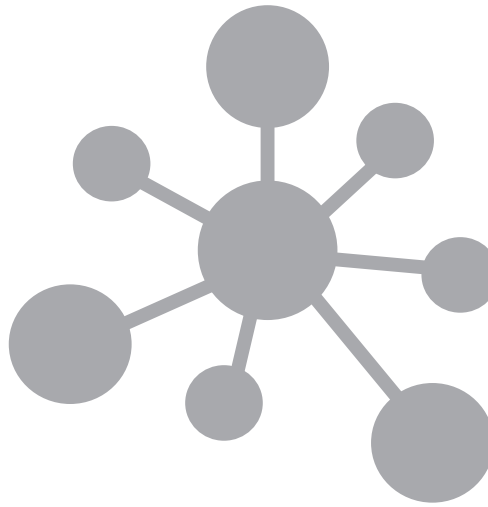

Test-enhanced learning

A practical guide to improving academic outcomes for all students

Kristian Still
Edited by Pete Henshaw

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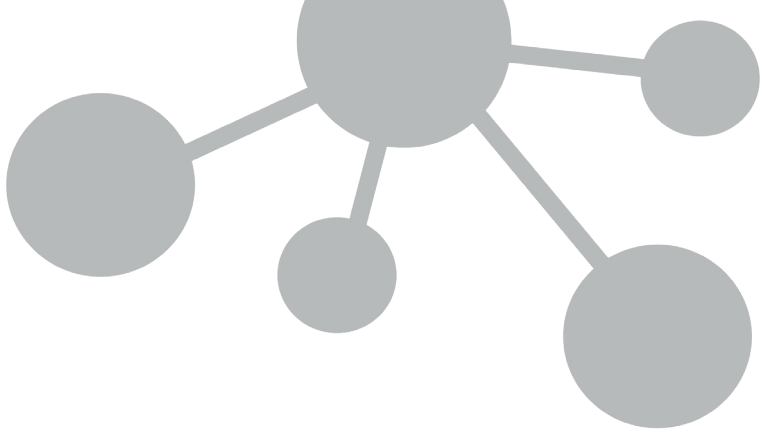

Introduction

It all began with Othello

In December 2021, in an article for secondary education magazine *SecEd*, I made the case that despite the 'wealth of evidence' (Agarwal et al., 2021: 1438) about the 'reliable advantage' (Yang et al., 2021: 299) of test-enhanced learning – more commonly referred to as the testing effect or retrieval practice – it is actually far more complicated than it is often presented as being and that 'retrieval practice alone is not enough' (Still, 2021). In that article, I argued that retrieval practice offered 'more than just improved memorisation skills and securing long-term learning', and encouraged teachers to exploit unsupervised, personalised spaced retrieval practice and to leverage the wider indirect benefits of testing. I argued towards adopting a set of learning principles or test-enhanced learning.

Feedback from that article led to a series of further articles in the same organ; the series then led to this book. In *Test-Enhanced Learning*, I will first explore the wealth of research, report the direct and indirect benefits of test-enhanced learning and review the ingredients of test-enhanced learning (i.e. cognition, repeated retrieval practice, spaced learning, interleaving, feedback and elaboration, successive relearning, metacognition and motivation), both inside and – just as importantly – outside the classroom. A review that ultimately points to the inherent inefficiencies of learning and the potential gains of personalisation. This review of the research (both laboratory and applied) is tied with my efforts to employ test-enhanced learning in my own classroom and with other teachers around the world.

Second, I outline my efforts to make personalised spaced retrieval practice available to teachers, educators and learners through RememberMore. This has three connected component parts. First, classroom.remembermore.app is an open and free web portal for creating bespoke classroom quizzes for teaching, retrieval and self-study in seconds (yes, seconds!). RememberMore.app is a digital flashcard system that boosts learning and reduces teacher workload. Importantly, it adopts confidence-based assessment to personalise spaced retrieval practice, thereby increasing retrieval gains. It also enables both teachers and learners to categorise and tag knowledge, providing a structure to organise knowledge and support interleaving. Finally, RememberMore includes a 'dashboard' that presents learner and flashcard insights via a graphical user interface to help inform teachers, teaching and learning. It is also the platform to quiz your understanding and the knowledge acquired in reading this book. Where would a book about test-enhanced learning be without a quiz about it?

