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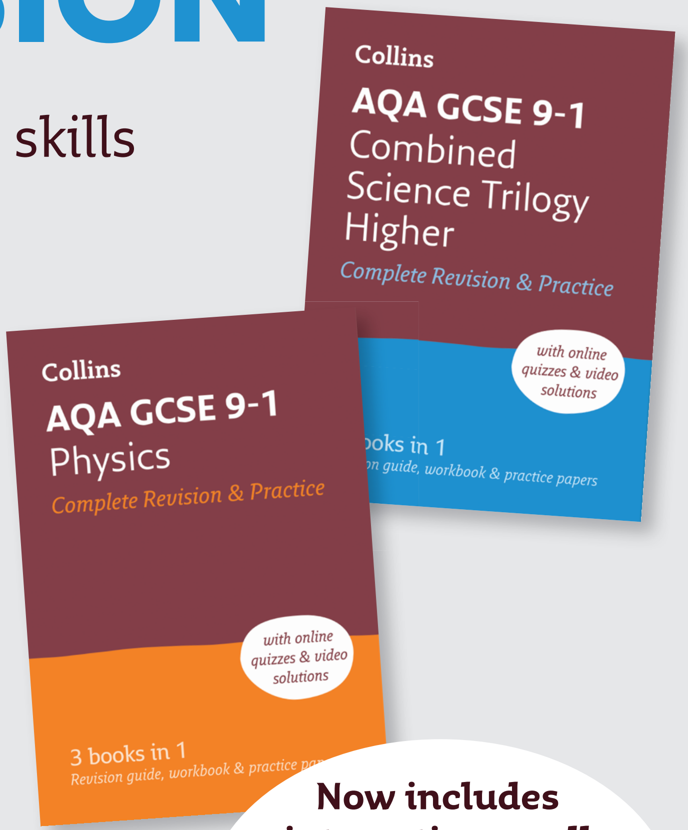

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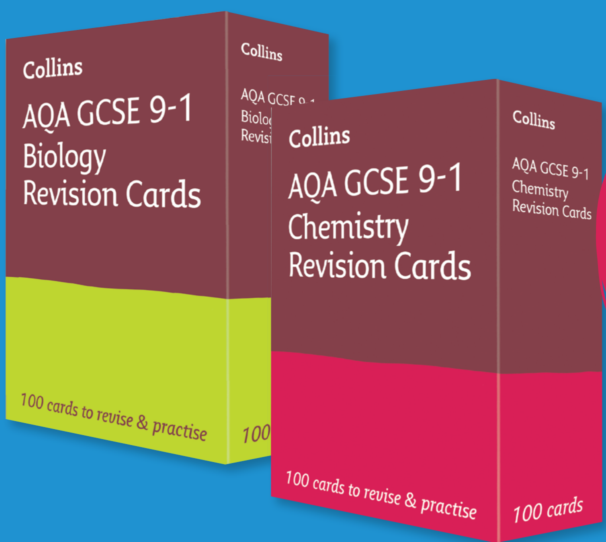

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Practitioner case studies

Andrew Chandler-Grevatt, Chair of the ASE 11–19 Committee, introduces two practitioner case studies

Science teachers are often implementing new ideas based on research evidence and making 'internal' professional reflections on how they work for them and their students. These case studies capture those implementations and professional reflections.

These professionally reviewed case studies, written by practising teachers, are small scale, context-dependent and not generalisable. However, they do offer a starting point for readers to address a similar issue in their own practice. Below are some guiding questions for readers.

Professional reflections

- What have you learnt from reading the case study?
- Is this an issue you have in your own context?
- Is the change suggested adaptable to your context?

Critical reflections

- What are the strengths and limitations of this case study?
- How was the evidence base used?
- What else would you want to find out before following up this case study?

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Would you like to see your own case study published?

If you are interested in submitting a case study proposal (please note that we cannot accept a complete case study without first receiving a proposal), then please visit https://forms.gle/tSo33t85UtRRuCVJ9

All accepted case study authors will be given the opportunity to work with a writing mentor and be provided with detailed guidance. Below, please find an abbreviated version of the structure of a typical case study.

Title	This just needs to be a short title we can use to identify the case study. e.g. Whole-class feedback, Word maps, Exam wrappers, etc.
Author name	
Author biography	
Author email and Twitter	
The issue	200–300 words Introduce the issue you faced and cite the evidence upon which the solution is based.
Context	100 words See recently published case study examples.
Approach	200 words Make it very clear to the reader what you did.
Findings	200 words This is based on professional reflection. They are findings you found in this case. You cannot make generalisations, but you can make claims in this context. Identify 2–3 key findings to present. Can be supported by an image of a pupils' work. Good examples make a claim and back it with evidence from the context.
Reflections and next steps	200 words Take the opportunity to refer back to the evidence base that you used as a solution. How did it work out? Raise any issues or concerns you had or have about the approach. State specific next steps you will take individually, as a department or even wider.
References	Only essential ones. Typically only needed if you quote from a published work.

Using episodic cueing in the science classroom

Charlotte Parker discusses how long-term memory is now seen as an important component of learning

With the introduction of the Core Content Framework (CCF) to initial teacher education in England (DfE, 2019), long-term memory is now seen as an important component of learning. The CCF describes long-term memory as a '*store of knowledge that changes as pupils learn by integrating new ideas with existing knowledge*', and it is our view that this could be perceived as presenting long-term memory as a unitary and undynamic system, which is far from the case (Renoult *et al.*, 2019). Long-term memory is multifaceted as shown in Figure 1.

We can see from Figure 1 that the CCF description of long-term memory appears to be only concerned with the semantic memory system. However, it is clear that despite being able to find distinctive differences between episodic and semantic memory in terms of behavioural outcomes, on a neurological level, these memory systems have shared and overlapping neural networks (Renoult *et al.*, 2019). Given the potential interplay between these memory systems, particularly in the early formation of memory, we investigated whether the use of 'episodic cues' would improve the retrieval of knowledge within the classroom, and whether students found the cues both interesting and useful. An episodic cue is defined here as a 'deliberate prompt' based on a context and/or event that is linked to specific information that is to be retrieved. Cued recall has been shown to support the retrieval of information, with studies demonstrating improved student test performance where cues are episodic in nature (Moreira *et al.,* 2010). In this inquiry, we were interested in ascertaining whether the nature and familiarity of the episodic cue influenced the ability of the students to retrieve information.

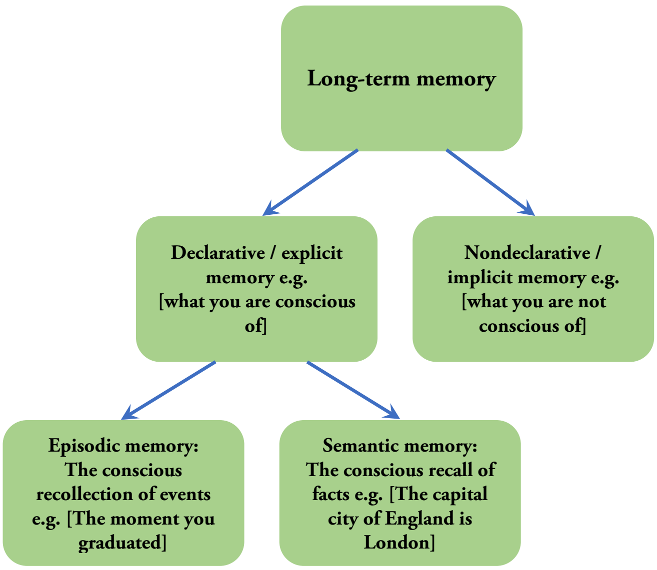


Figure 1 The relationship between the different facets of memory (Renoult *et. al.*, 2019)

Background

This classroom-based inquiry was undertaken as part of a PGCE secondary science course at the University of Bedfordshire. The inquiry was conducted in a mixed secondary school in Bedfordshire with a year 10 (ages 14–15) triple science GCSE chemistry class who were learning about rates of reactions.

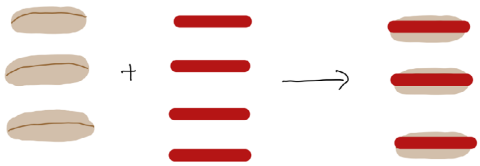
Description

Over the course of five lessons, episodic cues were presented and linked to an introductory explanation of a new concept. Each new concept was linked to a different episodic cue, which was then referred back to when students were presented with retrieval practice material, usually a starter activity in the next lesson. The cues were also referred to throughout lessons when students were required to recall from or build on prior learning and needed to retrieve specific knowledge, rather than prompting or cueing the knowledge directly. A range of different types of cues was tried to ascertain whether the nature of the cue had any effect. However, all the cues were designed to be related to real-life scenarios. The concepts and the episodic cues used are outlined in Table 1.

Outcomes

Overall, we found that the use of episodic cues did support the retrieval of the specific information linked to the cue; however, some episodic cues were more successful than others. In particular, the luminol cue was found to generate the best retrieval and application of knowledge during the lessons where the cue was used. For example, when the luminol cue was reintroduced in subsequent lessons, students were able to provide answers to questions relating to factors affecting the rates of reaction, and then transfer their knowledge to graphical representations of reaction rates at different temperatures.

Table 1 Episodic cues in context of their use

Concept	Analogy	Episodic cue
Rates of reaction	Students shown pictures of luminol being used in forensic science to show the presence of blood.	This was later linked to a discussion about the factors affecting the rates of reaction. Again this cue was used in the next lesson to prompt students on what factors may affect the rate of reaction.
Concentration	Students were shown a demonstration of the dilution of orange squash. 	This was then linked to particle theory and concentration. Questioning included 'Do you remember the really strong orange squash? Did this have higher or lower concentration?'
Limiting reagent	An analogy of making hotdogs, supported with a picture, was used where the number of complete hotdogs produced was limited by the number of buns. 	This analogy was used to prompt students on whether chemicals in problems presented after the analogy were sausages or buns, were they in excess or limiting?

The orange squash cue was found to be less successful since many students would refer to the 'orange squash lesson' rather than make the direct link to the concept of concentration, which seemed to interfere with their retrieval of the required knowledge.

Unfamiliar examples as cues, such as the luminol one, seem to facilitate better knowledge recall, perhaps because the novel stimulus can't interfere with prior knowledge, which the orange squash example could have done.

From anonymous surveys, 19 out of 26 students found the episodic cues useful in the retrieval of information. One student commented that the cues helped to '*refresh my memory*' and another commented on the luminol cue directly, saying it was '*cool to know how our learning is used in real life*'. When asked if they found the episodic cues interesting, 25 out of 26 responses were positive.

Reflections and next steps

Overall, there are mixed findings, and this inquiry has given us a good starting point with an insight into the types of episodic cues that may be effective. In practice, the addition of cues involved minimal extra preparation work for the teacher, with the seemingly higher reward of students having increased recall when prompted. We would like to explore using more novel situations as cues and create so-called 'epiphanic events' to link knowledge to (Bates and Connolly, 2019). We are also interested in investigating the use of these cues over a longer period of time and seek to ascertain how best to 'fade out' their use so that the knowledge is retrieved freely and in the absence of the cue in the long term.

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Encouraging questioning

Victoria Wong discusses how encouraging students to think scientifically by asking scientific questions improved engagement and increased confidence

The issue

Scientists ask questions. According to Osborne (2011), questioning is one of eight practices of science. However, in science classrooms it is often the teacher who asks the questions, with few lessons prioritising students behaving as scientists and asking questions themselves (Chin and Osborne, 2008). This might be because teachers are nervous about being asked questions they cannot answer, do not want to be asked questions that deviate from the lesson objectives or simply because they do not see it as important.

The ASPIRES research (see *Weblinks*) found that some students do not see science as 'for them', which makes engagement with science difficult (Godec, King and Archer, 2017). They argue that this lack of engagement is an issue of social justice for two reasons. First, that all students, including traditionally underrepresented groups, should be able to engage with science as it can be a route to social mobility. Second, scientific advances mean that scientific literacy is important for people to be able to engage as citizens with current issues.

The ASPIRES team argues that one way teachers can support students to engage in the classroom is to broaden what counts as science, recognising and valuing a wider range of experiences, skills and behaviours as legitimate, worthwhile and 'scientific' (Godec *et al.*, 2017). Curiosity and questioning are key practices of science, so to encourage this type of thinking is not only appropriate from a social justice standpoint but also because being curious and asking questions is to be enacting an authentic scientific practice.

