



The intent and implementation of subject-specific exercise books.

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Introduction

Ryefield Primary School is in the process of undertaking a year's trial on the use of bespoke science exercise books. These books, which currently range from Year 2 to Year 6, have been specifically designed to meet the needs of a changing curriculum, support subject-specific information and assist teachers in matching content to the needs of the cohort. The books are organised in the following order:

- a splash page and pre-unit assessment,
- a knowledge organiser,
- national curriculum statements,
- a mind map,
- an image to prompt boxed thinking,
- a post-unit assessment, and
- 'show what you know boxes': opportunities for pupils to individually recall information and transfer that learning to other topics and concepts.
- End of Year Assessment (*trialled in Y5 and Y6*)

This paper will seek to rationalise the school's intent and underlying pedagogical approach for incorporating these features into an exercise book.

Should the trial be viewed as a success, the same approach will be taken with the subject's history and geography.



Splash page

The splash page acts as the introduction to the topic. Its purpose is to identify the term in which that specific unit is taught, to provide a strong visual image to prompt memory recall¹. Imagery is important as it can trigger a buried memory and recall a precise moment in time much more rapidly than words. The combination of images and words (**dual coding**) is to provide two different representations of the information, both visual and verbal, to help students understand the information better.²

Ryefield Primary School Science Autumn Term 1



Body Systems

How many chambers does the human heart have?	Answer
What are the three different types of blood vessels in your body called?	Answer
What does blood do?	Answer
Why is exercise important?	Answer
How does nutrition affect our brain and behaviour?	Answer
Why is water important in keeping our bodies healthy?	Answer



Pre-unit, post-unit and end of year assessments

*'The act of retrieval itself is thought to strengthen memory, making information more retrievable later.'*³

Both pre and post-unit assessments support pupils with retrieval practice. Retrieval practice involves reconstructing something you have learned about in the past from memory and thinking about it right now. In other words, a while after learning something by

¹ <https://www.theguardian.com/lifeandstyle/2016/dec/18/pictures-trigger-memories-faster-than-words-neuroscientist>

² <https://www.learningscientists.org/blog/2019/6/6-1#:~:text=Dual%20coding%20is%20combining%20words,students%20understand%20the%20informatio n%20better.&text=Dual%20coding%20is%20about%20more%20than%20just%20adding%20pictures.>

³ Weinstien, Y., Sumeracki, M., & Caviglioli, O. (2019), Understanding How We Learn, A Visual Guide. Routledge, 116-134

reading or hearing about it, if you bring the information to mind then you are practising retrieval. Roediger and Karpicke⁴ state that retrieval practice improves learning compared to re-reading the information.

How many chambers does the human heart have?	Answer
What are the three different types of blood vessels in your body called?	Answer
What does blood do?	Answer
Why is exercise important?	Answer
How does nutrition affect our brain and behaviour?	Answer
Why is water important in keeping our bodies healthy?	Answer

This means that when we bring information to mind from memory, we are changing that memory. According to Weinstein et al, this suggests that we are making the memory both more durable and flexible for future use.

In addition to these benefits, retrieval practice can also benefit learning indirectly. Retrieval practice can also support both summative and formative assessments, as retrieval practice gives pupils feedback on what they know and what they do not know. This provides both pupil and teacher with feedback on their understanding of the material.

Knowing what pupils know and what they do not know, in addition, can help educators allocate classroom time appropriately, or can help professionals, pupils and parents address areas of misconceptions.

The pre-unit assessments provide educators with information around pre-existing knowledge and potential misconceptions; this can be used to inform future planning. The retrieval practise undertaken in the pre-unit assessment also supports pupils in learning more from looking over the unit materials than they would have if they had not practised retrieval beforehand. This is called *test-potentiated learning*⁵, and this has the potential to add further value to an already valuable learning strategy.

⁴ Roediger, H. L., & Karpicke, J. D. (2006) Test-enhanced Learning: Taking memory tests improves long-term memory. *Psychological Science*, 17, 249-255

⁵ Arnold & McDermott (2013). Test-potentiated learning: Distinguishing between direct and indirect effects of testing. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 39, 940-945

Research has also shown that frequent quizzing in the classroom can reduce overall test anxiety⁶. The approach taken in this book means that frequent assessments or quizzes that are worth a smaller number of points, or no points at all, help to reduce the pressure to perform and alleviate test anxiety when the pupils do take higher-stake tests or exams.

