Reforming Mathematics Education

Reform in mathematics education has been making its way into Canadian schools since the early 1990s. The latest K-4 Manitoba mathematics curriculum is an example of a document that stresses reform. It urges teachers to teach mathematics in ways that encourage students to learn through problem solving, to explain and communicate their reasoning in pictorial, verbal, concrete, and symbolic ways, and to see connections inside mathematics and between mathematics and other domains of human knowledge.

There is a substantial evidence that reform is needed. One type of evidence concerns problem solving. Consider the following anecdote.

> *The woman ahead of us wanted to buy four Teenage Mutant Ninja Turtle drinks, which come in those little cardboard drink boxes that adults cannot operate without dribbling on themselves, but which small children can instinctively transform into either drinking containers or squirt guns. The Toys "R" Us price was three drinks for 99 cents, but the woman wanted to buy four drinks. So the mathematical problem was: How much should the cashier charge for the fourth box?*
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> *Talk about your brain teasers! The cashier tried staring intently at the fourth box for a while, as if maybe one of the Ninja Turtles would suddenly blurt out the answer, but that didn't work. Then she got on the horn and talked to somebody in management, but that person didn't know the answer either. So the cashier made another phone call, and then another. By now I assumed she was talking to somebody in the highest echelon of the vast Toys "R" Us empire, some wealthy toy executive out on his giant yacht, which is powered by 176, 485 "D" cell batteries (not included).*
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> *Finally, the cashier got the word: The fourth box should cost - I am not making this up - 29 cents.*

Does the anecdote reflect what is typical of the general population? Research evidence suggests that it does. Assessment results tend to find that children and adults are not very good at the kind of problem solving illustrated by the anecdote.

Here is an example from a research project (Merseth, 1993). As part of a large-scale project that researched mathematical problem solving, researchers gave the following question to grades 5 and 6 students.

> **There are 125 sheep and 5 dogs in a flock. How old is the shepherd?**

Seventy-five percent of children provided a numerical answer to the above problem. The following kind of thinking was typical.

> *125 + 5 = 130 . . . Hum, too big,*
> *125 - 5 = 120 . . . still too big . . . while*
> *125 ÷ 5 = 25 . . . Yes! The shepherd must be 25 years old.*

A consistent theme in the research literature is the dominance of teaching mathematics by mindless mimicry of procedures. While mathematicians and others do want to have ritual procedures available to apply to tasks, that is not all there is to doing mathematics. Problem solving is an important component of doing and learning mathematics and it is largely absent when rote learning of procedures is the prevailing instructional method. "Chalk and talk", working from a text book, and using repetitive worksheets have been and still seem to be too prevalent. The result of this kind of teaching is that students tend not to be engaged in thinking about ideas. They are mostly engaged in blindly following prescribed mathematical procedures and that tends not to promote understanding or meaning making. This situation has led many to argue that there is a need for deep and systemic reform of mathematics education (Kirshner, 2002).

The evidence and opinions are best seen as indicators, not proof, that reform is needed. The validity of those indicators can always be questioned. However, to rework an old adage, if the fox thinks it's a duck, if the fish thinks it's a duck, if the bird lover thinks it's a duck, if other ducks think it's a duck, . . . then quite likely it is a duck. There only remains the question of what kind of duck.

References

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- Merseth, Katherine K. (1993). How old is the shepherd? An essay about mathematics education. Phi Delta Kappan, March.