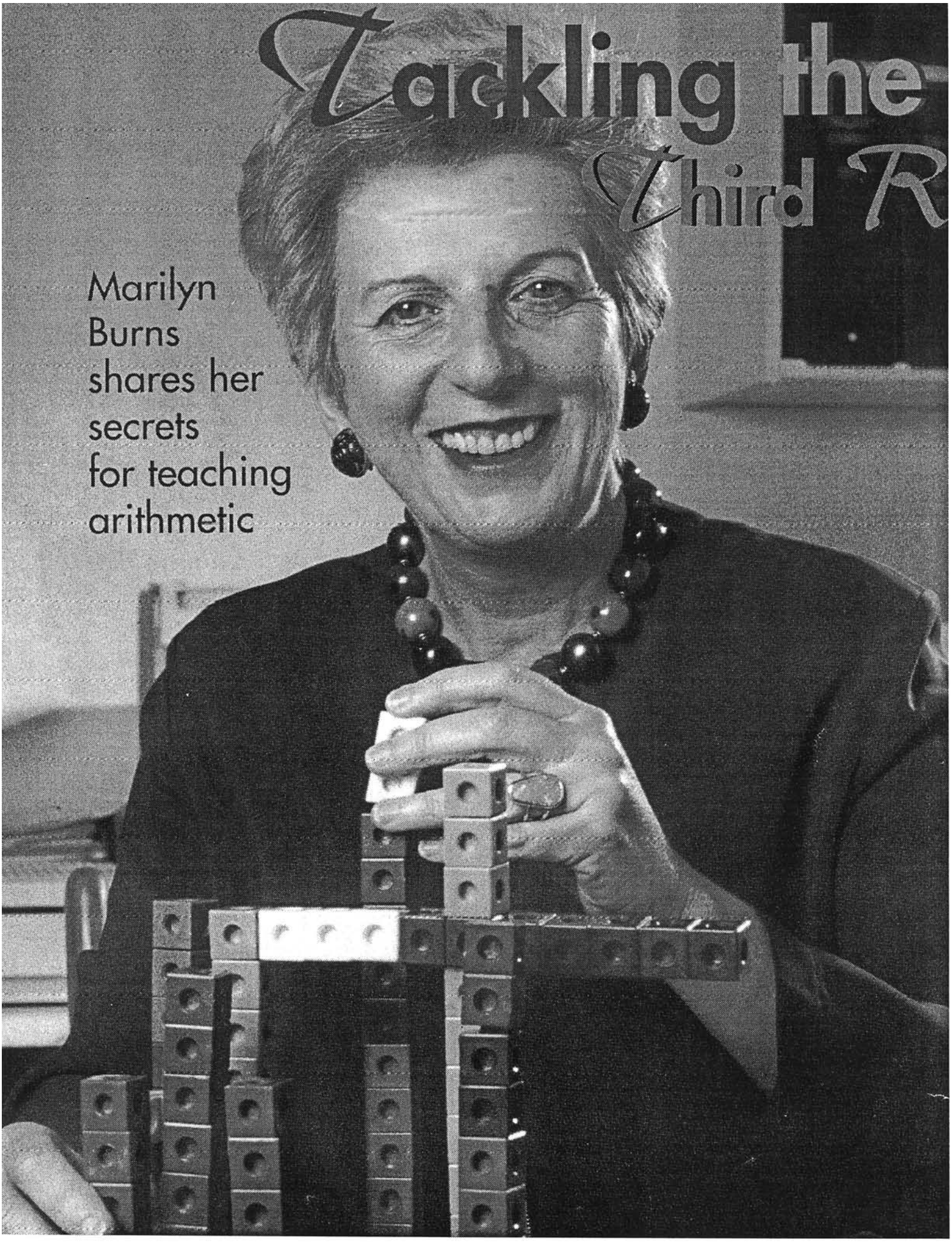
Tackling the Third R
Marilyn Burns shares her secrets for teaching arithmetic

Third R TOUGH to TEACH

When it comes to the three *R*s, arithmetic can be the toughest to teach. Some teachers rely mostly on pencil-and-paper practice, believing that children learn best through repetitive exercises. If you focus on the basics, they say, students will build a solid understanding in math. Others dismiss this approach, arguing that skill-and-drill worksheets turn students off to math and do little to develop understanding. Instead, these teachers favor problem solving and hands-on activities that call for students to *use* skills, not just practice them.

