A JOHN CATT PUBLICATION

Tom Sherrington

ROSENSHINE'S PRINCIPLES IN ACTION

with illustrations by Oliver Caviglioli

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by John Catt Educational Ltd,
15 Riduna Park, Station Road,
Melton, Woodbridge IP12 1QT

Tel: +44 (0) 1394 389850
Email: enquiries@johncatt.com
Website: www.johncatt.com

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TABLE OF CONTENTS

INTRODUCTION: WHY ARE BARAK ROSENSHINE'S 'PRINCIPLES OF INSTRUCTION' SO GOOD?

I first encountered Barak Rosenshine's 'Principles of Instruction' after the British educator and graphic illustrator Oliver Caviglioli shared his excellent visual guide on Twitter. This prompted me to seek out the *American Educator* article from 2012 where Rosenshine's ideas are set out. This article is taken almost directly from a pamphlet in the International Academy of Education (IAE) *Educational Practices* series in 2010. In his pamphlet Rosenshine set out ten research-based principles of instruction based on the ideas he and his colleagues had developed over the preceding decades.

On first reading, I was struck immediately by its brilliant clarity and simplicity and its potential to support teachers seeking to engage with cognitive science and the wider world of education research. In the last year, Rosenshine's 'Principles of Instruction' has been circulating increasingly rapidly around schools in the UK as more teachers discover its insights, sharing via social media and the growing array of grassroots teacher conferences.

The purpose of writing this short booklet is to capture some of the many discussions I've had with school leaders and teachers, taking the ideas off the page and putting them into action in the classroom. Although the principles are superbly helpful as Rosenshine has expressed them, my hope is that this booklet provides an extra layer of guidance that people find interesting and useful, informing their staff training programmes or the development of their personal practice.

Four strands

The organisation of ideas that make up 'Principles of Instruction' has evolved over time. In 'Teaching Functions', 1986, there were six main ideas. In the IAE pamphlet, Rosenshine outlines 17 'instructional procedures' that emerge from the research:

- Begin a lesson with a short review of previous learning.
- Present new material in small steps with student practice after each step.
- Limit the amount of material students receive at one time.
- Give clear and detailed instructions and explanations.
- Ask a large number of questions and check for understanding.
- Provide a high level of active practice for all students.
- Guide students as they begin to practice.
- Think aloud and model steps.
- Provide models of worked-out problems.
- Ask students to explain what they had learned.
- Check the responses of all students.
- Provide systematic feedback and corrections.
- Use more time to provide explanations.
- Provide many examples.
- Re-teach material when necessary.
- Prepare students for independent practice.
- Monitor students when they begin independent practice.

From these procedures he then formulates the ten principles. In seeking to explain the principles to audiences in the UK during various ResearchEd[1] conferences, I found that it helps to condense these ten ideas down to four strands. Partly this is because of the requirements of timing a conference presentation where ten ideas feels like a long list. However, I mainly found that after revisiting the document many times, I was continually skipping back and forth to make these connections.

1 ResearchEd – A UK-based organisation running teacher conferences that focus on educational research and its implications for teachers and school leaders. www.researched.org.uk

The Principles of Instruction

1. Daily review.
2. Present new material using small steps.
3. Ask questions.
4. Provide models.
5. Guide student practice.
6. Check for student understanding.
7. Obtain a high success rate.
8. Provide scaffolds for difficult tasks.
9. Independent practice.
10. Weekly and monthly review.

Four strands

Sequencing concepts and modelling
2. Present new material using small steps.
4. Provide models.
8. Provide scaffolds for difficult tasks.

Questioning
3. Ask questions.
6. Check for student understanding.

Reviewing material
1. Daily review.
10. Weekly and monthly review.

Stages of practice
5. Guide student practice.
7. Obtain a high success rate.
9. Independent practice.

I will use the four strands structure for the guidance that follows. But first, I'd like to explore why the 'Principles of Instruction' pamphlet is receiving such an enthusiastic response. There are several reasons:

Bridging the research-practice divide

Rosenshine provides a highly accessible bridge between research and classroom practice. His principles are short, easy to read, and packed with insights. This is refreshing. From a teacher's perspective, research is still hard to access. A lot of original research languishes in obscure journals that most teachers don't even know exist. Even when wonderful communicators like Daniel Willingham, John Hattie, Dylan Wiliam – or, more recently, Efrat Furst, Yana Weinstein and Megan Sumeracki (members of The Learning Scientists) – publish books and blogs, it is still a challenge to secure major engagement across a large group of staff in a school. This is partly due to the limitations of teachers' time – they are busy! – but it's also a matter of school culture. Schools carry a lot of inertia; teachers' habits are hard to shift. The punchy simplicity of the principles cuts through a lot of that.

