Learning to learn: Using evidence to enhance knowledge retention and improve outcomes

Like all secondary schools nationwide, we awaited the unveiling of the new linear GCSE and A-level qualifications with a mixture of emotions. Whilst looking forward to updating the curriculum, we were very alert to the challenges that they promised in terms of increased content and rigour, and the challenges for students as they would need to revise a much greater quantity of material for one exam season. We needed to look very carefully at how we empowered students to successfully revise material so that they could retain what they had learned in lessons throughout their new courses. This has coincided with our drive to embed evidence-informed teaching and learning across the school, and so it was logical to look in depth at evidence in the area of knowledge retention. Key concepts that we have found particularly helpful include Cognitive Load Theory, spacing, interleaving, elaboration and retrieval practice. Drawing together research evidence culminated in the creation of the 'Memory Clock', which was used to convey clear messages about how to relearn material effectively to students and parents.

Cognitive Load Theory

In January 2017, Dylan Wiliam commented on Twitter: 'I've come to the conclusion Sweller's "Cognitive Load Theory" is the single most important thing for teachers to know'. This would seem to be a reliable recommendation! Cognitive Load Theory (CLT) examines three types of cognitive loads that students face when learning new material: intrinsic, extraneous and germane. This theory has clear implications for teacher instruction; if new material can be presented carefully and in line with Sweller's research, teachers can reduce the intrinsic and extraneous loads on students, leaving as much room as possible in the working memory for the germane load – the effort taken to learn material more securely.

A feature discussed within the CLT literature concerns the knowledge that students possess already. If students have already learnt facts and information related to a new topic being taught, they don't need to use precious working memory capacity considering them; they can just recall and use them whenever needed (Chandler and Sweller, 2009). This then frees up capacity for the student to consider the new material and task at hand, enabling learning to take place more readily. Therefore, to maximise the chance of learning new material, students' knowledge of past topics should be committed to their long-term memory. This had implications for teaching new linear courses; not only would retaining knowledge of already-taught topics support students to be more successful come exam time, but this knowledge could also enable new topics to be understood and learnt more readily.

Teachers in our school were therefore keen to identify how they could effectively support students to commit topics to their long-term memory. The concepts of spacing, interleaving, elaboration and retrieval practice were helpful in this respect.

Organising revision: Spacing and interleaving

Cramming is an approach to revising that is familiar to many teachers. Cramming involves revising an entire topic all at once, shortly before a test – and, for some students, just the night before. Whilst this may be effective in the short term, with the end of a modular exam system at GCSE and A-level, a more effective and sustainable approach to revision was needed for students to tackle linear exams successfully. Spacing, also known as distributed practice, has been found to be a more effective approach to cramming (Roediger and Pyc, 2012). This involves students spreading out their revision over a long period of time – little and often – rather than intensely revising all at once. Even if it feels frustrating for students to forget, it's actually helpful in the learning process.

A related concept is interleaving. Interleaving is the process of revising several topics concurrently, rather than revising one topic at a time, and recognises the limits of studying one topic for too long. Critically, it has been found that whilst cramming may be effective for short-term retention, students who interleave when revising are able to retain their knowledge over the longer term (Rohrer, 2012); (Brown et al., 2014).

Revision techniques: Elaboration and retrieval practice

Some approaches to revision are more effective than others, and it was important to us that we were able to communicate these to our students. Passive revision activities such as rereading and highlighting have been found to be less effective than those that require more thinking (Dunlosky, 2013). Elaboration is a revision technique that involves students asking questions about the topic they're studying and making connections with other topics; essentially, if students think about the topic, they are more likely to learn it.

Retrieval practice emerges from the literature as a critical technique for successful revision; deliberately recalling information enhances and boosts learning, as it forces us to examine what we know (and don't know). This was a key strategy used in classrooms across many subjects in our school. In the form of regular low- or no-stakes quizzing – on paper or online – students were being supported to learn to remember more effectively. According to research, the use of practice tests can have both direct and indirect positive impacts on student learning (Dunlosky, 2013). For example, correct retrieval can have a direct effect on

