INVESTIGATIONS 3
TRANSFORMING MATHEMATICS TEACHING & LEARNING

Math Content by Strand

Analyzing Patterns and Rules

Grade 4

Students model mathematical relationships associated with two different contexts (Penny Jars and Windows and Towers) where two quantities are related in predictable ways. To show how the quantities in these contexts are related, students create their own pictures and learn to use tables and symbolic notation. These contexts, which have additive and multiplicative components, help students distinguish between additive and multiplicative relationships. Within each context, students solve multi-step problems that involve both operations.

Students generate number patterns in the contexts of Penny Jars and Windows and Towers. They learn to analyze these patterns and recognize how the additive part of the context (the starting amount) and the multiplicative part (the regular increase) define the relationship between the two quantities.

Penny Jar Table

Number of Rounds	Total Number of Pennies
Start	6
1	11
2	16
3	21
4	26
5	31

Windows and Towers Table

Number of Floors	Total Number of Windows
Start (skylights)	4
1	12
2	20
3	28
4	36
5	44

Using words and symbolic notation, students develop rules for finding the total number of pennies after any round in a Penny Jar situation, and for finding the number of windows in a tower of a certain height. For example, students write a rule for a Penny Jar that has a starting amount of 1, and 3 pennies are added each day.

Rules for Penny Jar A

Number of rounds times 3. Add 1.

Start with 1. Add on a 3 for each round.

$(3 \times N) + 1$

MAIN MATH IDEAS

- Modeling situations with mathematics
- Generating and analyzing patterns
- Solving multi-step problems

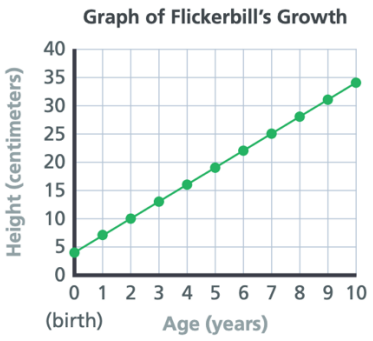
BENCHMARKS

- Generate a number pattern that follows a given rule and analyze features of the pattern in order to solve problems. (Unit 8)
- Model the mathematics of a situation with tables and with mathematical notation, including using letters to represent unspecified quantities. (Unit 8)
- Solve multi-step word problems using the four operations. (Unit 8)

Grade 5

Students use coordinate graphs, tables, and symbolic notation to model real-world and mathematical situations. They analyze arithmetic patterns in tables and the shapes of the corresponding graphs to describe and compare the situations.

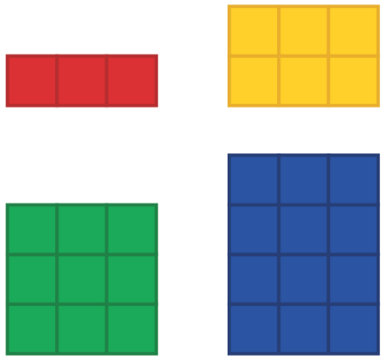
Age	Height (cm)
0 (birth)	4
1	7
2	10
3	13
4	16
5	19
6	22
7	25
8	28
9	31
10	34



Students work in situations in which one quantity varies in relation to another. Some situations are based on data, such as temperature changing over time, or height varying with age. Other situations are based on rules that determine the correspondence of two quantities, such as the heights of fictional animals that grow a certain amount each year, or geometric relationships, including how the area of a square changes in relation to the length of a side. For example, students use tables and graphs to consider how the perimeters change in a set of rectangles that are made from rows of tiles with three squares in each row.

Perimeter for 3-Across Rectangles

Number of Rows (n)	Perimeter (cm)
1	8
2	10
3	12
4	14
5	16
6	18
10	
15	
20	
100	
n	



As a class, they use words to express variations of a general rule for the perimeter of a rectangle, no matter how many rows of 3 squares it contains. For each variation, they represent the rule using symbolic notation. In this way, students become familiar with equivalent expressions with variables.

Double 3, double the number of rows, and add all that together.
$(2 \times 3) + (2 \times n)$
Double the number of rows, and then add 6.
$2 \times n + 6$
Add 3 to the number of rows, and then double that.
$(3 + n) \times 2$

Throughout this work, students move among the situation, tables, graphs, equations, expression of the rule in words, and other representations they have created. Their work with symbolic notation is closely connected to the context with which they are working. By moving back and forth across the context, the variety of representations, their own ways of describing general rules in words, and symbolic notation, students learn how notation with variables carries mathematical meaning.

For students to be able to create and use coordinate graphs, they must understand the structure and conventions of using a coordinate grid. See the **Geometry** section for more information about coordinate grids.

MAIN MATH IDEAS

- Reading and constructing coordinate graphs
- Modeling situations with mathematics: graphs, ordered pairs, tables, and symbolic notation
- Analyzing and comparing mathematical patterns and relationships
- Analyzing numerical patterns in the perimeters and areas of related rectangles

BENCHMARKS

- Use tables to record ordered pairs and construct coordinate graphs to represent the relationship between x-coordinates and y-coordinates. (Unit 5)
- Determine what values are represented by points on a coordinate grid. (Unit 5)
- Represent real world and mathematical problems by graphing points in the coordinate plane and interpreting the graph in the context of the situation. (Unit 5)
- Use tables and graphs to compare two situations governed by rules that generate numerical patterns. (Unit 5)
- Identify and explain numerical patterns when comparing perimeters or areas of related rectangles. (Unit 8)