Struggle and the rote memorisation of facts

Greg Ashman

Humans are unique among species in our ability to learn from each other. Many animals can mimic, but we have taken learning from others to the level of a superpower. We have developed complex systems of communication to exchange ideas. Our children have an extended childhood in which they spend a large amount of time learning. Instead of starting from scratch, each individual can build on what has come before – which is why we are capable of such creative feats. No individual, no matter how talented, could start from zero and invent antibiotics, the internet or the feature film.

So, it seems weird to suggest we should not use this power – that we should leave kids to struggle and try to figure things out for themselves.

Nevertheless, it is a seductive idea – one we can trace directly from *Rousseau's Emile* to *a recent article* in *The New York Times*. This siren call has been drawing teachers and their students on to the rocks for at least 260 years.

Due to the fact that it doesn't work very well, learning through trial-and-error is an idea in constant need of a new justification. In *The New York Times* piece, the justification amounts to an assertion that struggle is good because kids need a 'growth mindset' – they need to view themselves as able to learn rather than believe their capacity is fixed.

On its face, this justification is absurd. There is already enough struggle in learning complex concepts and skills such as algebra, balancing chemical equations or historical source analysis. Even when taught this content explicitly, with each element broken down and fully explained, most young people will find it hard – in such circumstances, they may well benefit from having a growth mindset.

It is not obvious why we should deliberately *increase* the level of struggle and it's not obvious that if we did, it would *cause* students to develop a growth mindset. These are hypotheses in need of evidence.

In fact, motivation for a subject and achievement in that subject *are closely linked*. So by deliberately making students struggle, we may instead cause them to become demotivated.

In *The New York Times* article, completing worksheets of problems that students find too easy is presented as the only alternative to these struggle sessions. Perhaps this is a major problem in American schools – I don't know. However, the alternative I would propose is to explicitly teach challenging concepts.

In order to deal with the research that is presented in the article, we also need a way of describing task complexity that goes beyond 'easy' or 'hard'. In my field of research, we use 'element interactivity' – the number of interacting items a student must hold in their limited working memories in order to complete a task. Critically, this not only depends upon the task but

also what students have in long-term memory. If a student simply *knows* that 7 x 8 = 56, then that part of a maths problem does not need to be processed in working memory.

Some tasks, though challenging to master, are inherently low in element interactivity. For instance, learning the names of a list of capital cities or the dates of a series of battles can be done by processing just one item at a time. Other tasks, such as learning how to solve a class of algebra problems, are initially high in element interactivity, but this gradually reduces as students commit more of the process steps to long-term memory.

Many of the most significant concepts we want students to learn in school – how to write a paragraph, plan an argument, control variables in a science experiment, etc. – begin high in element interactivity.

The *repeated failure* of approaches such as problem-based learning, inquiry learning, project-based learning and so on – approaches that promise so much – can be accounted for by the fact that they raise element interactivity way above the limits that students' working memories can handle. The *repeated success* of explicit teaching can be accounted for by the fact that it controls what items a student must pay attention to at any given moment and keeps the number of them within the limits of working memory.

Nevertheless, alternatives to explicit instruction *sometimes* seem to work well. Examples include the rote memorisation of items such as *second language vocabulary* or *anatomy information* – tasks that are low in element interactivity. In such tasks, introducing so-called 'desirable difficulties' that increase the load on working memory appear to enhance learning. For example, learning materials may first give the initial letter of a word and ask students to generate a response rather than simply giving them the word, or they could involve the almost immediate use of practice testing.

The New York Times article refers to *a 2021 meta-analysis* and claims:

> *Dr. Kapur recently co-wrote a meta-analysis analyzing 53 studies from the past 15 years that examined which teaching strategy was more effective: providing direct instruction on how to complete a problem before practicing it, or providing well-designed questions to provoke thinking on a concept before introducing knowledge about how to tackle it… Problem-solving practice before learning a concept was significantly more effective than the converse – learning the concept first and then practicing. (para. 17)*

I don't think this is an accurate representation of the research.

But first, notice how the issue has shrunk. We have gone from asking students to struggle to asking them to struggle *for a while* before providing direct instruction. This is significant. Since around 2009 and the publication of a scholarly work, *Constructivist Instruction: Success or Failure*, no serious educational

psychologist still promotes the concept of extended periods of self-directed learning – despite it being popular in schools. Even the fans of struggle have retreated to a position that concedes that complete instructional guidance is needed at some point; they just propose a little open-ended problem solving first.

Even so, I reviewed similar literature to Kapur in *the 2020 paper I co-authored and which is based upon my PhD research*. Many experiments have been conducted that have attempted to compare problem-solving followed by direct instruction with direct instruction followed by problem-solving. Unfortunately, a substantial proportion do not use robust experimental designs. Of those that do, the results are mixed and even then, can be hard to interpret.

For instance, *one of the stronger studies* showing the advantages of a struggle-first approach involved teaching students about a statistics concept. However, those students who first received direct instruction in the standard method then had to spend time attempting to solve one problem different ways using their own invented methods. It is unlikely a teacher would do this.

Sometimes, studies in this field find an advantage for struggle-first in 'conceptual knowledge' but not 'procedural knowledge'. This sounds impressive. Who cares about mere procedures? Except that procedural knowledge – such as how to balance chemical equations – is both important and high in element interactivity. And although it is critical for students to have an understanding of what the '=' sign in an equation means, the way this is assessed *often amounts to asking for a definition* and learning definitions is low in element interactivity.

In my own experiments in this area, I adopted a novel design to test the struggle-first hypothesis in the context of middle school students learning about energy efficiency. By using a reading filler task and staggering the two conditions, I ensured all students were in the same session of direct instruction. This meant that I could not unconsciously provide subtly different teaching to the two groups, a potential problem in many of the other studies. My results found an advantage for direct instruction followed by problem-solving over problem-solving followed by direct instruction. In one case, this extended to 'transfer' problems, i.e., problems that require students to apply what they have learnt in new situations. I found no support for the struggle-first hypothesis.

My concern is that the breathless New York Times *article will prompt yet more enthusiasm for setting students problems they cannot solve – with none of the nuance that even the proponents of struggle would emphasise – and then perversely celebrating the inevitable frustration this will generate.*

Even proponents of struggle-first list *several conditions* that are necessary to apparently achieve the effect. Most importantly, the problems students are initially posed must be understandable in everyday language and amenable to students' naïve solution attempts. It is hard to think of topics in, say, advanced mathematics that fit this bill. I managed to design such a task, but it was tricky.

My concern is that the breathless *New York Times* article will prompt yet more enthusiasm for setting students problems they cannot solve – with none of the nuance that even the proponents of struggle would emphasise – and then perversely celebrating the inevitable frustration this will generate.

I guess the counter-narrative that explicit teaching aids complex learning but struggle aids the rote memorisation of facts is unlikely to catch on in our faculties of education.

This article originally appeared on the author's blog, Filling the Pail.

Greg Ashman [@greg_ashman on Twitter] is Deputy Principal at Ballarat Clarendon College, Victoria. He is a prolific blogger and has written two books: The Truth About Teaching: An Evidence-informed Guide for New Teachers, *and* The Power of Explicit Teaching and Direct Instruction. *His third book,* A Little Guide for Teachers: Cognitive Load Theory, *is due for release soon. Prior to moving to Australia, Greg worked at a number of comprehensive schools in London.*