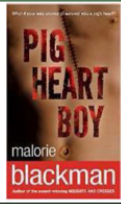
Retrieval practise tends to produce learning benefits after a delay. Pre, post and end of year assessments provide opportunities to embed longer-lasting and more durable learning.



Knowledge organisers

The purpose of a knowledge organiser is to provide pupils with accessible guidance about knowledge that they can study on their own to build a secure schema with a strong recall of the knowledge elements. They are intended as a summary, not a comprehensive, exhaustive list of all that should be known. However, they only serve a purpose if they are used effectively, and linked to retrieval techniques.

Animals including Humans: Circulatory System Knowledge Mat

Subject Specific Vocabulary		Interesting Book	Sticky Knowledge about the circulatory system
blood vessels	Blood vessels are a series of tubes inside your body. They move blood to and from your heart.		
drugs	A drug is a chemical that is not food and that affects your body. Some drugs are given to people by doctors to make them healthy.		<input type="checkbox"/> Your heart will beat about 115,000 times each day. Your heart pumps about 2,000 gallons of blood every day.
atria	The atria are the two upper most chambers of the heart. Blood is pushed from the atria to the ventricles.	<input type="checkbox"/> The entire trip around your body only takes blood about 20 seconds in total. Blood is what is used to transport oxygen, waste, nutrients, and more throughout the body.	
William Harvey	Was the first person to accurately describe the function of the heart and the circulation of blood around the body.	Important facts to know by the end of the circulatory system topic: <ul style="list-style-type: none">• Identify and name the main parts of the human circulatory system.• Know the function of the heart, blood vessels and blood.• know the impact of diet, exercise, drugs and life style on health.• Know the ways in which nutrients and water are transported in animals, including humans.• Know who William Harvey was.	
Cardiovascular	The blood circulatory system (cardiovascular system) delivers nutrients and oxygen to all cells in the body.		<input type="checkbox"/> The circulatory system includes the heart, blood vessels and blood, and is vital for fighting diseases and maintaining proper temperature.
ultrasound	An ultrasound machine uses sound waves to take pictures of the inside of the body.		<input type="checkbox"/> Because your heart is crucial to your survival, it's important to keep it healthy with a well-balanced diet and exercise, and avoid things that can damage it, like smoking.
cardiologists	A cardiologist is a doctor with special training and skill in finding, treating and preventing diseases of the heart and blood vessels.		<input type="checkbox"/> Your heart affects every part of your body. That also means that diet, lifestyle, and your emotional well-being can affect your heart.
capillaries	Capillaries are very thin blood vessels. They bring nutrients and oxygen to tissues and remove waste products.		
pulse	Your heart has to push so much blood through your body that you can feel a little thump in your arteries each time the heart beats		
ventricles	The ventricles are the two lower chambers in the heart.		

Where possible, the knowledge organisers have been designed to be 'quizzable'. The key information has been presented in such a way that supports self-quizzing. The useful features include:

- Tables with columns of related information allowing one or more columns to be covered.
- Bullet point lists of key ideas
- Sequences shown in flow diagrams
- Labelled and unlabelled diagrams
- Clear timelines

⁶ Smith, A.M., Floerke, V.A., & Thomas, A. K., (2016) Retrieval practice protects memory against acute stress. *Science*, 354, 1046-1048.

Strategies used by the teacher include:

Focussing on the specific element.

Typically knowledge organisers span much more information than can be quizzed on sensibly at any one time. Pupils can be directed to read specific elements in advance of any retrieval practice activities whilst highlighting how the section fits into the larger schema of knowledge. Teachers must use the quizzing process to build connections rather than isolating facts and ideas such that they lose meaning.

Read and Rehearse

Pupils read through their knowledge organiser and rehearse questions that are based on the content, whilst still looking at the organiser. This activity can be undertaken in pairs as well as individually. Paired work ensures that they go beyond merely staring at the information.