Who is right? What's the best equation for arithmetic instruction in today's classroom? With all the other topics to teach in the elementary math curriculum—from estimation to geometry—are teachers putting too much emphasis on computation?

To get answers, *Creative Classroom* turned to Marilyn Burns, a teacher and one of the nation's leading math educators. She offered the following insights.

Marilyn Burns is the author of more than 20 books for teachers and children and the creator of Math Solutions, five-day summer courses offered nationwide. For information, call (800) 868-9092 or visit Math Solutions Online at www.mathsolutions.com

1. Arithmetic is as important as ever—just read the draft of *Standards 2000*. Since I was a student, and even more since I've been a teacher, the elementary math curriculum has changed dramatically. Topics have been added such as geometry, measurement, probability, statistics, and algebraic thinking. New attention has been put on problem solving, reasoning, and communicating in math class. And calculators and computers are available in more and more classrooms.

Still, arithmetic reigns as the high-stakes topic to teach. It's front and center in *Standards 2000*, the revision of the National Council of Teachers of Mathematics (NCTM) *Curriculum and Evaluation Standards for School Mathematics*, first published in March 1989 and commonly known as "the Standards." In the new version, now available as a draft, "Number and Operation" is the first of ten standards. (See box on page 96.)

2. Students don't learn all they need by simply practicing computation. When I studied arithmetic in elementary school, the message was clear: pay attention to the teacher and learn to do what she does. I practiced and practiced, working quietly and mostly alone to line up columns neatly and check my work carefully. I learned the lessons well. But many of my classmates were not as lucky. They became math casualties who hopelessly struggled with numbers, learning to dislike rather than embrace math.

Children need to deal with numbers in a variety of settings, not just as computations done in isolation. They should be encouraged to estimate, to use numbers to solve problems, and to learn different ways to arrive at answers—all of which help them learn to think and reason numerically.

3. Problem solving and number sense are integral to arithmetic. When I think about teaching arithmetic, I picture a three-legged stool. *Computation, problem solving, and number sense* are the three legs that support the seat. Children must develop competence and confidence in each area. Only then will they become proficient in "the 3rd *R*" and establish a firm foundation for future learning. If they only become skillful in, say, computation, the stool will collapse, leaving in its wake students who are unsuccessful at and turned off to math.

Teachers need to pay attention to each leg of the stool so that students develop a firm, well-balanced support for understanding in arithmetic.

4. Developing number sense is an important goal for all students. Students with number sense think and reason flexibly, make sound numerical judgments, and see numbers as useful. It's important for students to see numbers as tools, not as barriers. Students with number sense are able

to think and reason numerically and make sense of numerical situations. They have good numerical intuition, can estimate, and are able to judge what's numerically reasonable in various situations.

5. Being able to compute is only as valuable as being able to use those skills to solve problems. When faced with a situation that calls for numerical calculations, students need to be able to choose the correct operations, decide on the numbers to use, do the necessary calculation, and then appropriately interpret the results. Along with routine one-step or multi-step word problems that have long been standard to math instruction, students should also have experience solving non-routine problems that call for more than computing and that may have more than one solution and more than one way to arrive at them.

6. Students must learn to calculate in their heads—not just with paper and pencil. Computing mentally is often shortchanged in school. Perhaps this is because figuring out problems in their heads doesn't produce written evidence of the children's work. Also, calculating mentally isn't something that lends itself to homework assignments. But think about the arithmetic problems you solve in your daily life—paying the bill at the supermarket, tipping in restaurants, figuring out when to leave to get to the movies on time, and so on. We figure in our heads for most of our daily arithmetic needs, which is one clear reason why children should be practicing mental computation throughout the elementary grades.