In the original publication, each short section outlining one of the ten principles follows a clear and persuasive structure: 'Research findings' followed by 'In the classroom'. Rosenshine does a superb job of relating research findings to classroom practice in such a way that conveys the key outcome of the research without getting bogged down in methodology and problematic considerations of effect size. The 2010 paper carries all the citations for anyone wishing to look a little deeper. There's power in the simple binary descriptor Rosenshine deploys to get his message across: *more effective* teachers vs *less effective* teachers. We all understand that implicitly there's a sliding scale – that more layers of nuance lie beneath – but 'more effective' cuts to the chase. And who doesn't want to be in that camp!

Trustworthiness

In addition to highlighting samples of evidence, the overall tone and content of the principles give teachers confidence that these ideas are not fads; they are rooted in evidence that has stood the test of time. Rosenshine introduces his pamphlet with a brief overview of the three sources of evidence that have informed his principles:

- Research on how our brain acquires and uses new information: *cognitive science*
- Research on the common classroom practices of those teachers whose students show the highest gains: *observational studies of 'master teachers'*
- Findings from studies that taught learning strategies to students: *testing cognitive supports and scaffolds that help students learn complex tasks*

He follows up with the acknowledgement that although the approaches are very different, 'there is no conflict at all between the instructional suggestions that come from each of these three sources. In other words, these three sources supplement and complement each other.' This fact 'gives us faith in the validity of these findings'.

The convergence of ideas from classroom observations and cognitive science is important. If it were the case that cognitive science suggested a different set of instructional practices from those being used by effective 'master' teachers, then we'd be in a muddle. How could we explain that? Happily, whilst learning and teaching are undeniably complex, it turns out that they are not *that* complex: we can formulate a coherent evidence-based model that links theory to practice. Rosenshine's Principles provide the coherence teachers seek, and that fosters trust. This matters because without trust, teachers don't buy into information; they simply ignore it, and the inertia grows.

Authenticity

A third aspect that I find to be fuelling interest in Rosenshine's 'Principles of Instruction' is that the paper, taken as whole, sounds to many teachers like common sense. It's an entirely recognisable set of ideas. There are no gimmicks, no fads, nothing that seems implausible, nothing outlandish. Teachers either recognise themselves in the descriptions or they see valid and obtainable models to aspire to. After many years of having teaching defined by external powers, this feels like a grassroots document, allowing it to gain acceptance that cuts through teachers' well-honed defence systems.

From my perspective, as someone who now spends most weeks working with teachers seeking to improve their practice, it's great to have a set of ideas that are rooted so authentically in classroom experience. This paper is uncontentious. The discussions are not about whether or not to adopt the principles; they are about how to adopt them more fluently, with more intensity or at a higher frequency; they are about how to interpret them through the lens of each subject domain, and how to adapt them for learners with different levels of knowledge and confidence.

For all these reasons, Barak Rosenshine's Principles of Instruction provide an incredibly useful platform for teacher development processes. It's a well-rehearsed notion that the lessons that make the difference to student outcomes are all the many lessons that go unobserved – where it is just the teacher and their students in a classroom enacting the teacher-student interactions that either lead to learning gains or don't. If teachers are going to be successful in improving their practice, they have to be working consciously and deliberately to do so. Teachers need to be working on developing better habits, seeking to be more effective day in, day out when nobody else except their students is looking. The kiss of death to teacher development is a school culture or accountability framework that motivates 'speed camera' behaviours – where teachers turn on the style when they are under scrutiny only to revert to less effective practices the rest of the time. If we're to avoid that, then we've got to foster a professional culture where good ideas gain acceptance, credibility, and momentum. I find that in Rosenshine we have a superb tool for doing just that.

Theory of action: what is the underlying model?

