GOOD YEAR BOOKS

Sample Pages

Sample pages from this product are provided for evaluation purposes. The entire product is available for purchase at www.socialstudies.com or www.goodyearbooks.com

To browse eBook titles, visit
http://www.goodyearbooks.com/ebooks.html

To learn more about eBooks, visit our help page at
http://www.goodyearbooks.com/ebookshelp.html

For questions, please e-mail access@goodyearbooks.com

Free E-mail Newsletter—Sign up Today!

To learn about new eBook and print titles, professional development resources, and catalogs in the mail, sign up for our monthly e-mail newsletter at
http://www.goodyearbooks.com/newsletter/

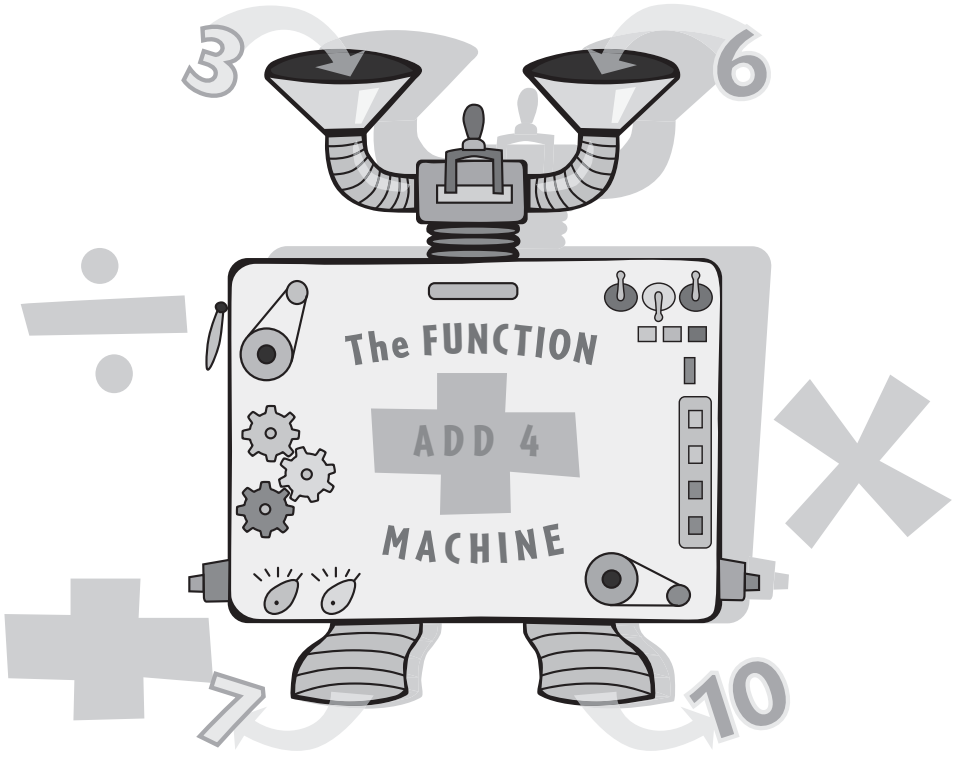
For more information:

10200 Jefferson Blvd., Box 802, Culver City, CA 90232
Call: 800-421-4246 • Fax: 800-944-5432 (U.S. and Canada)
Call: 310-839-2436 • Fax: 310-839-2249 (International)

PRIMARY ALGEBRA

Developing Algebraic Reasoning

Hope Martin



GOOD YEAR BOOKS

Dedication

My heartfelt thanks to Jill Martin, my daughter-in-law, for generously sharing her knowledge of the primary-grade mathematics curriculum and her experiences as a first-grade teacher.

Educational Standards

Primary Algebra contains lessons and activities that reinforce and develop skills as defined by the National Council of Teachers of Mathematics and the Common Core State Standards as appropriate for students in Grades K to 4. These include understanding patterns and functions; problem solving using numbers, pictures, and symbols; understanding equivalency and the meaning of equations; and making mathematical connections.

GOOD YEAR BOOKS

Our titles are available for most basic curriculum subjects plus many enrichment areas. For information on other Good Year Books and to place orders, contact your local bookseller or educational dealer, or visit our website at www.goodyearbooks.com. For a complete catalog, please contact:

Good Year Books
A division of Social Studies School Service
10200 Jefferson Boulevard
P.O. Box 802
Culver City, CA 90232-0802
www.goodyearbooks.com

Cover Design and Illustrations: Sean O'Neill
Text Design: Doug Goewey

Revised 2011.

ISBN-13: 978-1-59647-126-9

Art Credits

Fotolia.com: coin photos (all except half-dollar), pp. 76, 90, 91, 131–134, © Mario Bruno; bananas illustration, pp. 41, 44, 45, by Dawn Hudson; French fries photo, p. 72, © khz.

iStock.com: ghost illustration, p. 75, © Brendon De Suza; toy train, jack-in-the-box, teddy bear illustrations, pp. 93, 94, © Alison Hess; half-dollar photo, pp. 90, 91, 135, © Samuel Kessler; playing card illustrations, pp. 99–102, © Carol Woodstock.

