Studying the U.S. Standard Algorithms

In *Investigations,* the algorithms traditionally taught in the United States are studied and used by students after they have developed their own fluent methods for solving problems with whole numbers in each operation. In Grade 4, these include the U.S. standard algorithms for addition and subtraction. In Grade 5, students study and learn the U.S. standard algorithm for multiplication. Historically, these algorithms were developed for doing calculations by hand with a minimum number of steps and with compact notation. The power of these algorithms for quick calculation lies largely in the fact that they require the user to carry out a series of single-digit calculations. They were designed so that the user could rely on a small set of known number combinations and the repetition of a small sequence of steps to solve any problem. These algorithms, as human inventions, are elegant and efficient.

Although each student may primarily use one strategy for each operation, in *Investigations,* students are expected to study more than one algorithm or strategy for each operation. Students study a variety of approaches because:

- In making sense of different algorithms and strategies, students are developing meaning for the operations and understanding of the base-10 system.
- Students learn how to use a range of algorithms and strategies as tools for solving problems. Access to different algorithms and strategies leads to flexibility in solving problems.

Students with good understanding of an operation—what it is used for, what its properties are, how to efficiently solve a problem that requires an operation, how it is related to other operations, and how the base-10 number system is used in that operation—can use a study of *any* algorithm that has been invented for that operation as an opportunity to delve further into the operation itself. Studying how and why an unfamiliar algorithm works is a challenge to think through what we know about an operation. It requires pulling apart an algorithm, bringing meaning to shortcut notations, and finding parts of the algorithm that are similar to parts of more familiar algorithms.

Too often in the past, the "carrying" and "borrowing" algorithms were taught and learned without meaning. And, too often, these algorithms were seen as the central teaching tool for learning about an operation: learning addition was defined only as learning the steps of the "carrying" algorithm. In *Investigations*, students learn about these algorithms with meaning and, once they have made sense of them, they can choose to use them as one tool for solving addition, subtraction, and multiplication problems. Competent adults often use different algorithms for different contexts, use a mixture of algorithms, or use one algorithm or strategy to check another.

Another reason for studying conventional algorithms is that they are a part of the social knowledge in students' communities. Adults in students' lives may use these algorithms, and they need not be a mystery to students. Because a variety of algorithms have been taught in different countries and at different times in the U.S., you should have students bring in algorithms used by adults in their families. You may find that there is more than one algorithm commonly used in the students' communities for a particular operation.

The following are two primary goals for the study of numbers and operations in the elementary grades:

1. Understanding the meaning and properties of the operations by making sense of how each algorithm or procedure is based on the structure of the operation.
2. Attaining computational fluency with whole numbers by developing a repertoire of strategies and choosing among them flexibly to solve problems.