One of the big variables I find in working with teachers in a range of contexts is their ideas about how learning works. How do the actions and activities that a teacher engages in – or that they require their students to engage in – lead to learning? Sometimes teachers talk in terms of concepts 'sinking in', and I often hear complaints that despite explaining a concept over and over, students still managed to misunderstand it – or even worse, despite seeming to have been successful in a lesson, they forgot it all immediately afterwards. Too many teachers still believe that teaching according to students' preferred learning styles is a good idea, even though this has been soundly debunked.[2]

All of these problems stem from a weak model of the learning process. If teachers are going to improve their practice, then it's essential for the ideas they are basing their thinking around to be formulated on a sound model. Understanding the model isn't a necessary condition for successfully implementing the strategies the model suggests, but my personal view is that teachers are more likely to connect with ideas and implement them well if they can formulate a mental model of learning that underpins the practice. This is supported by the work of Deans for Impact in their excellent *Practice with Purpose* document:

> Deliberate practice both produces and relies on mental models and mental representations to guide decisions. These models allow practitioners to self-monitor performance to improve their performance.[3]

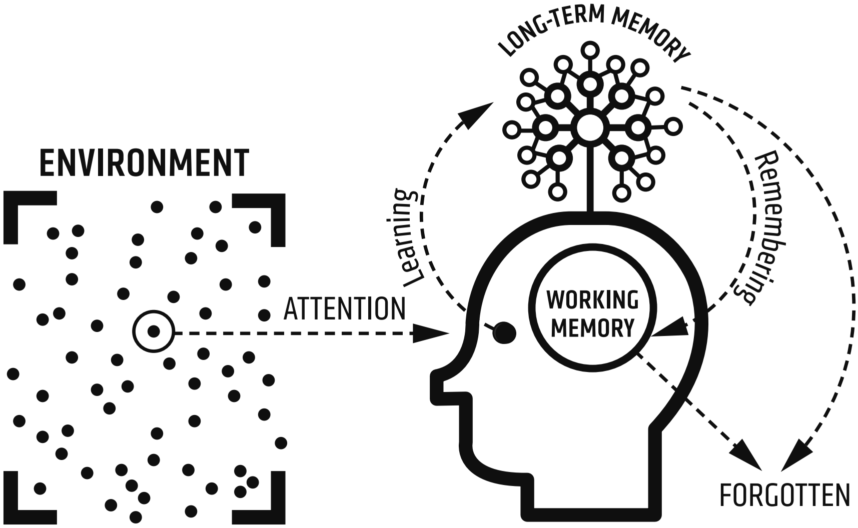
It's fascinating to me just how well the Principles of Instruction are supported by the learning model that emerges from contemporary cognitive science. For the purposes of this short book, it will help to rehearse the key elements of this model. It is based on ideas from the following sources:

- Daniel T. Willingham's *Why Don't Students Like School?*
- Graham Nuthall's *The Hidden Lives of Learners*
- Arthur Shimamura's *MARGE: A Whole-Brain Learning Approach*
- Yana Weinstein and Megan Sumeracki's *Understanding How We Learn*
- The many others who collectively contribute to our understanding: Robert and Elizabeth Bjork, John Sweller, Paul Kirschner, Carol Dweck

A simple model for how memory works is based on the concept of building schemata in our long-term memory, as follows:

2 Sumeracki, M. and Weinstein, Y. with Caviglioli, O. (2018) *Understanding how we learn – a Visual Guide* Routledge.

3 Deans for Impact www.deansforimpact.org/resources/practice-with-purpose



Conceptual information initially enters from the environment into our working memory.

Working memory is finite and actually rather small, so we can only absorb a limited amount of information at once.

We process information so that it is stored in our long-term memory. This is effectively unlimited, and we retrieve information back into our working memory as needed.

We organise information into schemata. Typically, new information is only stored if we can connect it to knowledge that we already have. As a result, prior knowledge is a major factor in our capacity to learn new information. The more complex and interconnected our schemata are, the easier it is to make sense of new related information and the better we are able to organise it so that it makes sense. The concept of understanding is really 'memory in disguise'.[4] This means that our schemata are more fully formed, are more interconnected, and can be explored and recalled more fluently.

If a schema contains incorrect information – a misconception or an incomplete model of how a process works – we can't simply overwrite it. A more primitive schema can return to dominate unless we unpick and fully re-learn a correct schema.

4 Willingham, D. (2009) *Why don't students like school?* Jossey-Bass

We forget information that we do not initially store successfully in a meaningful schema or that we do not retrieve frequently enough. This is entirely natural – we're primed to filter out information we might need and to discard the rest. Our capacity to retrieve information improves if we practise doing this more often and do so in more depth.

If we undertake enough retrieval practice, generating formulations of our memory and evaluating it for accuracy, we gain a degree of fluency and, ultimately, automaticity. This is true of anything we learn, be it reading, driving, or speaking a foreign language. A consequence of this, as explained by cognitive load theory,[5] is that the more fluent we are with retrieval of stored information, the more capacity we have in our working memory to attend to new information and problem-solving – if we are efficient in bringing up the information from memory, then there's more working memory space left to deal with applying the information. The opposite is also true: when we are less fluent with recall, our capacity to attend to new information and problem-solving is diminished. This is a key difference between novice and expert learners. Think of novice drivers, who become easily overwhelmed by the pressures of traffic and road signs: they are more likely to have difficulty absorbing all the external information as well as focusing on the skill of driving itself.

A key implication of this is that novice learners need more practice than more confident, experienced learners.

Following the work of Nuthall and Shimamura, I find it instructive to imagine a classroom of students as a room full of hidden schema-forming brains, each doing things we cannot see, each processing information differently depending on what they already know, on the level of attention they are giving to the new knowledge and on their capacity to self-regulate and to organise information successfully. In that context, instructional teaching needs to be highly interactive. We need to gain as much feedback as we can from our students, helping us gauge how well the learning is going so that we can then plan the next steps in our teaching. Learning is hidden, so we need to seek out evidence for it in a dynamic fashion during our lessons.

This interactivity, the need for 'responsive teaching'[6] underpins many of the ideas in the Principles of Instruction.

Knowledge-specified curriculum

A final preliminary consideration for teachers before we explore the principles themselves is the notion of a knowledge-specified or 'structured' curriculum.

5 Sweller, J., Ayres. P., Kalyuga, S. (2011) *Cognitive Load Theory* Springer

6 Wiliam, D. (2011) *Embedded Formative Assessment* Solution Tree Press

In the 1986 paper by Rosenshine and Stevens, 'Teaching Functions', they talk about the limitations of the principles:

> It would be a mistake to claim that the teaching procedures which have emerged from this research apply to all subjects, and all learners, all the time. Rather, these procedures are most applicable for the 'well-structured' (Simon, 1973) parts of any content area, and are least applicable to the 'ill-structured' parts of any content area.

They go on to explain that all subjects have 'well-structured' elements – some more than others. It's an important bit of nuance in the implementation of Rosenshine's principles. Evidently, some content needs more teacher-directed instruction and so the subject-specific curriculum context is important.

This also suggests that the more precise we are about the knowledge goals for learners, the more rigorous we can be about the process of ensuring that all students meet them. This rings true in my experience, having observed thousands of lessons. Very often, when engaging in feedback conversations with teachers, I feel that everyone in the class could have benefited from more precise knowledge goals – both teacher and students. It's hard to form a strong schema, to practice retrieval, or to evaluate the true extent of our knowledge if you are unsure what the knowledge is meant to be or if you are unsure what exactly 'success' looks like.

This will be illustrated further as we explore each of the principles.

In the following sections, I will take each strand in turn, referencing the original 17 instructional procedures where I think they belong. My aim is to amplify and augment the ideas as Rosenshine has expressed them, giving further examples without repeating those he used himself.

STRAND 1: SEQUENCING CONCEPTS AND MODELLING

I've started here because it seems sensible to begin with elements of instruction that require advanced planning before we get into the classroom.

Relevant instructional procedures include:

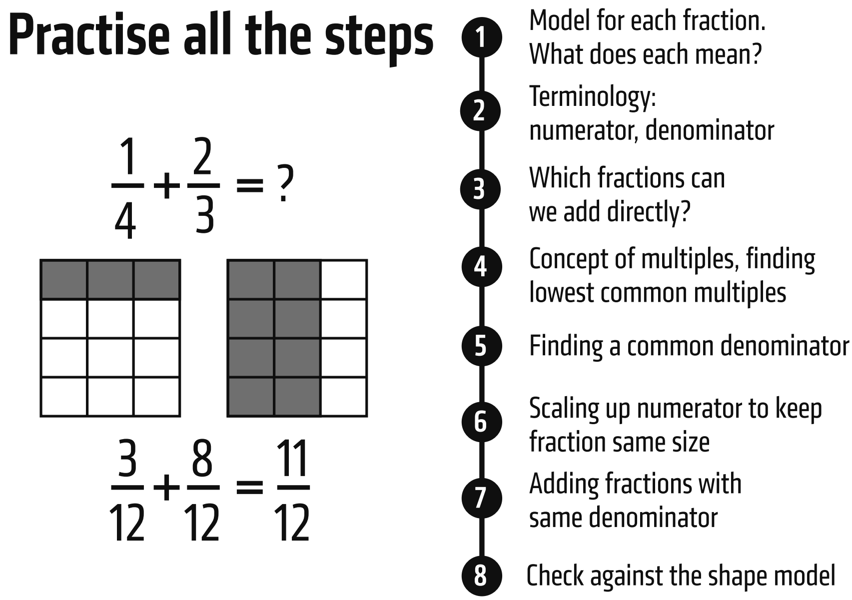
- Present new material in small steps with student practice after each step.
- Limit the amount of material students receive at one time
- Give clear and detailed instructions and explanations.
- Think aloud and model steps.
- Use more time to provide explanations.
- Provide many examples.
- Re-teach material when necessary.

2. Present new material using small steps

Rosenshine suggests that more effective teachers recognise the need to deal with the limitations of working memory and succeed in breaking down concepts and procedures into small steps. They then ensure students have the opportunity to practise each of the steps. The modelling and scaffolding that accompany this phase of a lesson all roll into one as part of the process of explaining, providing well-structured support for students as they build their schemata for new concepts.

Clearly, the implication here is that teachers need to invest time in analysing their curriculum material to see how it can be broken down. We can't separate generic instructional methods from curriculum content in practice.

There are many examples of where material is broken down into small steps. It's a common idea in teaching sports where complex actions and team games are built around the development of specific definable skills. In dancing, we don't try to learn a whole routine from start to finish; we learn the first step and then the second, rehearsing each one. Then we add a third and fourth and maybe practise steps one to four before adding step five. We build slowly, seeking to secure success at each point whilst also assimilating each part into the whole.



Many mathematical procedures are similar. As shown above, adding fractions, broken down, actually comprises several steps.

A student who struggles to add fractions may need more practice with building a concrete model of fractions as parts of shapes or may need practice finding lowest common multiples.

There are many more examples, each of which is highly subject specific. I would argue that a great deal of teacher development time would be wisely spent analysing the curriculum, so that teachers have a clear understanding of what the learning steps might look like. Sometimes this is hard because of the 'curse of knowledge' that experts experience: we don't always know what we know; we accumulate a great deal of tacit knowledge from experience in our specialist areas and it requires some thought to map this out for our novice learners.

One common strand of thinking about new material is to break a task down into a set of instructions. How do you build a wall and, in doing so, how do you go about checking that it will be 100% straight and vertical in every plane as you go along? How do you bake a cake, from selecting and measuring the ingredients to knowing what 'the right consistency' of the mixture means? How do you construct a paragraph with a particular goal in mind, selecting words and phrases to convey the meaning, create the mood, and express the style that you want? How do you explain how diffusion of gases works, linking the physical reality to a model that helps explain what you see (or smell!), step by step? How do you deconstruct the process of composition in art? If teachers in the relevant discipline can break these complex activities down into fine-grained stages, they'll be more effective in explaining them to their students.

Another form of sequencing is in moving from the big picture of a subject down to a detailed area of focus and back again. We zoom out to orientate ourselves and then zoom in, ever further, step by step. This helps students to form a clear schema, locating an area of learning in relation to others. For example, each event in history has a wider context at a bigger timescale and links to a set of wider historical or social themes. Who Rosa Parks was and why what she did matters only has meaning if we know about the bigger context of the Equal Rights Movement; in biology, we go from organisms to organs to tissues to cells to cell structures and, finally, to biochemical processes. It's confusing to learn about osmosis in stomata guard cells unless we have a very clear understanding of the context of cells within a schema for plant structure and function. In poetry, in order to engage in a meaningful discussion of the specific meaning of, say, Ted Hughes's 'Suddenly, he awoke and was running – raw' (the opening line from 'Bayonet Charge'), it's going to be important to have some prior knowledge about the WWI context, and an understanding of a range of literary language techniques and structures as well as some background about Ted Hughes .

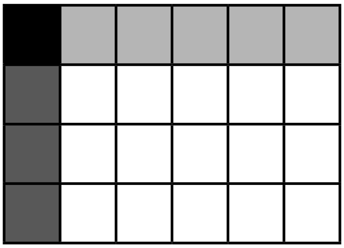
4. Provide models

Providing models is a central feature of giving good explanations. This has several meanings. Models can be:

