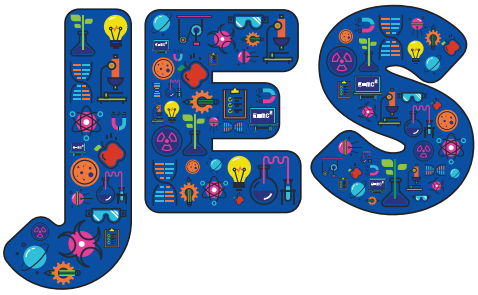
Using Explorify for retrieval practice: consolidating prior learning and supporting new learning



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Abstract

This article draws on research and ideas from cognitive psychology and cognitive science and explores a rationale for using Explorify activities to support the building of long-term memory. It describes the outcomes and recommendations from a small trial that explored the extent to which Explorify activities, which promote science discussion and the development of higher order thinking skills, can also be used effectively to support retrieval practice. Working with a group of seven teachers over a six-week period, the Explorify team at the Primary Science Teaching Trust (PSTT) curated and trialled a set of activities relating to the science of teeth, digestion and food chains. The participating teachers were given guidance about which Explorify activities could be used for the engagement, elicitation and introduction of ideas, and which provided opportunities for children to practise retrieving their knowledge. The teachers reported that incorporating Explorify activities in these different ways had a positive impact on children's recall of their learning. Their various experiences are shared and key factors for success are drawn from these. Finally, guidance is offered about how Explorify activities can be used more widely to support the development of long-term memory.

Keywords: Long-term memory, retrieval practice, Explorify, higher order thinking, discussion

Introduction

As teachers, we have all experienced blank looks from children when we mention something in a science lesson that we know they have been taught. This issue has also been highlighted in the Ofsted (2023) report *Finding the optimum,* where it was noted that *'Across primary and secondary schools, some pupils did not have sufficient opportunities to practise and consolidate what they learned before moving on to new content. This meant they did not remember key content taught previously'* (Main findings, Ofsted, 2023).

What can we do better to support the development of long-term memory in science? Earle and McMahon (2022) note that retrieval practice is one of the teaching and learning strategies to build long-term memory that is supported by cognitive science research. Coe (2019) provides an overview of this research; however, he points out that '*there is still a question mark about how effectively it can be incorporated by teachers into lessons*' (paragraph 1).

If we agree with Harlen (2010) that '*The goal of science education is not knowledge of a body of facts and theories but a progression towards key ideas which enable understanding of events and phenomena of relevance to students' lives'* (p.2), then fact-based quizzing should not be the only method that we use for retrieval practice. Indeed, Agarwal (2019) found that '*fact-based retrieval practice only increased fact learning, whereas higher order and mixed retrieval practice increased higher order learning*' (p.17). The results indicate that to consolidate learning for deeper knowledge, we need to provide opportunities for students to analyse and evaluate.

The Wellcome Trust report (CFE research, 2019) noted that over half of the primary-aged classes in their survey had under two hours of science curriculum time allocated per week. With this constraint on time,

it is difficult for teachers to justify spending time on retrieval practice when they are already finding that they don't have enough time to cover the science curriculum. The development of a time-efficient method for teachers to provide retrieval practice opportunities, where children can elaborate, reflect and be creative, could enable Harlen's vision of networks of connected ideas in science: *'the "small" ideas developed from studying particular topics build to form gradually "bigger" ideas'* (Harlen, 2010, p.11).

Rationale: why consider Explorify for retrieval practice?

The online resource Explorify (Figure 1) is designed to stimulate curiosity, discussion and debate. The activities were based on the research findings of the *Thinking, Doing, Talking Science* project (see weblink in reference list), which encourages children to use their higher order thinking skills: applying their knowledge in unfamiliar contexts requires children to evaluate, reflect and reason (EEF, 2016). External evaluations of Explorify (CFE Research, 2019, 2020) showed that it encouraged higher levels of participation in science discussions, with many teachers reporting increases in children's confidence to express their ideas in science.