Context is king

You may be expecting this introduction to start with an outline of what inspired me to dedicate most of my professional learning to investigating test-enhanced learning. However, my interest in this area of research started out with me simply trying to find a solution to what my pupils needed most at that time, which was being able to access knowledge to better understand the texts being taught in class. With clearly observable impact on pupil attainment and classroom culture, that interest led to reviewing the research more critically, connecting with researchers, while road-testing and iterating my own classroom practice. Finally, after three years' intensive work, I was asked to write this practical guide to improving academic outcomes for all pupils.

For context, I was returning to England from overseas after the new academic year had started. I was joining an oversubscribed, inclusive comprehensive secondary school with a pupil intake that reflects a wonderfully diverse and vibrant local community, in the third week of term as a full-time teacher of English (my second subject, having studied sports science (BSc) and kinesiology (MSEd)). I felt remarkably like I did when I started my teaching career. It was a school with a strong moral purpose, principled leadership, and defined and embedded school values: challenge, creativity, commitment, cooperation and courtesy.

Even with 20-plus years of teaching experience (eight years as a head teacher and senior leader), I knew that I would still need time to establish myself in a new school, and I didn't have all that much time to prepare – I was due to start teaching the following day.

Prior to meeting the classes, I put together a basic class profile (names, photos, prior attainment data and background), reviewed the long-term curriculum plan and schemes of work, and read the school's behaviour policy. The classes I would be teaching were predominantly low prior attaining, and a number of pupils had accumulated higher than average negative behaviour points. Just for good measure, I was (we were) nomadic – teaching in various classrooms throughout the school over the teaching week.

Following just a handful of lessons, the challenge was clear. The curriculum was rightly ambitious. I was new to the school and 'we' needed time to establish a positive classroom climate (made all the more difficult by often arriving to class at the same time as the pupils) and learning routines. In addition, it was evident that many of the pupils would benefit from experiencing success in lessons, as too many were more focused on what they couldn't do than what they could.

That first Friday evening, I was late home having made a lot of positive phone calls home and quite a few phone calls to introduce myself to parents/carers. A worthwhile investment, even with a busy weekend ahead of me.

With the unit outline already stuck in the front of the pupils' exercise books, I hurriedly built a basic knowledge organiser that defined and shared with pupils the substantive knowledge and explicit vocabulary from the scheme of learning that I expected them to learn. The process of building the knowledge organiser was as much for my professional learning as it was for the pupils, having not taught the assigned texts previously. I asked the pupils to add this to the back of their exercise books, as both a reference document and a tool for self-assessment.

I originally introduced a low-stakes retrieval practice (testing/quizzing) lesson starter routine (with self-assessed marking) as a practical solution to managing the chaotic arriving-at-the-same-time lesson starts – and to give me the opportunity to log in to the teacher's computer, take the register and set up the upcoming lesson. Equally, I was very aware of the wider benefits of test-enhanced learning – and the 'high utility' of both retrieval practice

and spaced or distributed practice more specifically[1] – but this was as much about managing the learning as it was about leading it.

Early reflections

Was it easy? No. Did the pupils thrive on the low-stakes retrieval practice starters? Not at first. (We will discover that there is much more to test-enhanced learning than low-stakes retrieval practice starters.) What I can immediately share with you, however, is that pupils are more receptive to 'quiz' and 'quizzing' than they are to 'tests' and 'testing', that 'retrieval practice' doesn't mean all that much to them at all, and that pupils know little about how they learn or the difference between performance and learning, and would much prefer to adopt more familiar learning strategies or none at all.