Library of Congress: photo of Helen Keller, p. 66; portrait of Benjamin Franklin, p. 63, by Chas. Wilson Peale; photo of Florence Nightingale, p. 70, by Perry Pictures; portrait of George Washington, p. 65, by Gilbert Stuart.

Sean O'Neill: Legs illustration, p. 77; function machine illustrations, title page, pp. 30–34; illustration of Martin Luther King, Jr., p. 67; illustration of Rosa Parks, p. 69.

U.S. Department of State: photo of Colin Powell, p. 64.

Wikipedia.org: photo of one-dollar bill, pp. 91, 136.

Contents

Introduction (continued)

NCTM Algebra Standard

	Expectations	
Instructional programs from pre-kindergarten through grade 12 should enable all students to:	**Grades Pre-K to 2**	**Grades 3 to 5**
Understand patterns, relations, and functions	✓ sort, classify, and order objects by size, number, and other properties ✓ recognize, describe, and extend patterns, such as sequences of sounds and shapes or simple numeric patterns and translate from one representation to another ✓ analyze how both repeating and growing patterns are generated	✓ describe, extend, and make generalizations about geometric and numeric patterns ✓ represent and analyze patterns and functions, using words, tables, and graphs
Represent and analyze mathematical situations and structures using algebraic symbols	✓ illustrate general principles and properties of operations, such as commutativity, using specific numbers ✓ use concrete, pictorial, and verbal representations to develop an understanding of invented and conventional symbolic notations	✓ identify such properties as commutativity, associativity, and distributivity and use them to compute with whole numbers ✓ represent the idea of a variable as an unknown quantity using a letter or a symbol ✓ express mathematical relationships using equations
Use mathematical models to represent and understand quantitative relationships	✓ model situations that involve the addition and subtraction of whole numbers, using objects, pictures, and symbols	✓ model problem situations with objects and use representations such as graphs, tables, and equations to draw conclusions
Analyze change in various contexts	✓ describe qualitative change, such as a student's growing taller ✓ describe quantitative change, such as a student's growing two inches in one year	✓ investigate how a change in one variable relates to a change in a second variable ✓ identify and describe situations with constant and varying rates of change and compare them

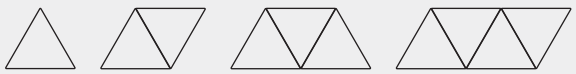
Chapter 1

Understanding Patterns and Functions

To understand is to perceive patterns.
Isaiah Berlin, 1909–1997

Very young children explore patterns in the world around them. Some of these patterns are displays of colors, combinations of shapes and geometric designs, and repetition of musical sounds. In the early elementary grades, patterns are described, classified, and created to help youngsters develop an understanding of why mathematics has been described as the study of patterns. Children analyze what *came before* to predict what *comes next*.

Patterns can be repeated or they can grow and change in a predictable way. Repeated patterns can be sounds (such as tap, tap, clink, tap, tap, clink), or colors (blue, red, red, green, blue, red, red, green), or geometric shapes (triangle, square, square, triangle, square, square) and so on. Growing patterns show an arithmetic change between what *came before* and what follows. These can be as simple as counting—1, 2, 3, 4, . . . —or recognizing the changes between the pairs of elements. This is an example of a geometric growing pattern:



Functions consider the relationship between the members of one set and members of another set. Early elementary students use "function machines" to find the rule that was used to calculate the *output number* from a given *input number*. An interactive Internet site that uses the idea of function machines to help students understand input, output, and function rules is http://www.shodor.org/interactivate/activities/FunctionMachine.

This chapter begins with the activity "Over and Over Again—Patterns That Repeat." These are examples of geometric patterns and use pattern block shapes. Students are asked to identify the pattern and then draw one that has the same name or is the same type of pattern. If these manipulatives are not available, see the book's Appendix for copies of pattern blocks. Duplicate the patterns on a heavy cardstock and then laminate them, and they will be sturdy enough for students to use as pattern pieces to design their own.

The activities in "Pattern Block Patterns That Grow" show students the first three or four arrangement of shapes and then ask them to predict what the next arrangement will look like based upon what came before in the pattern. Students are asked to explain their reasoning and then design their own growing pattern. The interactive Web site http://www.arcytech.org/java/patterns/patterns_j.shtml gives students an opportunity to use pattern block pieces to design their own repeating and growing patterns using these geometric shapes.

In the activity "What Comes Next," students begin to investigate number patterns. These are formed by a sequence of numbers that depend on previous numbers for their pattern. Some students may need calculators to complete some of the computation in the problems.

"Patterns in the 100-Table" encourages students who have strong visual skills to see number patterns as a design on a grid. After students find the pattern formed by multiples of 3, they are given the opportunity to choose their own number and discover what the multiple pattern for their choice of number looks like.

"Using Number Patterns to Help Us Count" asks students to analyze the position of the objects in a design, looking for patterns that will help them find the total number of objects in the picture. Of course, they can find the total by counting, but it is much more challenging and exciting to find all of the possible ways patterns can be used to make the job less tedious.