7. Paper and pencil skills are also important in children's arithmetic learning. When numerical problems are too complex or unwieldy to solve in their heads, students should be able to figure out answers with the help of paper and pencil. The emphasis in these situations should be for students to use paper and pencil to keep track of their thinking, not necessarily to follow one particular procedure. Just as adults don't all use the same method to calculate tips at restaurants, children may use different approaches for computation.

8. Memorization has an important place in arithmetic learning. Computing, whether mentally or with paper and pencil, requires having basics committed to memory—the sums to 20, for example, and the times tables. But emphasis on memorization should follow, not lead, instruction that builds children's understanding. The emphasis in learning mathematics must always be on thinking, reasoning, and making sense, even when computing.

Activities from Marilyn Burns

Lessons in elementary classrooms shouldn't only focus on one leg of the three-legged stool needed in arithmetic instruction—computation, problem solving, or number sense. Nor should any of these topics be presented separately. They're closely intertwined: In order to develop number sense, students need to learn to compute. In order to decide if an answer to a problem makes sense, an important aspect of problem solving, students need to draw on their number sense. And when learning how to compute, students also need to know which operations are needed in problem-solving situations. Here are classroom lessons that tap into all three areas.

How many claps in your name?

GRADES K-1

Collecting information from children and organizing it into a graph not only gives children experience with interpreting statistical data, but also gives them the opportunity to think about numerical relationships. For this lesson, I drew three columns on a piece of chart paper and labeled them 1, 2, and 3. I wrote Marilyn in column 3.

I explained, "I wrote my name under the 3 because my name has three claps." I demonstrated, saying my name and clapping for each syllable, "Ma-ri-lyn." I then had the children say Marilyn and clap as I did.

I called Belinda up to the front of the room. "Let's all clap together and see where to write Belinda," I said. The children followed my lead as I said, "Be-lin-da" and clapped three times. I repeated this twice more to help the children understand what I was doing. After writing Belinda underneath my name, I asked Aaron to come up.

"Raise your hand if you think you know how many claps there are in Aaron," I said. About half the students raised their hands, some children tried clapping, and some were still confused.

"I know," said Aaron. "I have two claps."

"Let's clap Aaron together," I said to the class. I did this several times to demonstrate that Aaron had two claps.

1	2	3
Ned	Lily	Marilyn
Doug	Michael	Belinda
John	Edie	Maria
Beth	Jason	Angela
Ann	Ramon	Fernando
Matt	Nancy	Jonathan
	Rudy	
	Cena	
	Aaron	

"I'm going to write Aaron's name under the 2," I said. "Who can explain why?" Hands shot up and I called on Melissa to explain.

I continued to ask the class to figure together the number of claps in their names. Soon we had all of the children's names on the chart.

"No one has more than three claps," Michael said.

PHOTO BOB ADLER

"There's a lot under the 2," Edie noticed.

I then asked the children several questions:

- How many children have names with one clap?
- How many have names with two claps? Three claps?
- How many children have more than one clap in their name?
- How many more children have two claps than one clap?

How many cubes?

GRADES 2-3

"How many cubes do you think are in this jar?" I asked a class of second-graders, holding up a jar filled with blue interlocking cubes. We were learning about addition and subtraction, and this lesson would give them a chance to think about quantities, make estimates, and then solve a problem. The children's guesses went from 10 to 123, not a surprising range for students this age. I then began removing cubes, one at a time, snapping them together until I had a train of ten.

"Look at how full the jar is now," I said, giving children the chance to consider new information. "Decide if you'd like to change your estimates." The range of guesses narrowed. I removed ten more cubes to make another train, leaving the jar less than half full. Again I asked the children for their estimates. After making a third train of ten, one cube was left in the jar. We counted the three tens and added on the one to determine that the jar held 31 blue cubes.

I then showed the children a jar the same size but half filled with orange cubes. "How many cubes do you think are in this jar?" I queried. This time I asked children to explain their estimates, using the opportunity to assess their numerical reasoning. We began counting and found that there were 16 orange cubes in the second jar. I posed a problem to the class: "How many more orange cubes would we have to add to this jar so it would have as many cubes as the jar with blue cubes?" I told the students that they each were to figure out the answer and explain their work on paper.