Context

Following on from two years of education disrupted by the COVID-19 pandemic, many of my students had very low self-belief, knowing that they had not engaged with online lessons and feeling they were lacking in science knowledge. Questioning them about their science knowledge would discourage them even before we covered any new content. I wanted a way to build my students up, to improve their self-confidence and to help them believe that science was for them. Inspired by the ASPIRES work, I decided to focus on encouraging them to be curious and to ask questions.

This case study focuses on the approach that I took with my year 8 (age 12–13) and 9 (age 13–14) mixed-prior-attainment science classes in a non-selective state school in Oxfordshire.

Approach

When I set my classroom expectations at the start of the year, I was explicit that I valued questions and reiterated regularly that asking questions and being curious was 'thinking scientifically' or 'thinking like a scientist'. I thanked students for each question and valued asking questions as much or more than I did answering questions that I had posed, using verbal praise and the school reward system of merits and postcards.

I tried where possible to set up a new topic with an activity or prompt to encourage curiosity. For example, testing the properties of sugar and salt (melting and conductivity of a solution) and asking students to write questions about what they found to start a bonding topic.

For some questions asked I would be able to tell students they would be able to answer them themselves by the end of the lesson. I would put the question on the board to ensure we came back to it and sometimes used it as our plenary. If a question related better to a future lesson then I would note it and remind the class of both the question and questioner in the appropriate lesson.

Findings

Students (anonymised) responded very positively to being encouraged to ask questions. For example, rewarding Alex, who found science difficult, for 'thinking like a scientist' or for the 'scientific thinking that led to that great question' led to them being more engaged with lessons, keen to take part and willing to try harder and challenge tasks. Basing a whole lesson on a question from Kit, who would not normally be considered successful in science, showed that their contributions were worthwhile and led to greater engagement for weeks after 'their' lesson. Ali struggles with concentration and focus. During the electricity topic, I allowed them to use the practical kit to explore questions they had asked, which led to them explaining ideas far beyond the lesson objectives to their peers. Charlie asked questions that went well beyond the content we were covering, which led to some in-depth discussions of science, often with them rather than the whole class.

Overall, students were so much more engaged that, although I had not set out to improve 'behaviour', both students and other members of staff commented that challenging year 8 and year 9 classes were far calmer and more productive than they were in many other lessons.

Box 1 Strategies to encourage student questions, drawn from my work

- Be explicit that questions are valued.
- Provide opportunities for students to ask questions.
- Explicitly link questioning with being a scientist.
- Discuss questions scientists asked that led to discoveries or new theories.
- Praise thinking and curiosity, not just knowledge, in class discussions.
- Reward questioning using school systems, including parents' evenings and reports.
- Use a student question as the basis of a plenary or whole lesson.
- Finish a practical task with writing questions rather than conclusions.
- Show interesting photographs and images on the walls and at the start of lessons.
- Have a short practical task (e.g. how many drops of water fit on a 2p coin) and then encourage students to think about questions that could be investigated.

Reflections and next steps

My aim was to improve the confidence of students and to broaden what counted as worthwhile in science so that all students felt their contributions were valued. I wanted my classroom practice to promote social justice by helping students to see science as 'for them'. I think it was so successful because it was, and felt, authentic. I regularly talked about questions that scientists have asked (as Chin and Osborne (2008) suggest), and questioning as something scientists do, so that when I praised students for thinking scientifically or acting like a scientist when they asked questions, they accepted it as genuine rather than forced or patronising.

In other words, broadening what counted as science in the classroom, as called for by Godec *et al.* (2017), meant recognising and foregrounding a practice that is genuinely scientific and can be engaged in by students even if they do not have a great deal of background knowledge. An unforeseen benefit was that students became more willing to ask for help when they did not understand, because they were asking questions and asking questions had been set up in the classroom as being scientific and valued.

In summary, encouraging questioning from students required small changes to planning and some flexibility and adaptability during lessons. The increase in student engagement was ample reward for the effort required.

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Weblinks

ASPIRES research: www.ucl.ac.uk/ioe/departments-and-centres/departments/education-practice-and-society/aspires-research

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