabulary and symbols.

3 Manipulatives build students' confidence by giving them a way to test and confirm their reasoning. One goal of the National Council for the Teachers of Mathematics Standards is to build students' confidence with mathematics. If students have physical evidence of how their thinking works, their understanding is more robust.

4 Manipulatives are useful tools for solving problems. In searching for solutions, architects construct models of buildings, engineers build prototypes of equipment, and doctors use computers to predict the impact of medical procedures. In the same way, manipulative materials serve as concrete models for students to use to solve problems.

5 Manipulatives make learning math interesting and enjoyable. Give students the choice of working on a page of problems or solving a problem with colorful and interestingly shaped blocks, and there's no contest. Manipulatives intrigue and motivate while helping students learn.

This newsletter was made possible by *Instructor,* America's premier magazine for teachers, published by Scholastic Inc.

Q&A Marilyn Burns Answers Your

▲ Manipulatives help my slower learners, but do my better math students need them?
Absolutely. The challenge of teaching any subject is to find activities that are accessible to all learners and have the richness to challenge more interested or capable students. Manipulatives are a wonderful resource for this. For example, I introduced fourth graders to Build the Yellow Hexagon (see page 51.) All students found different ways to build the hexagon and recorded their constructions with correct fractional notation. I asked the students who finished quickly: "How much larger is the red trapezoid than the blue parallelogram?" This challenged them to figure out how much more 1/2 is than 1/3.

Because Bo has had time for free exploration, he won't be easily distracted from tasks.

▲ How often should I use manipulatives in my teaching?
Ideally, the materials are available for students to use at any time to help them think, reason, and solve problems. When a manipulative material is key to a lesson, I initiate its use.

▲ What about students who work well with manipulatives but have trouble with textbooks?
Showing the bridge from concrete experiences to symbolism is essential. While it may be obvious to adults, it can be a stretch for students to see how a 3-by-4 rectangle built with tiles relates to the textbook explanation that 3 x 4 means three groups of four. I help children make connections by demonstrating how a rectangle can be separated into three rows with four tiles.

If your textbook doesn't reference manipulatives, talk about what students might use to help solve a problem. Often, students don't realize that what they use in one setting can be helpful in another.

▲ How many kinds of manipulatives do I need?
It makes sense to introduce one material and provide time for in-depth exploration. But one advantage of using a variety is that children can think about ideas in different ways. For example, we wouldn't want children to think of fractions as related only to round pies.

▲ Can't I make cheaper manipulatives?
For years I've had children cut paper cookies to explore fractions, fold shapes for geometry, and use strips for measurement. Students also cut paper squares into the seven tangram puzzle pieces to see that the pieces make a square. However, to create other shapes, compare areas and perimeters, or make observations over time, paper pieces aren't durable or exact. Manipulatives stand the test of time and are precise. They also allow students to discover the mathematical relationships inherent in them.

▲ Where do I fit manipulatives in when there's so much to do?
I use manipulatives as a support for teaching the math topics that are in the curriculum. I don't reserve materials for special days or assignments, but make them a regular and integral part of my general teaching.

▲ I worry that children will see the same materials year after year and lose interest. Do they?
Schoolwide planning to discuss which manipulatives you'll use and how to use them can be valuable. However, be careful not to designate certain materials or activities for only one grade. Most are appropriate for different levels, and repeat experiences help students stretch their thinking. For example, asking primary children to find different ways to make trains of six interlocking cubes using just two colors helps them explore different addends of 6.

Questions About Manipulatives

Older students can be challenged to figure out how many arrangements there are, not only for trains of 6, but also for trains of other lengths.

▲ I don't have enough of any one kind of manipulative to use with my whole class. What can I do?

Some teachers I know organize learning centers and have small groups work at them. Others introduce a few activities to be done over several days, and students make choices based on which materials are available. Still others pool materials for a week with other teachers to create class sets. In all cases, having students work cooperatively not only cuts down on the amount of material you need, but also encourages communication—which in turn promotes learning.

▲ How do I know when it's time for students to put away the materials?

I let students be my guide. Observing them gives me valuable information. Sometimes I've assigned students the problem of finding all of the rectangular arrays using 6, 12, and 24 tiles. While some need to build all of the rectangles with tiles and then record them, other students stop using the tiles and are comfortable drawing the rectangles.

▲ I worry older students will complain that manipulatives are babyish. Any advice?

I rarely get this reaction. Most are delighted to get their hands on concrete materials. If you anticipate naysayers, talk about how, for example, architects often build models of buildings and engineers construct prototypes. Tell students that they'll use materials to model a problem or situation. Then be sure they first experience something that offers a challenge and that you provide free exploration time.

WIN a Marilyn Burns Video!

Here's your chance to win *Mathematics with Manipulatives: Pattern Blocks; Mathematics with Manipulatives: Geoboards;* or a videotape for parents, *Mathematics: What Are You Teaching My Child?* Each 20-minute videotape from Cuisenaire Company features Marilyn Burns teaching in actual classrooms. For a chance to win, send a postcard with your name, school address, and the grade you teach, to Math Video Giveaway, Instructor, Scholastic Inc., 555 Broadway, New York, NY 10012-3999, by May 1, 1996. Specify which video you prefer. Ten winners will be chosen in a random drawing.

"Wow! Look at my discovery!" announces Allison as Elissa ponders the problem.