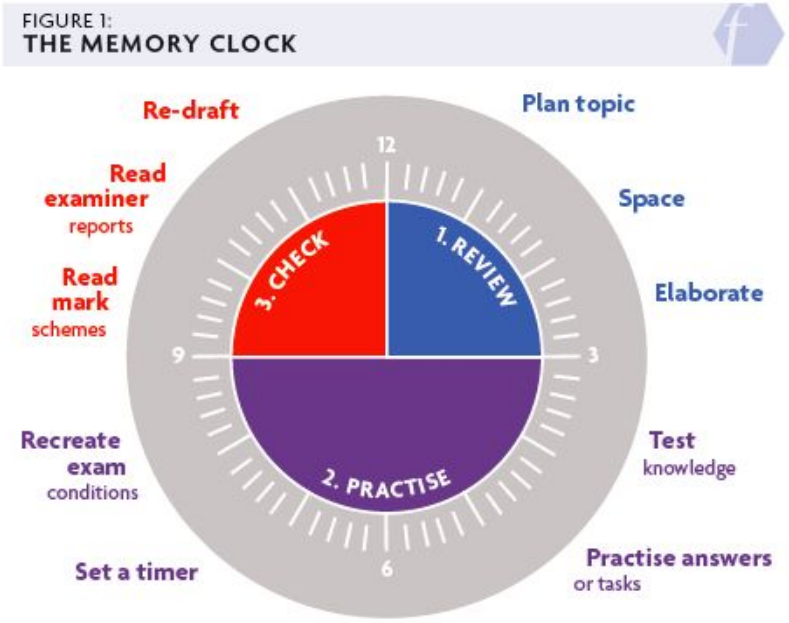
memory but, equally, failure to correctly retrieve information can indicate that a topic needs to be restudied.

Translating theory into practice: The Memory Clock

The evidence-based approaches to organising and carrying out revision outlined above have been used by individual teachers and departments, and were seen to be making a positive difference to the knowledge retention of students in exam classes. However, there was a need to embed key messages and strategies across all departments and empower students and parents to understand the evidence and use suggested strategies. With cramming and highlighting well established in many students' revision routines, this was going to be a challenge. The Memory Clock was developed to help with this wider level of communication and understanding.

The idea is captured in Figure 1 and illustrates how a student could spend an hour of their time when revising (and could be applied to any time period). It aims to highlight the fact that more than 'reviewing' is needed if students are to have the best chance of committing their subjects to memory. Hence, we split our clock into three parts: review, practice and checking activities, which aimed to translate the evidence about spacing, interleaving, elaborating and retrieval practice into a coherent approach.

FIGURE 1:
THE MEMORY CLOCK



The first part of the clock focuses on the process of reviewing what needs to be learned. Planning is important to ensure that students have time to cover all topics, and this includes the consideration of spacing out and interleaving revision, rather than mass-revising topics. Communicating the importance of elaborative techniques rather than passive activities such as highlighting was critical in our context, given how many of our students were content to simply reread and highlight notes. We deliberately made this section of the clock short – 15 minutes out of a one-hour period as a guide – as we had observed students revising by only reviewing the material to be learned, rather than moving on to test themselves.

We termed the next phase of the Memory Clock 'practise', which covers low-stakes quizzes and self-testing using cue cards through to the completion of practice exam questions. Testing oneself can be an uncomfortable experience; the feeling of not knowing something immediately can be demoralising. However, what we know from the evidence is that testing – i.e. engaging in retrieval practice – actually supports learning and does so more effectively than most other techniques. As such, we devoted the majority of our Memory Clock to this in order to underscore its importance to our students.

Finally, we prompted students to check their work. The checking stage highlights the need to check the correct answers after testing oneself, which supports learning and identifies mistakes or misconceptions that, if unchecked, could set in (McConnell and Hunt, 2007).

Evaluating the impact

The Memory Clock has been used across most subjects and has been communicated to all students in Years 10 to 13 since 2016/17. Multiple specific subject example models of the memory have been developed by teachers to help students to pick out appropriate activities for each section. Changes in student behaviour are evident. Students have been engaging in revision activities earlier in the school year and are more regularly seen writing out flashcards rather than relying on their highlighters. Furthermore, feedback from student surveys indicates a growing awareness and use of more effective study activities.

Despite excellent exam results in the summer of 2017, where our students achieved levels of progress unmatched by previous cohorts, we're keen to evaluate the effect of the Memory Clock more rigorously. A member of our school's Professional Learning team has successfully applied to carry out a school-based random control trial (RCT) with the Educational Development Trust and the Wellcome Trust. The outcomes of this trial will enable us to consider the efficacy of how we have tried to translate the research on effective revision into a tangible model for students.

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