When children are actively participating in science discussions, this gives teachers rich opportunities to make formative assessments. Using Explorify to elicit pupils' prior knowledge is recommended as an effective device for responsive teaching in the Teacher Assessment in Primary Science (TAPS) Pyramid Tool (see weblink in reference list), as it enables the teacher to plan an appropriate sequence of learning. It is also possible that, by providing a safe space for deep discussion, Explorify activities could offer opportunities for retrieval practice and review of prior learning. This small study set out to explore this possibility.

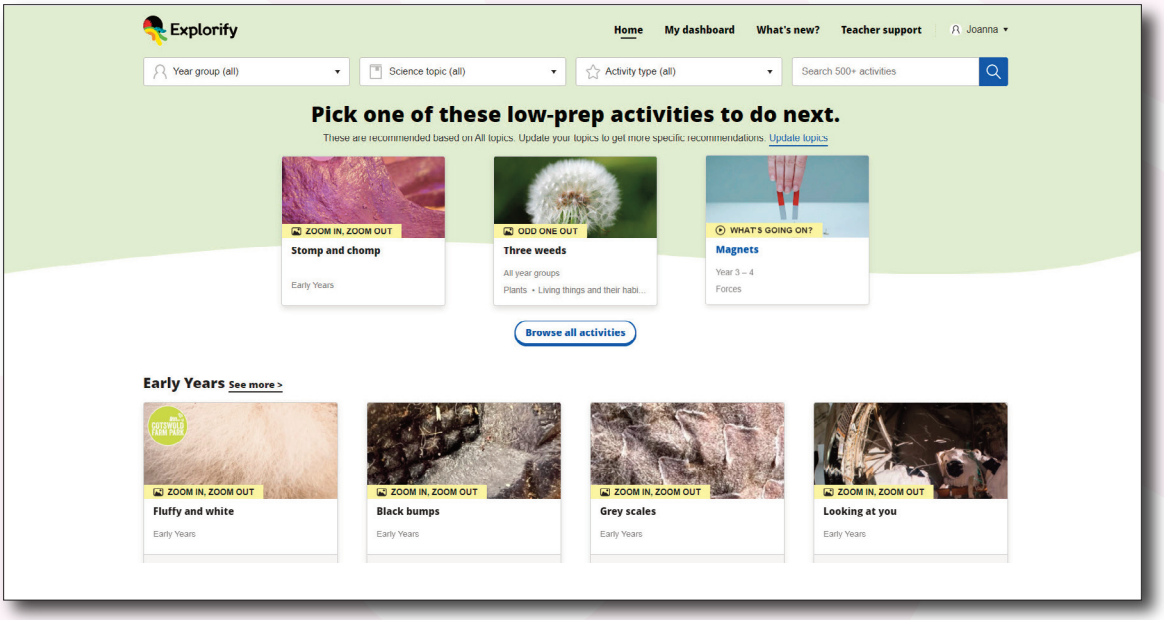


Figure 1. The web page for Explorify offers a completely free digital resource for teaching primary science: https://explorify.uk/

Applying cognitive psychology ideas to primary science

Shimamura's (2018) MARGE model suggests that important factors that promote the formation of long-term memories are **M**otivate, capture **A**ttention, **R**elate, **G**enerate and **E**valuate.

The Wellcome Trust (CFE Research, 2019, 2020) report that using Explorify positively affected children's **motivation** to learn by making science fun and engaging (Figure 2). The visuals, alongside the interactive nature of the activities, helped to capture and hold their **attention**.

Shimamura's third principle, **relate,** focuses on how *'learning is facilitated by finding similarities (comparing) and differences (contrasting) between new material and what you already know'* (p.23). Explorify's 'Odd One Out' activities clearly support this approach. By asking for similarities and differences between three images, they provide an opportunity for in-depth discussion and making connections between knowledge and ideas.

Shimamura explains: *'The generation effect is one of the most efficient ways of improving memory retention. When we **generate** information – such as telling someone about what we've heard or learned recently, we substantially improve our memory for that information'* (p.4). All Explorify activities are underpinned by partner/group talk where children talk about what they know and what they think. We suggest that this social construction of knowledge and opportunities for retelling supports the development of long-term memory, as well as children's science learning in general.

The final component, **evaluate,** requires higher order thinking. When using Explorify's 'Odd One Out' activities, after identifying similarities and differences, children are asked to use the differences to select their odd one out. The activities are designed so that there are good reasons for all the images to be selected. Because there is not only one correct answer, the stakes for children are lowered, increasing their **motivation** to participate.

Figure 2. Children need to be motivated and the activities must hold their attention.

McMahon *et al* (2021) have explored applying cognitive science principles to primary science teaching, and some of their conclusions about how to strengthen memory are pertinent to Explorify activities. They report that *'It seems that combining the two modes (speech and visuospatial) makes it easier to recall memories'* (p.9), which means that discussing pictures works well. The value of children thinking in science was also highlighted: *'We might think of retrieval practice as recapping or revisiting, but the crucial factor is that it is the pupil that does this and puts in the effort to retrieve the memory. It is not the same as the teacher repeating content or a pupil simply looking something up'* (p.7). In addition, they pointed out that children applying their knowledge in new contexts has value: *'There is something about the effort involved in retrieving the memory that strengthens it. Teachers can aim to provide many different contexts for retrieving memories to develop a range of connections with that memory, making it more useful and more meaningful'* (p.7). Explorify provides an easy way for teachers to deliver a variety of well thought-out contexts that are relevant to children's own lives.

Method to evaluate the impact of Explorify for retrieval practice

To assess the impact of the purposeful use of Explorify for retrieval practice, a group of teachers from across England, who were teaching the science unit 'Teeth, digestion and food chains' with children aged 8-9 years, volunteered to participate in a small-scale trial. They agreed to use at least 15 Explorify activities, eight of which were from a specified list, over six weeks in the autumn term 2022. The guide (Figure 3) allowed a flexible approach so that the Explorify activities could be fitted around the schools' existing schemes of work. Teachers who wanted support with subject knowledge, or guidance about activity ideas to underpin the key learning, were directed towards possible Explorify activities that provided help in the 'Background science' and 'Take it further' sections. To support the trial, thirteen new Explorify activities (mostly 'Odd One Out' activities) were designed and published.

Figure 3: Part of the guide for participating teachers (available on Explorify: https://explorify.uk/teacher-support/science-teaching-support/developing-long-term-memory).

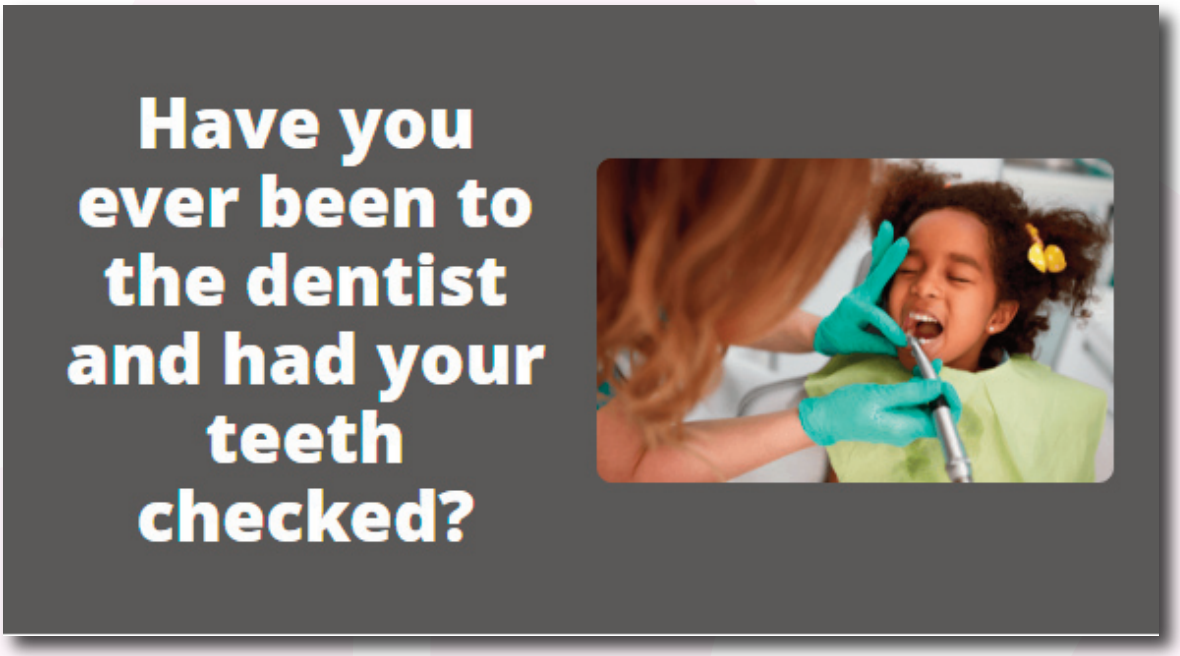
Explorify Guide: Improving long-term memory with embedded assessment and retrieval practice
Teeth, digestion and food chains