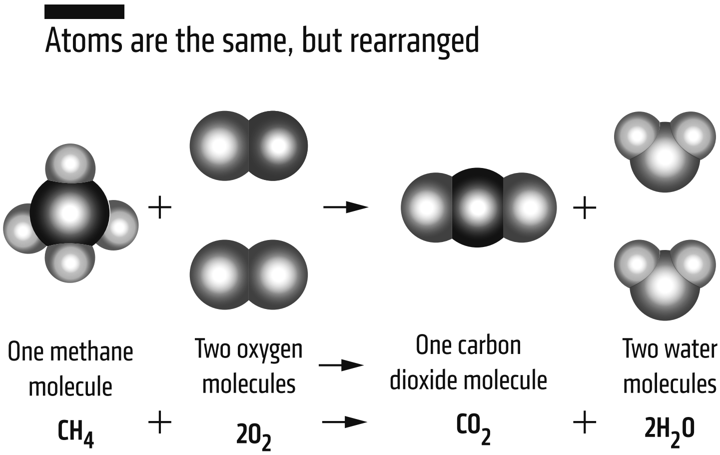
- physical representations of completed tasks – exemplars that can be used as scaffolds, such as a model paragraph for opening a history essay.
- conceptual models – such as the one we need to form to understand the behaviour of particles in solids, liquids and gases.
- explicit narration of our thought processes when thinking through how to solve problems or undertake a creative activity.

There are lots of ways teachers can develop their practice by developing the way they provide models:

> ***Link abstract ideas to concrete examples***
>
> This includes the use of physical manipulatives – blocks and shapes – when learning about numbers and fractions. An important example would be equivalent fractions – using diagrams or physical objects to build a model where ½ + ½ = ¼ + ¼ + 3/8 + 1/8. Another example is linking multiplication tables and division to a model:
>
>> 6 × 4 = 24. 4 rows of 6; 6 columns of 4. 24/6 = 4 Children are well prepared for future learning if their schema for multiplication has a secure foundation of this kind.



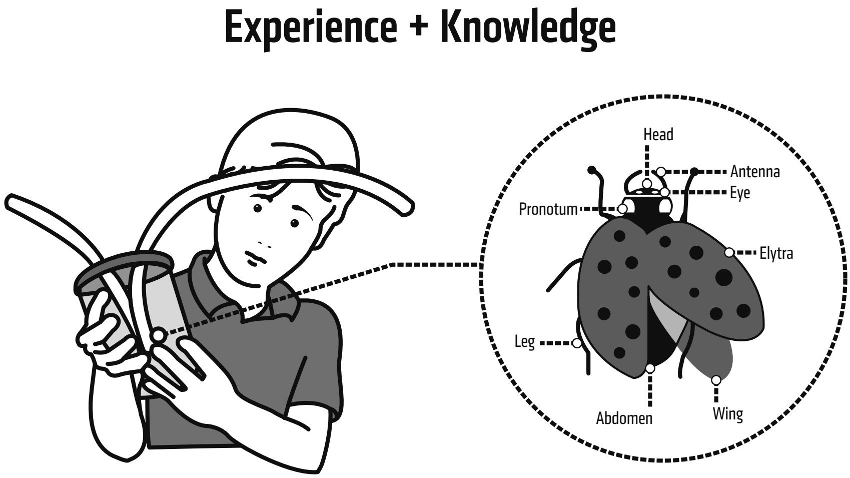
> In science, using a molecular diagram and symbol equations to explain practical chemical reactions is essential, as with burning hydrocarbons:
>
> Hydrocarbons + Oxygen → Carbon dioxide + Water
>
> Methane: $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$; the atoms are the same, but rearranged.



In English, it's helpful to know concrete examples of technical grammar structures or features of writing. 'All of a sudden' is a fronted adverbial; 'She glided like a swan' is a simile; 'the wind swooshed and swirled around the houses' includes examples of onomatopoeia and alliteration. Moving to and fro between the abstract and the concrete is important in many aspects of language.

Link abstract knowledge to experiential 'tacit' knowledge

This builds directly on the section above. Concrete examples are often 'tacit'. As a science teacher, where the interplay of theory and practical work is well-rehearsed, I would extend Rosenshine's ideas into this important area – although it has implications in other subject domains.



In the preamble to the ten principles, Rosenshine makes an important statement following a neat summary:

> The most effective teachers ensured that their students efficiently acquired, rehearsed, and connected background knowledge by providing a good deal of instructional support. They provided this support by teaching new material in manageable amounts, modeling, guiding student practice, helping students when they made errors, and providing for sufficient practice and review. Many of these teachers also went on to experiential, hands-on activities, but they always did the experiential activities *after*, not before, the basic material was learned.