The truth is that the pupils found it hard, effortful and, with only nominal reward in the opening half a dozen or so lessons, a little deflating. I would have to be honest and say that the pupils were not entirely convinced. I would later learn that I had not only missed a critical step, but I was also missing a lot of the knowledge and know-how that we will cover in this book. We will come back to this in detail later.

For now, I knew *why* we were investing in these high-utility, evidence-informed practices and the wider benefits of test-enhanced learning, but just the teacher knowing why is insufficient. Nor is it just the doing that matters, but *how well* you are doing it. *How you know how well* you are doing it is equally important. Still, as I will outline, there is more to consider beyond retrieval and distribution or, for that matter, the spacing of test-enhanced learning. The good news is that you will be much better informed than I was.

1 According to Dunlosky et al. (2013), 'high utility' refers to the generalisable benefits across learning conditions, pupil characteristics, materials and criterion tasks.

Coming up for air

By the end of the first term (12 weeks, or 60 or so lessons later), I had started to earn the pupils' trust and routines were more established (if arriving at the same time as the pupils ever gets much easier). Together, we had travelled through the 'valley of disappointment' (Clear, 2018: 20) – that is, the period of investment where teachers and pupils feel discouraged, having put in hours of effortful practice and experienced nominal results, preceding accelerated benefits. I had also gained some important practical pedagogical insights on the use of quizzing: on the benefits of every pupil having a directed focus and working independently through a routined lesson starter quiz, the style of questions or cues that were most effective, the breadth of questions to cover, how many questions to set, whether to report or not report scores, the use of timers, how to transition to teaching the lesson, the potency of relearning, and the importance of self-assessment and low-stakes routines generally.

Perhaps most importantly, the pupils could now reference tangible learning gains for themselves – directly in what they knew and could remember and in their improved end-of-unit assessment grade, and indirectly in how they felt about themselves as successful learners and how they approached their learning. (We will explore the direct and indirect benefits of test-enhanced learning throughout the book.) The end-of-term pupil feedback review responses were largely positive too. Pupils reported a growing confidence and 'security' in lessons, and on reflection, a wider group of pupils were now contributing to class and we were all benefiting from the routined start to lessons. We have to remember that these were particular pupils who were largely indifferent to their learning – or shall we say bruised by their experiences of English teaching, possibly of education generally.

Outside of class, I leant heavily of the knowledge and expertise of my department colleagues, and I continued to read research journals and the blogs of practising educators like Blake Harvard (@effortfuleduktr and theeffortfuleductor.com). I paid closer attention when guests on the Mr Barton Maths Podcast (www.mrbartonmaths.com/podcast) or Ollie Lovell's Education Research Reading Room Podcast (www.ollielovell.com/errr) mentioned memory, cognition or retrieval practice. The research clearly supported the performance gains of test-enhanced learning, of the testing effect and of retrieval practice, and it also signalled the benefits of spaced or distributed practice and interleaving (all covered in depth in later chapters of this book). What I rarely encountered was research connecting with metacognition, motivation and, given the speed of digital adoption at this

time, personalisation (where learning is adapted to meet the needs of each learner).

The last point, personalisation, irked me. The fabulous work of Professor Graham Nuthall in *The Hidden Lives of Learners* (2007) (the only education book I have read three times) remained ever constant in my thoughts when reading the broader test-enhanced learning research.[2]

> ***Our research has found that students already know, on average, about 50% of what a teacher intends his or her students to learn through a curriculum unit or topic. But that 50% is not evenly distributed. Different students will know different things, and all of them will know only about 15% of what the teacher wants them to know.***
>
> ***Nuthall (2007: 35)***

I knew that, for all its benefits, the quizzing routines I was teaching were still being presented *to the entire class* – questions to many pupils and questions fishing for a correct response. Yet, what Nuthall kept on emphasising was that learning is highly individual and we need to ensure that new knowledge firmly connects to and integrates with previous knowledge, which is difficult, at best, when each pupil has unique prior knowledge. By the end of this book this will sound all too familiar. Was personalisation a potential solution to Nuthall's research observations 13 years later and to classroom questioning ineffectiveness and inefficiency?

