Algebra in the Elementary Grades? Absolutely!

By Marilyn Burns

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THE LESSON

1 To begin the lesson, I used pattern blocks to build a tree and show how it grows. "This is a young tree that's only one year old," I explained as I put a small loop of masking tape on the back of each of three pattern blocks and stuck them on the board (one orange square, one red trapezoid, and one green triangle). I wrote *1 year old* to the left of the blocks. I then wrote *2 years old* underneath and constructed another tree, this time with five blocks (two squares and two trapezoids plus one green square). Jamaal volunteered how to build a three-year-old tree; I wrote *3 years old* on the board and taped up the seven blocks he identified.

2 Mylla was eager to extend the pattern. "Next year it will have four and four, and the triangle on top," she said. I sketched Mylla's idea on the board. I then drew a T-chart and labeled the columns *Years Old* and *Blocks*. I wrote a *1* in the *Years Old* column and asked, "How many blocks did I use for a one-year-old tree?"

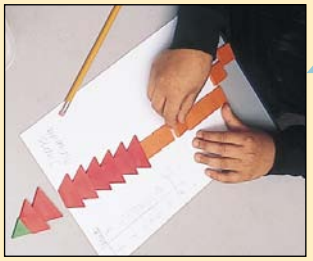
"Three," the children responded. I recorded a *3* in the *Blocks* column. With the children's help, I filled in the number of blocks for two-, three-, and four-year-old trees and then, using dots to indicate that I was skipping numbers, wrote 10 in the left column with a question mark next to it, and, farther down, 25. Finally, I wrote on the board two problems for the students to solve: *How many blocks are in a 10-year-old tree? How many blocks are in a 25-year-old tree?* "You can use the blocks to help you," I explained to the students. "Also, record on a T-chart, look for patterns, and write about how you solved the problems."

PHOTOS: BOB ADLER

While most of us first encountered algebra and the world of *x*'s and *y*'s when we reached high school, developing algebraic thinking is a top priority in today's elementary math curriculum. Algebra is now second in importance after number and operations, even for elementary students. This is a fairly recent requirement, and the NCTM *Principles and Standards for School Mathematics* explains why: "By viewing algebra as a strand in the curriculum from prekindergarten on, teachers can help students build a solid foundation of understanding and experiences as preparation for more sophisticated work in algebra in the middle grades and high school."

However, many elementary teachers are not comfortable with their own memories of algebra, much less with teaching it to their young students. In this article, Marilyn Burns invites you into a second-grade class in Emeryville, California, and gives you a step-by-step look at an algebra lesson. Not only does the lesson give the children experience with the important algebraic ideas of interpreting, extending, and representing a growth pattern, it also supports the children's learning about number and geometry.

3 As the children got to work, I circulated and gave help as needed. Although most of the students got started on their own, Eliyah and Amanjot (above) needed help. I sat with them and explained again what they were to do, then left them to work on their own.



4 Most students built the trees with blocks. Some, like Pierre, recorded by carefully tracing or drawing the blocks.

Other students, such as Carla, didn't draw or trace the blocks, but simply recorded numerically after building each tree.

A few students, like Christian, didn't need to use the blocks or record on a T-chart, but instead solved the problem in their heads.

5 As I circulated, I observed and talked with children to learn more about how they were approaching the problem and reasoning. I asked Yelmy (above) to explain to me how she knew that the four-year-old tree she built was correct. Our conversation didn't distract Paul from concentrating on tracing blocks. *(Continued on page 26)*

Early Algebraic Concepts

The following algebraic concepts are important in the elementary grades.

- **PATTERNS:** Creating, recognizing, extending, and generalizing growth patterns
- **EQUIVALENCE:** Understanding the equal sign as an indication that quantities have the same value, not as a signal to write the answer
- **VARIABLES:** Using symbols to describe a relationship between two quantities (such as the age and number of blocks for trees), to stand for unknown quantities, to represent mathematical properties (such as $a + b = b + a$), and in formulas
- **GRAPHING:** Using pairs of numbers to plot points, thus learning another way to represent a relationship between two quantities

What About Older Students?