I think this needs careful interpretation in different subject contexts. Rosenshine is firmly saying that some experiential activities are not successful in securing learning unless 'basic material' has been learned. Plenty of activities can seed confusion and misconceptions if students don't know enough about what they're doing. However, 'tacit' knowledge can also constitute the essential background or basic material that has to be learned. In my experience, many of the phenomena taught in science can be better understood once we've gained some tacit knowledge from hands-on experience in field studies, demonstrations or experiments. If we have studied insects by looking at them in a jar close up, then the technical work about labelling body parts and describing their form and function has a basis in our own reality. If we know what it feels like to control the speed of rotation of an electric motor, we are better placed to discuss the theoretical explanation. A well-sequenced curriculum will provide opportunities of this kind with hands-on activities in the most appropriate place to maximise learning.

Narrate the thought process

An important role for teachers is to support students in developing their capacity for metacognition and self-regulation[7] by modelling their own thought processes when engaging in a task. Effective teachers will be able to narrate the decisions and choices they make: where to begin with a maths problem; where to start with an essay; how to plan the timing of a 20-minute writing task; how to write in a style appropriate for a certain purpose and audience, making particular choices of words and phrases. By making the implicit explicit, teachers are supporting students to form their own mental models, gaining confidence with the decisions they make.

Organise the information

Modelling can help students to organise information into secure, well-structured schemata. As Shimamura suggests in the R of his MARGE[8] theory, we need to relate new knowledge to what we already know. He suggests that the three Cs – compare, contrast, categorise – can be helpful in doing this. Teachers can model the way complex sets of information can be sequenced, connected, and arranged into patterns to make it possible to learn and recall later.

7 Education Endowment Foundation www.bit.ly/2YZvdqE

8 Shimamura, A. (2018) MARGE *A Whole-Brain Learning Approach for Students and Teachers.* PDF available from www.bit.ly/2UEi1IB

An example of this might be to show how certain quotations in Shakespeare's *Macbeth* support the view of Macbeth as weak or guilt-ridden whereas others show him to be calculating and driven by ambition. Modelling the use of quotations provides a framework for students to engage in that process themselves.

Further examples would be any context where we might categorise advantages and disadvantages or arguments for and against and, more obviously, where categories relate to physical entities such as metals and non-metals or types of tectonic plate interactions. The more teachers illustrate the formation of relational models, the more likely it is that students will grasp the ideas and form sound schemata of their own.

Worked examples (aka worked-out examples)

As described briefly by Rosenshine, John Sweller and others have demonstrated the power of worked examples as an outcome of cognitive load theory. Effective teachers will tend to provide students with many worked examples so that the general patterns are clear, providing a strong basis from which to learn. The trick is then to gradually reduce the level of completion, leaving students to finish problems off and ultimately do them by themselves.

18% of £65	37% of £120	68% of £1050
$\frac{18}{100} \times 65$	$\frac{37}{100} \times 120$	$\frac{68}{100} \times 1050$
$= 0.18 \times 65$	$= 0.37 \times 120$	$= ? \times ?$
= £11.70	= £44.40	= ?

Rosenshine suggests that less effective teachers tend not to provide enough worked examples, thus adding to cognitive load as well as leaving students unsure of the procedures at hand and how to apply them.

Worked examples are powerful wherever calculations are involved but can also be used in any kind of structured writing or technical procedures, such as with grammar exercises in English or foreign languages, or balancing chemical equations. It's often the case that when I observe a teacher struggling to make headway with a class of students who seem stuck, I want to say 'show them another example'. So often this is the key to unlocking the next step in their understanding: seeing how it can be done.

8. Provide scaffolds for difficult tasks

Rosenshine tells us that it can be important for students to undergo a form of 'cognitive apprenticeship' whereby they learn cognitive strategies from a master teacher who models, coaches and supports them as they develop a level of independence. The key is that the scaffolds are temporary; they support the development of a cognitive process but are withdrawn so that students don't become reliant them. This is a form of guided practice as a precursor to independent practice. All of the ideas in the fourth principle ('Provide models') above can be used as temporary scaffolds that are later withdrawn.

A classic example of scaffolding is the use of stabilisers for learning to ride a bike. I had this experience with my own daughter. She found riding a bike difficult, so we put on stabilisers that allowed her to gain confidence with steering, pedalling, and the beginnings of balance. Then, we took the stabilisers off and I ran behind her holding the saddle. Eventually she called out, 'You can let go now, Dad!' The beautiful thing was, I already had! She was off, riding independently. The stabilisers and my saddle-holding had served their purpose as she moved through the learning process.