In search of a personalised solution

In search of a more personalised (sometimes referred to as adaptive) quizzing or retrieval practice solution, I kissed quite a few frogs before settling on perhaps one of the most accessible flashcard platforms – AnkiApp (*Anki* is Japanese for memorisation). First, of course, as a digital solution, distributed or spaced practice came baked into the software. Second, it also meant pupils had access to the anywhere-anytime learning to which we have become accustomed. (Hold that thought!) My account showed that I had first used Anki in 2017, some three years previously. I also seemed to recall that Daisy Christodoulou – the author of *Seven Myths About Education*

2 For a short overview of Nuthall's work, see Jan Tishauser's (2019) *researchED* article or Tom Sherrington's (2020) helpful blog post.

(2013) and other education titles, former head of assessment at Ark Schools and now director of education at No More Marking – was an Anki fan, and used the app to try and prevent forgetting what she had read.[3] So started a mini research enquiry to investigate the suitability of Anki to support personalised spaced retrieval practice as a core component of my teaching.

With a full term under my belt, come January 2020 I would be faced with the additional challenge of teaching Shakespeare's *Othello*. This would be the teaching experience that became the driving *motivation* for the design and development of RememberMore, the digital flashcard system I mentioned back at the start.

Why knowledge is essential for learning

Having attended more than a handful of Professor Paul Kirschner's presentations, read his papers and books, and listened to him interviewed on various podcasts, it would be impossible not to be influenced by his eloquent expertise and infectious enthusiasm. Rarely does he fail to reference the work of American psychologist David Ausubel and that 'the most influential factor for learning new things is what the learner already knows'; prior knowledge to you and me. According to Ausubel, new things that we want or need to learn must be connected to what we already know. Kirschner (2022) hits the nail squarely and firmly on the head when he says: 'The more you know, the better you learn and the more you learn, the easier it gets!' If your pupils do not have the basic 'hooks', or relevant prior knowledge, to which to attach more complex information, they will very quickly find themselves adrift in the lesson.

Back to teaching and the introduction of *Othello*. Here was a multicultural, all-boy Year 8 class with very little to no prior knowledge of Shakespeare or Elizabethan England, or the issues encapsulated by the play, and even less motivation to study it. Although a good number of pupils see value in their learning and some may seek clarification or your help, some may do nothing, at ease with being adrift, while others may seek to derail the learning to mask their sense of vulnerability and avoid further academic bruising. Without some basic background knowledge of the play and Elizabethan England, much like the protagonist Othello himself, the class were going to be in for a tough learning experience.

3 'I love Anki! Planning to blog more about it soon …' (Christodoulou, 2022).

Take two – the spring term

I had the substantive knowledge prepped on a knowledge organiser and on hand within Anki, making knowledge available to pupils both in and out of the classroom. I may not have realised it back then, but it was unwise not to take account of both metacognition and motivation when teaching – and inconceivable when employing test-enhanced learning. That is why there are three chapters in this book dedicated to these important components of learning, too often passed by in general conversation around retrieval practice.

As before, the course outline was stuck in the front of the pupils' exercise books and the knowledge organiser in the back. In addition, we had a deck of flashcards available via Anki for quizzing in and out of class. We were now building on an emerging metacognitive belief that quizzing, test-enhanced learning and retrieval practice worked for these pupils, both directly and indirectly.

You see, when I set out on this 'edventure' (if Shakespeare can make up words, I would like to think we all can) with these academically bruised Year 8 pupils, I hadn't explicitly told the learners *why* or *how* quizzing worked, that retrieval practice was not the easy option and that the learning benefits are often deferred, if durable and demonstrable. Educating the pupils about cognition, and about test-enhanced learning, was the critical missed step I highlighted previously. (How to go about this will also be covered in more detail in the book via the work of McDaniel and Einstein (2020) and others invested in this process.) At least the second time around, in the spring term, I was better prepared and the pupils were more receptive based on their knowledge, informed beliefs, deepening commitment and personal successes. More pupils were starting to focus on what they could do and what they had done than what they couldn't.

