Personal Strategies (Invented algorithms)

The term 'personal strategy' is current jargon for a student-invented arithmetic algorithm. An algorithm is a step-by-step procedure designed to achieve some objective, often with several steps that repeat or "loop" as many times as necessary. The most familiar algorithms are the elementary school procedures for adding, subtracting, multiplying, and dividing, but there are many other algorithms in mathematics. A student-invented algorithm is a procedure that the student him/herself figured out. It may or may not be similar to a conventional algorithm (like the ones you grew up with). Here are two examples of a personal strategy.

Example #1

To do 41 x 16, multiply 41 x 8 to get 328 and then double 328 to get 656.

Example #2

To do 8 + 9 + 18, add 7 and 10 and 20, then subtract 2 to get 35.

Personal strategies play an important role in the new K-4 Manitoba mathematics curriculum. Why is that the case? Should conventional algorithms (the ones you likely learned) disappear from the curriculum? The following addresses these questions.

The place of algorithms in school mathematics is changing partly because of the widespread use of calculators and computers outside of school. Before such machines were invented, the preparation of workers who could carry out computations by hand was an important goal of school mathematics. Today, being able to mimic a $5 calculator is not enough: Thinking mathematically has become valued. How the school mathematics curriculum should adapt to this new reality is an open question, but it is clear that proficiency at non-understood paper-and-pencil computations is far less important outside of school today than in the past. It is also clear that the time saved by reducing attention to teaching such computations can be put to better use on such topics as problem solving, mental arithmetic, and geometry.

Researchers have identified a number of serious problems with the traditional approach to teaching computation. One problem is that the traditional approach fails with a large number of students. Despite heavy emphasis on paper-and- pencil computation, many students never become proficient in carrying out algorithms for the basic operations. In one study, only 60 percent of U.S. ten-year-olds achieved mastery of subtraction using the standard "borrowing" algorithm. A principal cause for such failures is an overemphasis on procedural proficiency with insufficient attention to why the procedures work. This unbalanced approach produces students who are plagued by "bugs," such as always taking the smaller digit from the larger in subtraction, because they are trying to carry out imperfectly understood procedures.

An even more serious problem with the traditional approach to teaching computation is that it engenders beliefs about mathematics that impede further learning. Research indicates that these beliefs begin to be formed during the elementary school years when the focus is on mastery of standard algorithms. The traditional rote approach to teaching algorithms helps foster the following kinds of beliefs:

- ★ mathematics consists mostly of symbols on paper;
- ★ following the rules for manipulating those symbols is of prime importance;
- ★ mathematics is mostly memorization;
- ★ mathematics problems can be solved in no more than 10 minutes - or else they cannot be solved at all;
- ★ speed and accuracy are more important in mathematics than understanding;
- ★ there is one right way to solve any problem;
- ★ different (correct) methods of solution sometimes yield contradictory results;
- ★ and mathematics symbols and rules have little to do with common sense, intuition, or the real world.

The prevalence of math phobia, the social acceptability of mathematical incompetence, and the avoidance of mathematics in high school and beyond indicate that many people feel that mathematics is difficult and unpleasant. Research indicates that these attitudes begin to be formed when students are taught the standard algorithms in the primary grades by using the traditional method of teaching (show-and-tell with lots of worksheets).

Allowing children to create and use their personal strategies should help them become proficient at computation while also preserving their belief that mathematics makes sense. Reducing the emphasis on paper-and-pencil computations does not mean that paper-and-pencil arithmetic is eliminated from the school curriculum. Paper-and-pencil skills are practical in certain situations, are not necessarily hard to acquire, and are widely expected as an outcome of elementary education. If taught properly by stressing concepts and principles, conventional algorithms can reinforce students' understanding of our number system and of the operations themselves. Exploring algorithms can also build estimation and mental to other areas of their lives. More and more, people need to apply algorithmic and procedural thinking in order to operate technologically advanced devices. Algorithms beyond arithmetic are increasingly important in theoretical mathematics, in applications of mathematics, in computer science, and in many areas outside of mathematics. In other words, conventional algorithms are not “evil” things if an understanding of why they work is an important part of instruction. This is a balanced stance.

Two crucial matters to consider

A personal strategy can be as mindless as a rote-learned conventional algorithm. If the child simply decides that doing this kind of thing gives him/her the right answer without understanding the principles and concepts that underlie the strategy, then there is not much thinking going on. This is just like a teacher telling a child: “*Follow these steps to get the right answer. Don't ask why.*” Both situations involve mostly mindless activity.

A teacher can teach a “personal strategy” in a show-and-tell way as was typically the case when teaching a conventional algorithm. This denies the purpose for students' inventing strategies. Nothing has changed except the nature of what is “conventional”.