The final activities, "The Function Machine" and "What's My Rule?", introduce students to the important concept of functions by having students analyze the relationship between input and output numbers. The first lesson of "The Function Machine" gives students the input numbers and a rule and asks them to find the output numbers. Then students are asked to find the rule when they know both the input and output numbers. Finally, students are given the opportunity to design their own functions using blank function machines. "What's My Rule?" makes the concept of functions a bit more abstract by using tables. These problems also require students to add, subtract, or multiply to find the output.

Over and Over Again—Patterns That Repeat

What is the algebra?

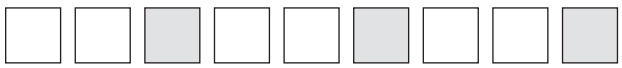
Describing, extending, and analyzing patterns

What do you need?

- "Over and Over Again—Patterns That Repeat" activity sheets (pp. 8–9) for each child
- "Design Your Own Patterns That Repeat" activity sheet (p. 10) for each pair of students.
- Pattern blocks (available in the Appendix)
- Crayons

Some classroom procedures

Introduce patterns to students. Patterns that repeat usually begin as sound patterns, such as clap, clap, snap, snap, clap, clap, snap, snap. Students then work with visual patterns, such as:



They can also be patterns formed using repeating geometry shapes such as the ones in this lesson. The sound pattern above is an A A B B pattern—clap, clap is represented by the letter A and snap, snap by the letter B. The visual or color pattern is an A A B pattern: Two white squares (A) and one dark square (B) make up the pattern. It is important that students understand how the letters used help define the pattern. To help students become comfortable with this model, have them design a sound pattern that is an A A B B B pattern. Ask, "How do you know that it can be defined in this way?" Once students are comfortable with patterns, hand out the "Over and Over Again—Patterns That Repeat" activity sheet and the pattern blocks. Then:

1. Have students use their pattern blocks to form patterns and define them using the AB model.
2. Design an original pattern block pattern that has the same model as the one shown above.

Give students a chance to describe and name their patterns based on the symbols used. Not all students will understand that a collection of symbols can only be described as a pattern if we can predict what will come next. Discussing student examples will help clarify, using this hands-on activity, the meaning of a repeating pattern.

How to extend the lesson

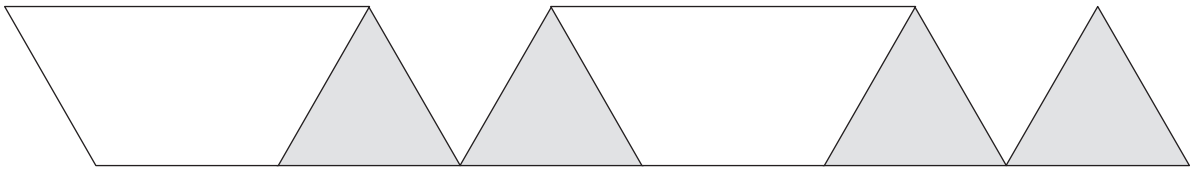
After students have completed the pattern worksheet, they can make their own unique repeating patterns working with a partner and using templates of pattern blocks or other geometric shapes. These can be shared with the rest of the class who will then be asked to "name" the patterns using letters from the alphabet.

Activity answers

1. ABB, ABB
2. AB, AB, AB

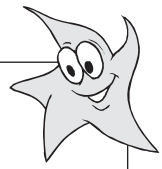
Over and Over Again—Patterns That Repeat

Directions: Use your pattern blocks to make this pattern.



1. This is called an ___ ___ ___, ___ ___ ___ pattern. Explain why you named this pattern the way you did.

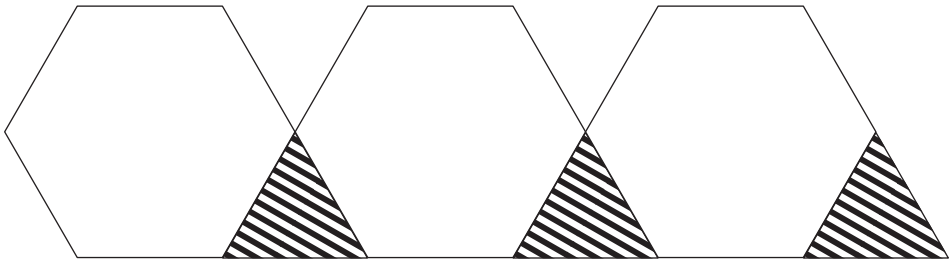
Use your pattern blocks to design a pattern that is also an ABB pattern. Draw it in this space.



Over and Over Again—Patterns That Repeat

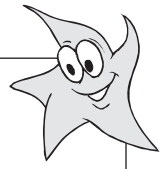
(continued)

Directions: Use your pattern blocks to make this pattern.



2. This is called an ___ ___, ___ ___, ___ ___, pattern. Explain why you named this pattern the way you did.

Use your pattern blocks to design a pattern that has the same name as the one above. Draw it in this space.



Design Your Own Patterns That Repeat

Directions: Use your pattern blocks to design your own original pattern. It can use two or three different pattern blocks . . . but remember that if it is a **pattern,** your partner must be able to predict what will come next.

My pattern is named an _____

because:

This is a picture of my pattern: