What surprises teachers when first using retrieval practice is just how quickly some learners forget learning - learning which seemed to be fully mastered at the point of teaching only a few days ago. Teachers are trained, assessed and sometimes even coached in "getting learning into the learner in the lesson" but little advice is given on "making it stick" after the lesson.

Learning is a perishable product.

Thinking of food, how foolish would it seem if a farmer tended the soil and optimally planted the seeds, yet failed to protect the crops from pests and water shortage? … if at harvest time the farmer congratulated the onions for being the best crop and lamented "why didn't the peas and beans do better?" … more foolish still if the farmer repeated the same behaviour the next year?

Ofsted's requirement that learners make "significant and sustained gains in their learning" is only possible for **all** learners if we ensure that learning is retained.

Since 1895 when Ebbinghaus published his theory "Über das Gedächtnis", translated as "about memory", his findings have stood the test of time. Yet how we teach in schools has changed little in respect of his findings. In my opinion there is an over reliance on what happens "in the lesson" to embed learning, particularly "over-learning" which we know to be very

inefficient at embedding learning, and too little use of "time in subsequent lessons".

Recently, cognitive scientists research with respect to retrieval practice, has finally made a cross over into schools. It turns out, Mr Gove, that teachers are interested in applying what experts say. It turns out that educational policy makers have been listening more to politicians than experts and that as a result perhaps millions of people have left school convinced they are "not good at learning", almost all of whom would have been "good at learning" had teaching more reflected how we learn best.

The mp4 "the solution: embedding learning" introduces the "spacing effect" and explains how repeated retrieval practice can embed learning. The mp4s "DIY retrieval practice" and "timely practice: efficient learning" give advice on using retrieval practice to embed learning. For most learners, most of the time, if retrieval practice is done at close to optimal spacing - the ideal gap between the point of teaching and the first retrieval practice, or the gap between one retrieval practice and the next - learning is embedded and the learner can answer their practice questions.

In this mp4 "making embedding learning easier" I look at what might be happening and what the teacher can do

- when despite what "ought to be the correct spacing", learning is not retained
- when the learner can recall their learning but other factors impede the the learner from applying their learning.

Looking first at recalling learning, "what goes on inside the learners brain, which neither the teacher nor the learner are aware of when the learner can recall?" Math teaching works because we are focussing on adding a skill which builds on other skills. The learner can use expertise they have built up in their existing memory of the pre-requisite skills to learn the new skill. The teacher shares their expertise,

- think of this example …
- lay your working out like this …
- you can think of (this strange concept) like (this more familiar concept) …

The maths learner is assisted by both the fact that all the questions are similar and by the "recently fired examples" and the "scaffolding" on the white board, the learners page, etc. Usually the unacknowledged scaffolding of the lesson is unconsciously replaced by a "mental schema" by the learner; the new learning, if practised in a timely manner, will enable the learner to apply the learning later.

However sometimes the scaffolding isn't replaced or fully replaced by the learner's mental schema - the teacher can help the learner do this.

If the learner is stuck …

Often the learner is able to look back at their work from the previous lesson, or have their memory jogged by the teacher usually by a short probing question.

However sometimes this is not enough.The help that the learner asks for or the feedback that the teacher gives the learner sometimes seems like a "quick re-teach". It may be the re-teach is needed only once, it goes smoothly and there is no more to do.

It may be that the re-teach doesn't turn out to be that quick and feels to both the teacher and the learner an "uphill struggle" if that is the case and this happens more than once, then the teacher or the learner probably should decide that this skill is "best learned later".

It may be that a quick re-teach is needed several times and each time the learner is able to be more independent. If the teacher is aware of what they are doing, the teacher and the learner working together may be able cue the learner - what "teeny thing" added to the learners memory would help unlock the rest of the learning? Let's look at different types of "teeny thing"

(1) learning an example, that the learner writes down from memory, which the learner can then use as an example to help them. An

example I use regularly is $10^2 = 100$ so $\log_{10}100 = 2$, {one which may be more pertinent to learners using timely practice is boxB x 10^boxI when I is negative = small number when no sign its plus and big number}

(2) de-confusing concepts by writing down both possibles {a + a + a then a x a x a then writing down both answers and then selecting the correct one}

(3) the learner draws or write out a pro-forma which helps them begin {speed = distance over time triangle or solve flag chart}

(4) encourage the learner to write out long winded-ly and if need be reassure the learner that over time they might only need to imagine doing this { 1 packet = 7 pencils, 2 packet …}

(5) encourage learners to draw a diagram {e.g. A: B is box box : box box box} Singapore maths and many recent text books encourage using a line but I think "our client group" work better with boxes

On the other hand perhaps the learner is have difficultly with reading the question, matching remembered skills to questions or merely with the accuracy of their numeracy skills.

Any or all of these problems would, without timely practice, stop the learner successfully applying their learning to problems and some or all of these difficulties would also make future maths learning harder.

Being unable to select the correct skill to apply to the problem, happens much less rarely with timely practice than I would have imagined although as explained earlier the teacher may need to help the learner de-confuse concepts, it is nearly always that the names of the concepts are confused.

With problems of "reading questions with meaning" a useful method can be "I'm going to ask you to read out this sentence" and later on as the learner gets closer to mastery "which sentence do you think I'd ask you to read out?"

What seem to be "poor numeracy skills" problems can be "reading with meaning" problems or "selecting the correct skill problems" or "working memory overload problems". When the learner makes a numerical slip this could be an "applying written methods problem" "working memory overload problems"or see the mp4 "simple word problem problems" for more detail.

Finally timely practice's primary purpose is embedding learning through retrieval practice, sometimes it is better to decide to "best learn later" if timely practice's secondary purpose "ensuring feedback is able to be applied" is using too much of the teacher's or learner's lesson time.