There is a guide to how to use this outline below the table.

Learning focus	Possible activities from Explorify (you can use your existing plans which cover the learning focus)	Elicit and engage	Deepening learning
Review previous learning	Assessment for learning techniques to help determine your starting point, generate displays of questions and review progress. You could include: Mind maps, vertical relay using body outlines, Explore, engage, extend activities, KWL grids. **Key questions:** *What do you already know about the digestive system?* *How should we care for our teeth?* *Can you sort these animals into carnivores, omnivores and herbivores?* *Can you complete a food chain?* *What's your favourite animal, is it a predator or prey (or both)?*	It takes more than guts Pearly tips Hot-steppers Say cheese Hunter and hunted	
Functions of different teeth	Big question Why do we have different teeth? Use the **activities in the Take it further and watch the videos.**	Have you ever been to the dentist and had your teeth checked?	**Bite, rip, mash** We had no teeth? You had teeth like a snake? Hidden away
Understanding tooth decay by carrying out an investigation	Use the **CIEC resources** recommended in **Take it further** of: What's going on? Disappearing eggshells	Sparkling smiles This is a mystery bag activity where you add objects linked to teeth hygiene.	What if toothbrushes didn't exist?
Plan and carry out a comparative test	Testing the impact of different drinks on our teeth. Disappearing eggshells has the		Healthy drinks

There was a clear distinction between the Explorify activities that could be used for the engagement, elicitation and introduction of ideas, and those that provided opportunities for children to practise retrieving their knowledge. Those in the first category supported Assessment for Learning (AfL), helping teachers to assess the children's knowledge and vocabulary, including what had been retained from previous science units (Figure 4).

Figure 4. An example of an Explorify activity suitable for engagement and elicitation of children's ideas.



It was suggested that the Explorify activities for retrieval practice could be used at a variety of times, including: at the beginning of the lesson after a new concept had been taught; later in the week; further into the unit; or even after the unit. Teachers could use them within their science lessons and/or whenever they had a spare 15 minutes during the school week.

The teachers were asked to complete a questionnaire at the end of the trial giving feedback on the impact that it had on their teaching and the children's learning. One of the questions that they were specifically asked was to compare the use of Explorify activities for retrieval practice with other strategies that they used.

Findings from the teacher trial

All the responding teachers agreed that increasing their use of Explorify had a positive effect on consolidating children's long-term memory. Even though all the teachers had already been using Explorify, 85% of them reported that participating in the trial had changed their practice. Teacher comments included:

'It has made me think more carefully about the activities I use and how effective they are in consolidating the facts.'

'I used them at more points within the unit of work and at different points within the lesson. In the past, I simply used them as discussion starters.'

'I now use it more as it is a good way to challenge/get children to start thinking and discussing.'

