Explore x Engage x Chat –– Autonomous Learning with Word Problems

Further reading about the Appetizer

The fact that students are drilled in methods and rules that do not make sense to them is not just a problem for their understanding of mathematics. Such an approach leaves students frustrated, because most of them want to understand what they are learning. Students want to know how different mathematical methods fit together and why they work. This is especially true for girls and women, as I shall explain in chapter 6. The following response from Kate, a girl taking calculus in a traditional class, is one that is similar to those I have received from many young people I have interviewed:

> We knew how to do it. But we didn't know why we were doing it and we didn't know how we got around to doing it. Especially with limits, we knew what the answer was, but we didn't know why or how we went around doing it. We just plugged into it. And I think that's what I really struggled with – I can get the answer, I just don't understand why.

Young people are naturally curious and their inclination – at least before they experience traditional teaching – is to make sense of things and to understand them. Many maths classes rid students of this worthy inclination. Kate was at least fortunate to still be asking *why*? even though she, like others, was not given opportunities to understand why the methods worked. Children begin school as natural problem solvers and many studies have shown that students are better at solving problems *before* they attend maths classes.[5,6] They think and reason their way through problems, using methods in creative ways, but after a few hundred hours of passive maths learning students have their problem solving abilities knocked out of them. They think that they need to remember the hundreds of rules they have practiced and they abandon their common sense in order to follow the rules.

Consider for a moment this mathematics problem:

> A woman is on a diet and goes into a shop to buy some turkey slices. She is given 3 slices which weigh $1/3$ of a pound but her diet says that she is only allowed to eat $1/4$ of a pound. How much of the 3 slices she bought can she eat while staying true to her diet?

This is an interesting problem and I urge readers to try it before moving on. This was a problem that was posed by Ruth Parker, a wonderful teacher of teachers who has spent many years working with parents to help them understand the benefits of inquiry approaches. In one of her public sessions with children and parents she posed this problem and asked people to solve it. Her purpose in doing so was to see what kind of solutions people offered and how these compared to their school experiences. Many of the adults who had experienced passive approaches were unable to solve the problem because they could not apply a rule they had learned. Some of them tried $1/4 \times 1/3$, as they knew that something should be multiplied, but they recognized that their answer of $1/12$ was probably incorrect. Some tried $1/4 \times 3$ but their answer of $3/4$ of a pound also did not make sense. To use a rule they needed to set up the following equation:

$$\textbf{3 slices} = 1/3$$
$$\boldsymbol{x}\ \textbf{slices} = 1/4$$

Once Ruth told them this then the people who had remembered rules and methods were able to do the rest – to cross-multiply and say that:

$$1/3\ \boldsymbol{x} = 3/4$$
$$\textbf{so } \boldsymbol{x} = 9/4 \textbf{ slices}$$

But as she pointed out the most important part of the mathematics that is needed is to be able to set up the equation. This is something that children get very little experience of – they either use the same equation over and over again in a maths lesson and so do not focus on how to set them up, or they are given equations that are already set up for them and they rehearse how to solve them, over and over again.

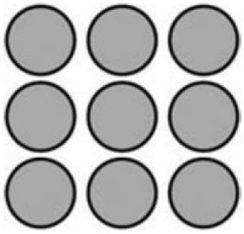
But look at some of the wonderful solutions offered by young children who had not yet been subjected to rule-bound, passive approaches at school:

One year 5 student said:

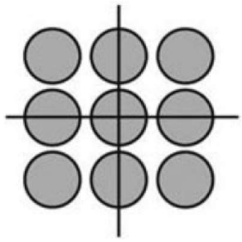
If 3 slices is $^1/_3$ of a pound then 9 slices is a pound. I can eat $^1/_4$ of a pound so $^1/_4$ of 9 slices is $^9/_4$ slices.

Another solved the problem visually:

Representing a pound:



And then a quarter of a pound:



These elegant solutions are the sorts of methods that are suppressed by passive, rule-bound

Learning without Talking?

Another major problem with passive approaches to mathematics is that students don't talk about maths. Some may believe that working in silence is the optimum learning condition, but in fact this is far from the truth. I have visited hundreds of classrooms in which students sit at their desks silently watching the teacher demonstrate methods and then practice the methods – often chatting to their friends as they do so, but not about the maths. This approach is flawed, for a number of reasons. One problem is that students often need to talk through methods to know whether they really understand them or not. Methods can *seem* to make sense when people hear them, but explaining them to someone else is the best way to know whether they are really understood.