So, every Friday after break, the pupils would wheel around the laptop trolley and we would invest in personalised spaced retrieval sessions as provided by the Anki platform.[4] The pupils were hugely positive about these Friday sessions, describing the learning as 'recapping lessons' and the lessons as 'quite relaxing'. The lessons were relaxed and calm yet purposeful – and why wouldn't they be, given the personalised nature of the learning? Remember, these were pupils who had accumulated higher than average negative behaviour points, turning up towards the end of break time to set

4 All documented at https://www.kristianstill.co.uk/wordpress/tag/anki.

up the laptops and leading their own personalised learning. Even the head teacher offered a slightly perplexed yet supportive glance after scanning our unlikely Shakespeare scholars hard at work while on one of his many tours of the school. The pupils' agency was palpable.

What's more, a good handful of the class downloaded AnkiApp onto their mobile devices, and some logged in to their web accounts at home and reviewed cards outside of class. Self-paced learning and then 'knowing stuff' in class appeared to be attractive to these boys. However, without them showing me, I had no way of knowing what flashcards they had quizzed and how successful they had been, as Anki lacked an administration dashboard and learner metrics.

Fast-forward to a second term (a further 12 weeks, or 60 or so lessons). Apart from the obvious tribulations of booking the laptop trolley, finding out who had the key last, wheeling it down the corridor during busy break times and racing to get 30 laptops packed away again, the class had become huge fans of Lucian Msamati's Iago (in the Royal Shakespeare Company's 2015 production), if not Shakespeare's writing.

They knew 'stuff' about the context of the play and about the character of Iago. They were rarely short of an opinion. But they now had access to knowledge and vocabulary to think with, to evidence and extend these opinions. They also had the confidence to engage with lessons. In this way, our four other lessons – and class climate – benefited immeasurably too.

In summarising Willingham's (2007) paper 'Critical thinking: why is it so hard to teach?', Mccrea (2019: 17) offers: 'As our knowledge becomes deeper and more comprehensive, our capacity for critical thinking, problem solving and creativity within that domain emerges.' Underpinning knowledge underpins thinking. This made me reflect on the commentary of world-renowned Canadian computer scientist Professor Yoshua Bengio. Known for his pioneering work in artificial intelligence and deep learning, Bengio speaks of 'productive thought' – that only once you have all the information, only after you have filled your mind with a problem, can you 'really start seeing through things and getting things to stand together, and solidly, and now you can you can extend science right now'.[5] The pupils were now able to 'think productively', and their writing had started to showcase it.

Towards the end of the term, one of these Year 8 boys told me: 'I found it easier to feel comfortable in class and not feel pressured or underprepared

5 See https://www.youtube.com/watch?v=d1qA8vvpZZk&t=4229s.

when a question is asked.' As in the previous term, I had noticed greater participation in lessons (particularly from some of the less likely class contributors), but perhaps these were the first hints that personalisation had a lot to offer pupil motivation, agency and self-efficacy, as well as knowing stuff. I just didn't recognise at that point that success precedes motivation, that test-enhanced learning could most certainly be designed to lower the failure rate and promote success, whereas self-directed personalisation almost completely removed the external threat of public class failure.

In addition to Shakespeare's *Othello*, pupils had opinions and feature requests for Anki too!

What next?

I would love to tell you that it was solely the pupils' end-of-unit assessment grades that convinced me to invest the next two years in developing a personalised spaced retrieval practice solution for teachers, educators and pupils. Of course, pupil outcomes are important. However, it was the climate shift in the classroom that accompanied the deployment of test-enhanced learning and personalised spaced retrieval practice (in and out of the classroom) that was most convincing: improved attention in class and pupil confidence, fewer distractions, better note-taking, far more robust class discussions and improved punctuality. I would even go as far as testifying to a deepened commitment to learning.