Teachers also valued that, because the Explorify activities only took 15 minutes, it helped deal with the challenge of the time constraints that they faced. The activities do not have to be done as part of the science lesson, but can be fitted in before lunch or at the end of the day, as well as during science lessons.

Common strategies that the teachers were often already using in the classroom to revisit and recap learning included questioning, discussion and information organisers. Less frequently, teachers also used quizzes, true/false statements or cloze texts. When asked to compare these strategies with using Explorify activities, teachers rated Explorify activities as either equally or more effective for building long-term memory.

Their comments provided further insights:

'It gives children a spark which then creates an interest and then the children remember more of their learning.'

'You delve deeper. The discussion allows a depth of knowledge to show.'

'The visual imagery is powerful and the lack of "words" makes it accessible to all.'

Which activities worked well for retrieval practice?

When asked to select the most useful activities for retrieval practice, a wide variety were mentioned. For example, 'Bite, rip, mash' (Figure 5) provoked this response:
'Children were discussing which type of teeth would be needed to eat the different foods...and also which groups of animals would eat them, herbivores, carnivores or omnivores.'

As anticipated, 'Odd One Out' activities in general were considered helpful:
'The odd one out activities really stuck in the children's mind as they helped to build knowledge, but the children were then also able to build on previous knowledge.'

Figure 5. An 'Odd One Out' activity that was created for retrieval practice.

'Hidden Depths', a 'Zoom In, Zoom Out' activity showing an X-ray of a child's jaw, was also identified as effective for consolidating children's knowledge about teeth. This unusual context '*hooked them straight away*' and stimulated rich discussion about the form and function of different tooth types. 'What if we had no teeth?' was another activity that *'really sparked a lot of conversation and discussion'* and got children thinking creatively, applying their knowledge of the functions of teeth as *'they discussed blending food, mushing it up or drinking through straws'*.

'Disappearing eggshells', a 'What's Going On?' video, models what happens when teeth come into contact with acid. Teachers explained that they were able to use it to provide scaffolding for children to design their own investigations: *'We tested the effect of different drinks'.* Links to real life were capitalised upon by

asking children to give *'advice about what drinks a teacher should give to her child'*. Some teachers felt that this activity also helped consolidate children's understanding of tooth decay. One class conducted their investigations first and then *'used the activity to further explain the science behind it'.* Another teacher noted that *'the results of the experiment had been imprinted on their brains!'* These findings resonate with research by McMahon *et al* (2021), who describe how structured enquiry can provoke elaborations and stimulate children to ask meaningful questions.

Reflections on key factors to create activities suitable for retrieval practice

This trial only involved a small number of teachers and focused on one science unit, but it does suggest that Explorify-style activities can support teachers to deepen children's learning. If teachers want to select 'Odd One Out' activities, or make their own, to support retrieval practice across the science curriculum they need to ensure:

- that the images are relevant to the knowledge and understanding that you want the children to revisit and will stimulate recall;
- a low-stakes environment so that children can focus on their reasoning without fear of being wrong;
- that it is neither too obvious nor too hard for children to work out, and that it offers several reasons why each image could be the 'Odd One Out';
- that there is a new and interesting context;
- that there are opportunities to reinforce vocabulary; and
- that it is relevant to the real-world and/or their own experiences.

Ofsted (2023) states that *'In many schools, retrieval practice only went as far as asking pupils to remember facts in isolation, usually through short quizzes. It was rarely used to support pupils to develop interconnected knowledge, for example by asking them to compare their knowledge of related but different concepts'* (paragraph 111). Explorify activities encourage children to make connections between different areas of science precisely because of the quality and breadth of the discussion that they encourage.

There is a 30-minute professional development video (see reference list) on Explorify's website designed to introduce the approach to teachers and to make suggestions about how they can select Explorify activities to support deepening learning. Teachers have responded positively and requested similar guidance for other science topics. This is something that the Explorify team has added to their work programme.

Acknowledgements

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