The lesson as described can be extended for older students. While the focus for younger students is to represent patterns concretely with materials, numerically on T-charts, and verbally, older students can also describe the pattern of growth using algebraic symbols. For any age tree, the total number of blocks is equal to twice its age (once for the orange squares and once for the red trapezoids) plus one more block (the green triangle at the top).

Using Δ to represent the total number of blocks and o for the tree's age, you can represent this relationship as

$$\Delta = o + o + 1 \text{ or } \Delta = 2 \times o + 1.$$

Students should also have experience using letters for variables. For example, the relationship can be expressed as

$$y = x + x + 1 \text{ or } y = 2x + 1.$$

Relationships can also be represented as graphs by plotting the pairs of numbers from the T-chart and investigating the pattern formed by the points. For the tree pattern, the points all lie on a diagonal line. The second graders in the lesson shown below had learned to plot points and identify their coordinates, but they hadn't yet used this skill as another way to represent patterns.

THE LESSON

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6 Next, I helped Laura (left) confirm that what she had done so far matched what was recorded on the board.

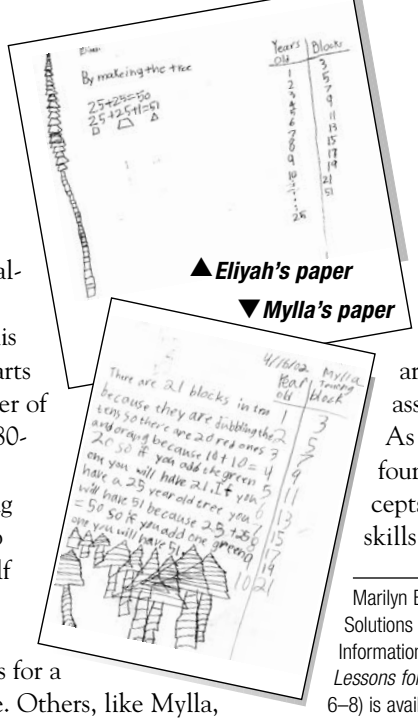
7 Then, Pierre (above) showed me how he counted the blocks to figure how many were in a 10-year-old tree.

8 Bismilla (above) wasn't sure about how Christian had solved the problem without using the blocks, so I asked Christian to explain to her what he had done. He gave an example and then generalized. He said, "I know because ten plus ten is twenty, and one more is twenty-one. They're all like that. You go the number plus the number plus one more." Christian's explanation was mathematically sophisticated for his age. *(Continued on page 28)*

Children Show Their Work

Organizing their work is a valuable learning experience for children, and for that reason I gave the children blank paper rather than a prepared worksheet with a T-chart already drawn and space for them to draw and write. When children have to take responsibility for representing their work, they focus on making sense of the problem, not merely on filling in the answers.

As is typical, the children's papers differed. Some, like Paul and Amanjot, focused on tracing the blocks and didn't have time to figure out the answers to the problems. Other chose not to trace or draw the trees, but worked numerically; Robert, for example, filled his paper with T-charts listing the number of blocks up to an 80-year-old tree. Christian, finding the problems too easy, gave himself the challenge of figuring out the number of blocks for a 113-year-old tree. Others, like Mylla, Martell, and Nicole, included drawings, T-charts, and explanations about how they solved the problems.



▲ *Eliyah's paper*

▼ *Mylla's paper*

Children's papers are extremely useful for assessing their progress. As students build a solid foundation in algebraic concepts, they will gain valuable skills for future success. ■

Marilyn Burns is the founder of Math Solutions Inservice and Publications. Information about her first three-book series, *Lessons for Algebraic Thinking* (K–2, 3–5, and 6–8) is available at www.mathsolutions.com

THE LESSON

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9 I observed Robert (right) continue the pattern in his T-chart up to an 80-year-old tree.

▼ Then, Jamaal (below) asked me for help. He was concerned because he knew that a 25-year-old tree should have 51 blocks, but on his T-chart, he had written 49 blocks. He had misaligned some numbers, and I helped him find his error.

10 After the children completed their work on the assignment, I began a class discussion. The children were eager to report how many blocks were needed for the 10- and 25-year-old trees. I also asked them to explain the patterns they noticed and their methods for finding the solutions.