There are gains for the teacher, too, many highlighted by the teachers who have contributed case studies to this book, not least that building a deck of retrieval flashcards *is* professional learning, and organises and consolidates your own understanding of the content. Access to pre-planned and tagged questions at any point in the lesson is super-helpful, and the lesson-by-lesson benefits of routined and direct (with a little 'd') instruction make a teacher's life more manageable and more enjoyable. Experiencing a very busy end of term, including two parents' evenings, year group data captures and college applications for his Year 11 tutor group, teacher Ben Windsor reflected:

> ***I must say, having a 5-lesson day and parents' evening, RememberMore as my DIN [do it now] has helped massively to pace myself and claw back some cognitive space.***

Yet, Anki was not going to be the long-term solution, with its lack of an administration dashboard and learner metrics, and the numerous pupil feature requests. The search was back on.

Far more complicated

I continued to read and apply the research when, in early 2020, I stumbled upon Dr Katherine Rawson's earlier research on successive relearning. Add that to the perpetual Nuthall itch, the issue of personalisation (being able to pose the right question to the right pupil at the right time), my own and shared teaching experiences and a growing interest in test-enhanced learning research (which is a significant body of work), and I started to realise that there was more to test-enhanced learning than retrieval practice alone. That, at times, as educators, we oversimplify things to make them more accessible.

My interest in test-enhanced learning has always been about all learners having access to more knowledge, so they can engage and explore lessons more broadly and deeply and achieve better academic outcomes, but it has become so much more. It became an iterative investigation on how to create a successful and secure classroom climate, to seek teaching effectiveness and learning efficiency at the same time as reducing teacher workload.

Together with Alex Warren, a full-time senior software developer, I embarked on a project to design, build and iterate a digital flashcard system to boost learning and reduce teacher workload. A system that supported quizzing in classrooms and offered personalised spaced retrieval practice. A system that reported usable learner metrics and teaching insights with which to inform teaching. A system co-designed with pupils and with the support of a host of teachers, school leaders, applied cognitive psychologists and data scientists. We launched the RememberMore app in September 2021, making personalised, spaced, interleaved retrieval practice available to any teacher who wants to leverage the benefits of test-enhanced learning for their pupils.

Test-enhanced learning

Explores the wealth of evidence behind and the benefits of test-enhanced learning, spaced retrieval practice and personalisation.

This exceptional book details the most up-to-date research into improving learning and retention. It takes us on a journey into test-enhanced learning, spaced retrieval practice, motivation, metacognition and personalisation. In so doing, it provides a blueprint for all teachers and schools to enable them to improve the academic outcomes of their students and to achieve this in ways that improve the motivation of learners and reduce the workload for teachers.

The book is supported by the free Remembermore app which uses digital flashcards as an aid to delivering the learning gains of personalised, spaced retrieval practice, providing teachers with insights into the effectiveness of their own teaching. It also contains a number of practical case studies from teachers who have used these techniques and the app to produce great results in their schools.

Suitable for all teachers in all settings.

I highly recommend this book and consider it to be a launch of a new era in which context and techniques are intelligently integrated.

Oliver Caviglioli, co-author of the Teaching WalkThrus books

An extraordinarily well-researched guide to support teachers as they practically employ retrieval through quizzes, self-tests and other memory-stimulating activities.

Margaret A. Lee, educator, consultant, co-author of *Mindsets for Parents*

A fascinating exploration of the testing effect in practice. Finely balancing research and case studies, it will provide food for thought for any teacher or school leader interested in learning more about this important subject.

Kieran Mackle, teacher, author, host of the *Thinking Deeply about Primary Education* podcast

Test-Enhanced Learning is illuminating, informative, applicable and actionable for teachers in all aspects of their job.

Dr Kerensa Ogbe, Assistant Head for Teaching and Learning, Clifton College

A book that is accessible to both new and long-time enthusiasts of the science of learning.

Zach Groshell, PhD, instructional coach and teacher, blogger, author, host of the *Progressively Incorrect* podcast

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