Algebraic Thinking Grades 3-5

What is algebraic thinking?

Algebraic thinking in the elementary school is the study of mathematics with a focus on operations and functions rather than numbers and computations. The goal of this instruction is to provide students with critical thinking skills that they can apply to everyday problems. Algebraic thinking can be broken into two categories: algebraic ideas and mathematical thinking tools. Algebraic ideas are the building blocks of algebraic thinking and include patterns, variables, and functions. In comparison, mathematical thinking tools are the analytical habits of the mind, such as problem solving, representation, and reasoning.

Importance

Algebraic thinking has a wide variety of real-world applications. It is found in all of mathematics and is essential for making mathematics useful in daily life. It is often taught separately in the curriculum, but should be embedded in all areas of mathematics. In order to get students to think algebraically, we must start this type of thinking in kindergarten and continue to develop it throughout the elementary years.

Essential Understandings through the Grades (Van De Walle, 2007)

Students thinking algebraically will:

**Generalize numbers and operations (1st-5th)**
- Recognize the equal sign as a symbol showing the relationship of the expressions on either side
- Use variables as a tool that allows for the expression of generalizations

**Make structure in the number system explicit (2nd-5th)**
- Create and debate conjectures until someone proves it or finds a counter example
- Determine when a conjecture is always true, sometimes true or never true
Algebraic Thinking Grades 3-5

Decipher patterns (3rd-5th)
- Identify patterns found in pictures, charts, or number lists

Grow patterns (sequences) (3rd-6th)
- Extend the pattern and look for a generalization or algebraic relationship that will determine the next step in the pattern
- Understand the concept of a function
- Model patterns with materials or drawings to create visual, as well as, table representations

Create function statements (5th-8th)
- Identify independent and dependent variables
- Write a general formula that will relate the growing pattern to any step (nth-term) in the representation

Graph the patterns (6th-8th)
- Use values from a table to graph the pattern
- Use a formula to graph the pattern

End Goal

A student strong in algebraic thinking is able to:
- Recognize when patterns exist
- Extend patterns or sequences
- Represent patterns through drawings, charts, formulas, and graphs
- Use algebraic representations to problem solve, reason, and communicate mathematically
## Algebraic Thinking Grades 3-5

The following table outlines the Common Core State Standards for 3rd through 5th grade in algebraic thinking.

<table>
<thead>
<tr>
<th>Grade 3</th>
<th>Grade 4</th>
<th>Grade 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solve problems involving the four operations, and identify and explain patterns in arithmetic.</td>
<td>Generate and analyze patterns.</td>
<td>Write and interpret numerical expressions.</td>
</tr>
<tr>
<td>8. Solve two-step word problems using the four operations. Represent these problems using equations with a letter standing for the unknown quantity. Assess the reasonableness of answers using mental computation and estimation strategies including rounding.</td>
<td>5. Generate a number or shape pattern that follows a given rule. Identify apparent features of the pattern that were not explicit in the rule itself. For example, given the rule “Add 3” and the starting number 1, generate terms in the resulting sequence and observe that the terms appear to alternate between odd and even numbers. Explain informally why the numbers will continue to alternate in this way.</td>
<td>1. Use parentheses, brackets, or braces in numerical expressions, and evaluate expressions with these symbols.</td>
</tr>
<tr>
<td>9. Identify arithmetic patterns (including patterns in the addition table or multiplication table), and explain them using properties of operations. For example, observe that 4 times a number is always even, and explain why 4 times a number can be decomposed into two equal addends.</td>
<td></td>
<td>2. Write simple expressions that record calculations with numbers, and interpret numerical expressions without evaluating them. For example, express the calculation “add 8 and 7, then multiply by 2” as 2 × (8 + 7). Recognize that 3 × (18932 + 921) is three times as large as 18932 + 921, without having to calculate the indicated sum or product.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Analyze patterns and relationships.</td>
</tr>
<tr>
<td></td>
<td>3. Generate two numerical patterns using two given rules. Identify apparent relationships between corresponding terms. Form ordered pairs consisting of corresponding terms from the two patterns, and graph the ordered pairs on a coordinate plane. For example, given the rule “Add 3” and the starting number 0, and given the rule “Add 6” and the starting number 0, generate terms in the resulting sequences, and observe that the terms in one sequence are twice the corresponding terms in the other sequence. Explain informally why this is so.</td>
<td></td>
</tr>
</tbody>
</table>

### References