Close/Cover and Recall

This is an active step and pupils need to remove the information from view and then engage in a *generative recall process*: completing a table, listing the bullet points, adding labels to a diagram, placing ideas in the correct sequence and remembering definitions. Teachers can support this process using prompt questions, modelling the kind of questions students should be asking themselves when they self-quiz.

Check for accuracy

After a short generative recall process (see above), students should reveal the covered information to check the accuracy of their recall, in as much detail as possible. It can be useful to repeat both read & rehearse and close/cover in an iterative loop, filling in the gaps in knowledge and adding fluency each time the pupil feels that they can recall the information.

Over time, pupils should re-engage with the process with increasing time gaps after studying the topic.



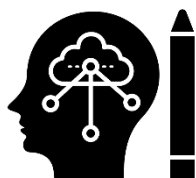
National curriculum statements,

Previous national curriculum statements are included to ensure that the planned content is unmissable and obvious. The key objectives will help teachers to orientate learners and remind them of the knowledge and understanding they are building upon.

Teachers may use these statements to assist in recapping and supporting pupils to consolidate prior learning. The statements also pertain to the current year and will act as a guide for both teachers, subject coordinators and school leaders, to ensure that the essential knowledge is presented to the pupils in a precise and relevant fashion.

National Curriculum	Living things: Body Systems
Year 5	describe the differences in the life cycles of a mammal, an amphibian, an insect and a bird
Year 5	describe the life process of reproduction in some plants and animals
Year 5	describe the changes as humans develop to old age
Year 6	describe how living things are classified into broad groups according to common observable characteristics and based on similarities and differences, including micro-organisms, plants and animals
Year 6	give reasons for classifying plants and animals based on specific characteristics
Year 6	identify and name the main parts of the human circulatory system, and describe the functions of the heart, blood vessels and blood
Year 6	recognise the impact of diet, exercise, drugs and lifestyle on the way their bodies function
Year 6	describe the ways in which nutrients and water are transported within animals, including humans

It is anticipated that this will also assist students with regards to improving their test potentiated learning (page 4). The national curriculum statements provide the students with oversight of the unit's content and how it either builds upon prior work or is an entirely new topic being introduced.



Mind maps,

Mind mapping is a technique that is used for generating, structuring, and presenting ideas and thoughts, as well as for studying and organizing new information. Mind mapping is a retrieval-based learning activity that requires students to bring information to mind: they can write and organise everything they know on a mind map. In addition, these can be scaffolded by the class teacher or completed in discussion and partnership with their peers. Scaffolding mind maps helps pupils to successfully retrieve information. Karpicke et al⁷ note that pupils

⁷ Karpicke, J. D., Blunt, J. R., Smith, M., A., & Karpicke, S., S. (2014) Retrieval based learning: The need for guided retrieval in elementary school children. *Journal of Applied Research in Memory and Cognition*, 3 198-206.

remembered much more information when they used the mind map to practice retrieval compared to just reading.

Mind maps are usually created around a specific concept or idea that are visually presented as a central key element. This particular topic, later on, branches out to present close relationships with a broad range of ideas. In mind mapping, it is possible to use **dual coding** (words, images, and symbols) so that an idea or a concept is better understood and memorised.

The technique of mind mapping is easy to understand and is great for practising, as it stimulates us to visually present numerous things. Their versatility means that teachers and students can use mind maps for personal and educational goals, individually or in a group.

One thing that makes mind mapping particularly useful are the benefits that it has for the memory process. Mind mapping can improve an individual's memory via the process of association and imagination.

Association and imagination⁸ can facilitate the generation and presentation of ideas. For example, when it comes to studying, students can use a particular word association to link it to new information. This way they will make the new material easy to remember. So, later on, when students would want to compose a mind map on a specific subject they studied, they will have the chance to use the association for a better presentation of the new knowledge.

By explaining how memory works and how it can be improved, it could be stated that memory and mind mapping have many things in common. Particularly, both association and imagination can be used when creating mind maps and improving the memory process. By including words, images, colours, and branches, the mind map helps the mapmaker to place information into their memory.