Writing frames

In the classroom, a common, useful tool is a writing frame to scaffold writing. This might be the use of an opening sentence for literary analysis:

- *Throughout the novel, the author…* – a structure that helps to discuss a long-running theme
- *At first glance, the character appears… However…* – a structure supporting comparison between surface and deep features of a character
- *Both poems… However, poem A… whereas poem B…* – a structure for comparing two poems

Writing frames can also be useful answering questions in science:

- Initially, the concentration is…
- *Then, as the level of X increases…*
- *This, in turn, causes…*

A very common feature of teaching in writing-heavy subjects is to provide paragraph structures as scaffolds:

- PEE: Point, Evidence, Explain
- SQuID: Statement, Quotation, Inference, Development
- PETAL: Point, Evidence, Technique, Analyse, Link

The idea is to teach students how to organise their ideas. For many students, this is critical to their success in developing their knowledge of forms of expression. However, if overused, there is a risk that these paragraphs read as very formulaic, so students need to be weaned off them as they reach higher levels where a greater degree of flair and individuality is expected. The whole point of scaffolding is that, eventually, it has to be taken down!

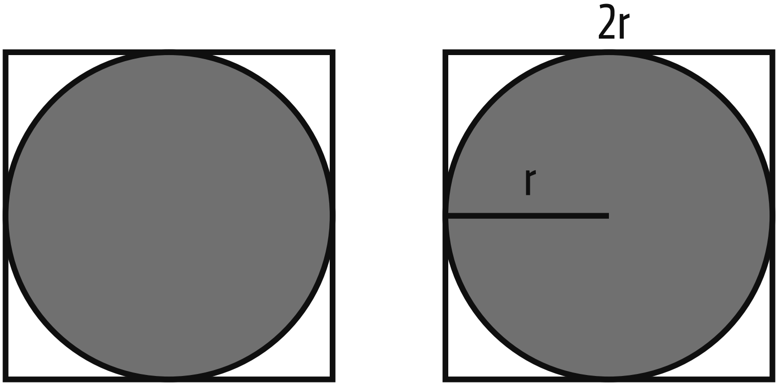
Exemplars

A useful form of scaffolds can be the examination of exemplars produced by previous students or by the teacher. Written success criteria can feel rather dense and difficult to interpret whereas the differences between exemplars of different standards can be much easier to understand. If students are asked for the positive features of an exemplar and ways it can be improved, and then asked to compare their own work to the exemplar, they can often make much better sense of the component elements that contribute to the idea of success. This can apply to writing or any creative process – an art piece or technology product.

Strategic thinking

In the question on the next page, many students who could answer the right-hand version would struggle with the left-hand version. This is simply because, in the apparent lack of any dimensions, they feel there is nothing they can do. The simple act of labelling the diagram provides a way into the problem. Once a radius is labelled, the area of the circle can be written as πr^2 and the square area can be seen to be $2r \times 2r$. However, students need to learn that they have the power to make the decision to undertake the labelling themselves; to introduce an algebraic variable and then use it. It's quite a big leap that needs modelling and scaffolding before students are able to do this independently with confidence.

What fraction is shaded?



Most problem-solving subjects have a relatively small set of archetypal problems. Once students become familiar with them, their cognitive load is greatly reduced with subsequent encounters. In this sense, simply exposing students to multiple examples of the typical problem types scaffolds their capacity for problem-solving.

Anticipate errors and misconceptions.

An important aspect of modelling is to anticipate common errors and to explicitly challenge misconceptions. In maths and science, there are numerous well-known common misconceptions and errors; in writing, there are many common spelling and grammatical errors. A form of scaffolding is to tackle these things head-on, highlighting potential pitfalls and supporting students in checking their own work so that, ultimately, students have gained a sound knowledge of the pitfalls and are able to self-check and self-correct.

This could include basic numerical operations, such as keeping place value aligned in subtraction, multiplication and division; attending to the BIDMAS order of operations; checking for a positive increase when subtracting a negative number or when dividing by a number smaller than 1.

For writing, students can be provided with a checklist of common errors – full stops and capital letters, correct use of apostrophes – which students use initially and gradually stop relying on as they internalize the conventions.

In science, common misconceptions include the idea that the Earth's shadow causes the phases of the moon (it doesn't), that the mass of a tree comes from the soil (it comes from the air), or that 'cold' can flow into a house (it's heat that flows out, reducing the temperature inside; there is no such thing as 'cold' as an entity). In anticipating and teaching these ideas directly, students are able to form a more complete schema for the relevant topic.