On the next day, we gathered on the rug and several students presented their solutions and methods so that students could learn from one another.

The scoop on beans

GRADES 4-6

To begin this multiplication lesson, I showed fourth-graders the materials I had assembled: a small jar, a coffee scoop, and a bag of beans. My goal for the lesson was for them to see that there were several ways to do multiplication and that the numbers should determine what made sense for a particular situation. After putting two scoops of beans in the jar, I asked the students how many scoops would fill it. After everyone gave estimates, I continued scooping to show that the jar held six scoops.

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How Parents Can Help

Invite parents to contribute to their children's arithmetic learning and give them some suggestions for doing so. A letter home is one way to do this. Here's a sample:

Dear Parent,

As when you were in elementary school, arithmetic is the major emphasis of your child's math learning. Your child's arithmetic program has three important areas—*computation, problem solving,* and *number sense.* Our goals include having children learn to compute efficiently and accurately; apply skills to solve problems; and develop the numerical intuition needed to reason flexibly, make reasonable estimates, and judge whether or not answers make sense. Here are some ways you can support your child's learning at home:

- **Empty your pocket or change purse each evening and have your child count how much money there is.**
- **Have your child figure change when you're shopping.**
- **Ask for help figuring out what time you need to leave to get to the movies.**
- **Play card games that involve counting and adding.**

The more number activities you do with your child, the more help you'll be providing.

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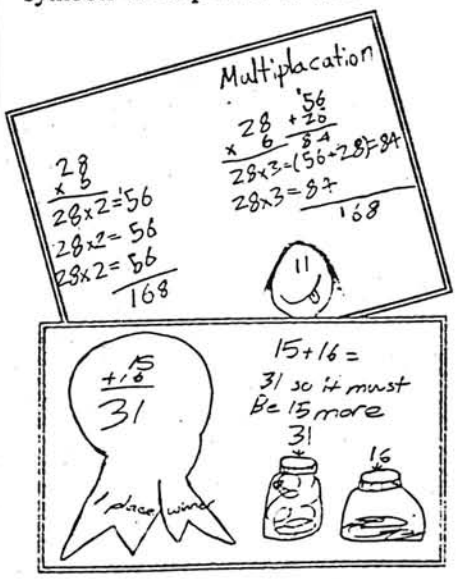
TOUGH to TEACH

"How can we find out how many beans have filled the jar?" I then asked. Tom said, "Just count the beans." Sally suggested, "Count one scoop and multiply by six." "That would be less counting," Judd commented.

"Let's try Sally's way," I said. "I'll put a scoop of beans at each table for each group to count. I'll record your results on the board." The counts were 28, 31, 27, 29, 28, and 28.

"Measurement is never exact," I told the class. "How can we choose one number to use?" Answering this question was a way to integrate statistics with the arithmetic lesson. We listed the numbers in order and found the mode (28) and the median (also 28). We calculated the mean (about 28.5). The class decided that 28 was a good number to use for the average.

"What ideas do you have about how to multiply 28 times 6?" I asked. As I had done many times before in class, I recorded their ideas on the board to model for the class how to use mathematical symbols to keep track of their thinking. To end the lesson, I asked the students to solve the problem individually with paper and pencil, showing at least two different ways to arrive at the answer. Asking for more than one way keeps the emphasis on thinking and reasoning, not just memorizing a procedure, and develops students' flexibility.



The NCTM Standards and Arithmetic

Standard 1 in the draft of the National Council of Teachers of Mathematics' *Standards 2000* states: "Mathematics instructional programs should foster the development of number and operation sense so that all students:

- understand numbers, ways of representing numbers, relationships among numbers, and number systems;
- understand the meaning of operations and how they relate to each other; and
- use computational tools and strategies fluently and estimate appropriately."

Standard 1 also states, "Number, operation, and computation have a long and prominent history in the school mathematics curriculum. In addition, this area of mathematics, perhaps more than any other, is widely recognized and valued beyond the school setting."

Later in the year, and with older students, I've done the same activity using different sizes of jars and beans to generate problems with larger numbers.

"Show me your answer using numbers, words, and, if you like, pictures," Marilyn tells students.