Images to prompt thinking,

At the start of a topic, a striking visual image is used to act as a prompt for discussion and generating questions. The starting points are often, 'What is this picture showing me? ', however, they are extended to 'How might it relate to the topic?'

Students may refer to any prior learning identified either on their mind maps, or within their knowledge organisers, and use this to extend their thinking. These discussions will often be facilitated by the class teacher; who will display a large colour version of the image on the classroom's interactive whiteboard.

⁸ <https://www.academictips.org/memory/assimloc.html>

What is this picture telling me?




Their purpose is to encourage students to access their prior learning, stimulate discussion and promote creative thinking. It is hoped that, through making connections with previous experiences and knowledge (that may sit outside of the topic), students broaden their schema of learning.



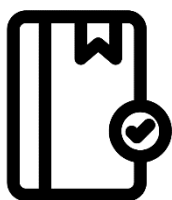
Show what you know boxes

The tables pictured below are seen throughout the exercise books.

 Show what you know. Recall two things on the topic.	Connect - can you link this to one more thing that you know.
1.	
2.	

They support both generative retrieval of information that will enable students to consolidate their learning and ensure that the retrieval process is spaced out throughout the unit. Ebbinghaus's⁹ '*forgetting curve*' shows that the brain places higher information on repeated information. Through spacing these tables throughout a topic, the frequent emphasis placed on the generative process of information retrieval seeks to improve a student's ability to retain subject-specific content.

⁹ Bedford, A., (2021) *Pupil Book Study: An evidence-informed guide to help quality assure the curriculum*, John Catt Publishing, p. 113.

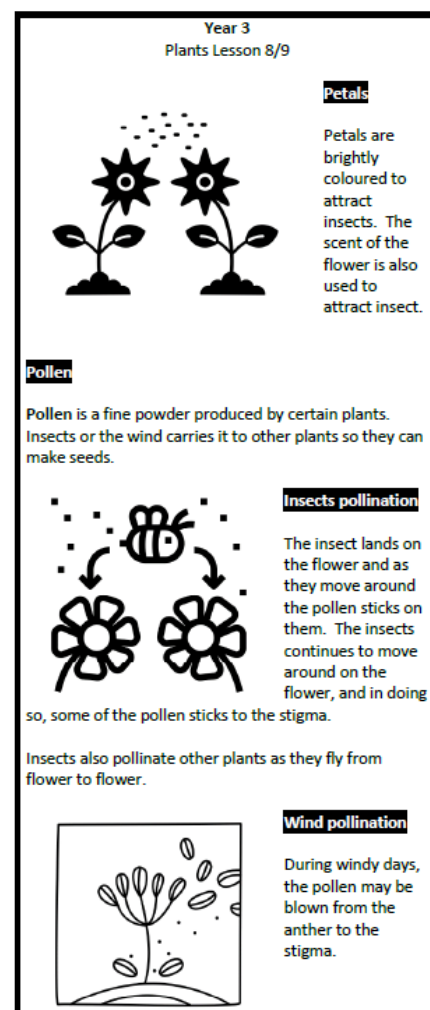


Knowledge Markers

Sweller's¹⁰ cognitive load theory dictates that individuals can only think about something once it has been brought to the attention of the working memory. Typically, Sweller asserts, the brain handles around 4-7 new pieces of information at once.

These resources seek to minimise the bottlenecking of a student's working memory. By employing **dual coding** (combining striking visuals with text), knowledge markers aim to reduce cognitive load by presenting either essential information, concepts, or key vocabulary to assist the learner in better understanding the topic.

The knowledge markers have also been designed to support pupils in their acquisition of Tier 2 and Tier 3 subject-specific vocabulary.



Conclusion

The school hopes that the use of bespoke subject books that are designed to promote generative information recall, test-potentiated learning, and seek to reduce cognitive load via dual coding and the use of knowledge markers, enhance the curriculum provision of science, the effect of teaching and the depth and retention and connection students make with their learning.

If deemed to be successful the school's intent and underlying pedagogical approach for incorporating these features into an exercise book will be expanded across other national curriculum subjects.

¹⁰ Bedford, A., (2021) *Pupil Book Study: An evidence-informed guide to help quality assure the curriculum*, John Catt Publishing, p. 107.